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Gulf Region

Canadian Science Advisory Secretariat
Science Advisory Report 2024/037

# SOUTHERN GULF OF ST. LAWRENCE, NAFO DIVISION 4T, SEA SCALLOP (*PLACOPECTEN MAGELLANICUS*) STOCK ASSESSMENT TO 2023

## CONTEXT

The Fisheries and Harbour Management Branch of Fisheries and Oceans Canada (DFO) has requested a stock and fishery assessment for the southern Gulf of St. Lawrence (sGSL) (Northwest Atlantic Fisheries Organization (NAFO) 4T) Sea Scallop (*Placopecten magellanicus*). This stock is prescribed under section 6 of the *Fisheries Act*. This Science Advisory Report is from the regional peer review of March 27-28, 2024 on the Southern Gulf of St. Lawrence, NAFO Division 4T, Sea Scallop (*Placopecten magellanicus*) Stock Status to 2023. 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 exploitable biomass estimate of the southern Gulf of St. Lawrence (sGSL) Sea Scallop stock is in the Critical Zone of the Precautionary Approach (PA) Framework and has a very high (greater than 99%) probability of being in the Critical Zone.

### Trends

- Initial biomass of the sGSL Sea Scallop stock was high (~4,000 tonnes of meat weight, t) prior to the onset of commercial fishing and rapidly declined below the limit reference point (LRP) over a period of approximately 10 years; biomass has remained stable below the LRP since 1982.
- Biomass estimates have shown a slight increase toward the LRP in the last three years (2021-2023).
- Recruit numbers peaked in 2021 for the survey time series (2019-2023).
- Clapper index (proxy of natural mortality) has also been increasing in recent years.

### Ecosystem and Climate Change Considerations

- Because Sea Scallops are mostly sedentary molluscs, the sGSL Sea Scallop stock is susceptible to climate change stressors.
- Sea Scallops are vulnerable to temperatures exceeding 21 °C. Maximum summer bottom temperatures in the Northumberland Strait have increased steadily since 1995. The number of days exceeding 21 °C per year has also been increasing.

## Stock Advice

- The estimated biomass of the sGSL *Sea Scallop* stock dropped below the LRP in 1982 and has remained there since.
- Stock projections are not available.

# BASIS FOR ASSESSMENT

## Assessment Details

### Year assessment Approach was Approved

Data-limited population models were reviewed and a biomass dynamics model (JABBA model) was selected as the assessment method in 2023 (Harbicht et al. 2024).

### Assessment Type

Full Assessment

### Most Recent Assessment Date

Last Full Assessment: 2018 (DFO 2019, Niles et al. 2021)

### Assessment Approach

1. Broad category: Data-limited
2. Specific category: Data-limited model (JABBA)

## Stock Structure Assumption

The core area represents the core Sea Scallop habitat in the sGSL and encompasses the entirety of Scallop Fishing Areas (SFAs) 22 and 24, which is where 94% of fishery landings occur; these two SFAs encompass the three main scallop beds (Cape Tormentine, West Point, and Pictou). It is assumed that managing the core area at or above sustainable levels benefits the overall scallop population within the sGSL. One Limit Reference Point (LRP) has been developed for the core area stock.

## Reference Points

- Limit Reference Point (LRP):
  - $0.4B_{MSY}$ estimated to be 571 t (Harbicht et al. 2024).
- Upper Stock Reference (USR): Not defined.
- Removal Reference (RR): Not defined.
- Target (TRP): Not defined.

## Data

- Catches from commercial landings/sales slips: 1923-2023.
- Catch per unit effort (CPUE): commercial landings/active boats, 1976-2023.
  - Effort from sales slips and fishery logbooks.
- Sea Scallop research survey: 2019-2023.

- Clapper index, biomass index, recruitment index, condition.

- Sea Scallop condition at-wharf sampling: 2021-2023.

## ASSESSMENT

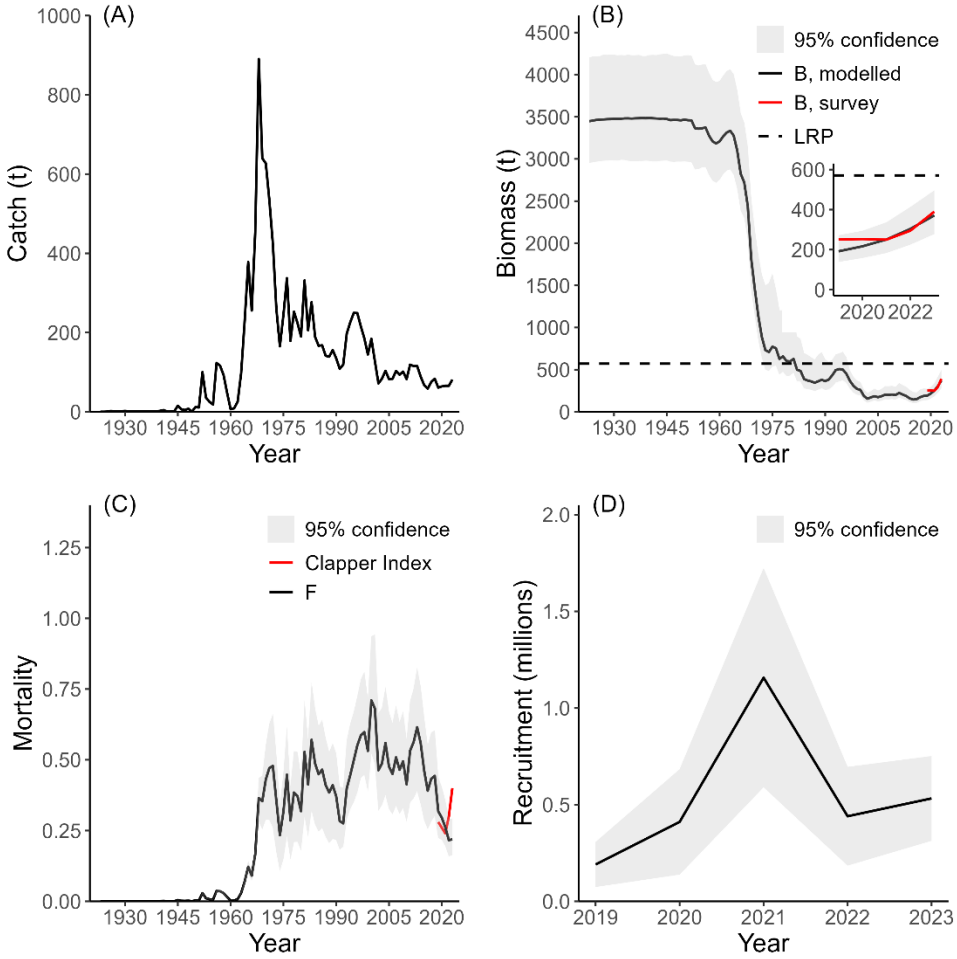


*Figure 1. (A) Sea Scallop landings in tonnes of meat, (B) Exploitable biomass, 95% confidence interval, and Limit Reference Point ($0.4B_{MSY}$) as predicted by the JABBA model. The Biomass index estimated from the research survey is in red and the inset represents the most recent 5 years, (C) Fishing mortality and 95% confidence interval estimated by the JABBA model along with the Clapper proportion index (proxy of natural mortality) from the research survey, (D) Recruitment index in millions of scallops from the research survey and 95% confidence interval.*

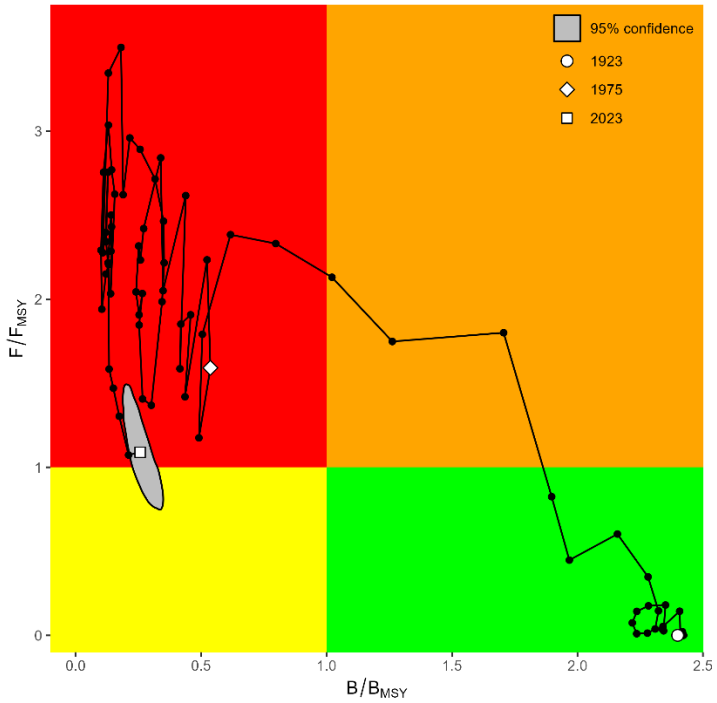


*Figure 2. A Kobe plot of relative fishing mortality as a function of relative biomass estimated by a JABBA model fit to Sea Scallop landings and effort data from 1923 to 2023. This model estimates $B_{MSY}$ at 1428 tonnes while $F_{MSY}$ is estimated to be 0.201.*

## Historical and Recent Stock Trajectory and Trends

### Abundance

The fishery independent survey provided abundance indices of commercial size Sea Scallop (shell height greater than 80 mm) with an increasing trend from 16 million in 2019 to 30 million in 2023 in the core area of the sGSL.

### Biomass

According to the updated JABBA model, using commercial catch and CPUE up to 2023, as well as research survey biomass indices, biomass levels have been relatively constant around 250 t since the late 1990s to 2021 when the levels begin to increase, reaching 412 t by 2023 (Figure 1B).

The survey exploitable biomass index within the core area of the sGSL remained relatively stable at approximately 250 t of meat, throughout the period from 2019 to 2021. A slight increase in the last two years has been observed, reaching 390 t in 2023 (Figure 1B).

The commercial fishery CPUE averaged 6.64 kg $h^{-1}$ (2017−2023) and reached a peak of 9.39 kg $h^{-1}$ in 2023 in the core area. This peak is thought to be, in part, due to an increase in abundance that was observed in the 2022-2023 survey data for two of the major scallop beds (i.e., Cape Tormentine and Pictou) as well as high condition observed during the SFA 22 fishery.

### Density

The density of commercial Sea Scallops (number per $m^2$) from the research survey has increased from 0.012 scallops per $m^2$ to 0.026 scallops per $m^2$ between 2019 and 2023 for the scallop beds of the sGSL.

### Removal Rate

The fishing mortality rates from the JABBA model were <0.01 from 1923 to the early 1950s, increased to a peak of 0.71 in 2000, and then decreased to the current estimated level of 0.22 in 2023 (Figure 1C). The exploitation rates (percent of the estimated exploitable biomass that was reported in landings) estimated from the research survey for the core area of the sGSL decreased from 25% to 21% between 2019 and 2023.

### Natural Mortality

An index of natural mortality from the research survey (2019-2023), based on the proportion of clappers to total scallops with shell heights greater than 80 mm, ranged from 0.15 to 0.40 and showed an increasing trend over the last three years (Figure 1C).

### Recruitment

The recruitment index (number of scallops of shell height 65-79 mm) in the core area beds of the sGSL, based on the research survey (2019-2023), was lowest in 2019 at 0.19 million, peaked at almost 1.2 million in 2021 and then stabilized at 0.44-0.53 million in 2022 and 2023 (Figure 1D).

## History of Landings

First recorded landings were in the early 1900s and peak landings of 900 t occurred in 1968. Landings sharply declined to less than 250 t over the subsequent six years and continued to steadily decline until 1982. Landings have since remained ~100 t and preliminary landings were 80 t in 2023 in the core area of the sGSL (Figure 1A). Fishing effort has substantially varied over this period.

Commercial catch rates for the core area from 2017-2023 averaged 6.6 kg of meat $h^{-1}$ (8.09 kg $h^{-1}$ and 5.24 kg $h^{-1}$ for SFA 22 and 24, respectively), higher than the 2003-2016 rates reported in the previous assessment (DFO 2019). In fact, catch rates in 2023 were the highest in the entire time series (2003-2023).

*Table 1. Landings from commercial logbook for Scallop Fishing Areas 21, 22 and 24 and core area (SFA 22 and 24) and total southern Gulf of Saint Lawrence from 2017-2023. Note that landings for 2023 are preliminary.*

| | Landings (t) | | | | Total |
|---|---|---|---|---|---|
| Year | 21 | 22 | 24 | Core | |
| **2017** | 7 | 50 | 24 | 74 | 83 |
| **2018** | 6 | 62 | 22 | 84 | 91 |
| **2019** | 4 | 42 | 20 | 62 | 66 |
| **2020** | 5 | 37 | 28 | 65 | 71 |
| **2021** | 3 | 34 | 30 | 64 | 67 |
| **2022** | 3 | 36 | 30 | 66 | 69 |
| **2023** | 3 | 49 | 30 | 80 | 83 |

### Ecosystem and Climate Change Considerations

Sea Scallops become physiologically stressed above 18 °C and temperatures exceeding 21 °C can be lethal (Dickie 1958). Warmer sea water temperatures may already be impacting scallop stocks in the core area of the sGSL (i.e., the Northumberland Strait) and may further impact these stocks in the future as the climate continues to warm. In recent years (2007−2021), maximum bottom temperatures above 21 °C were recorded in at least 20 days in the Northumberland Strait. Sea Scallops are also sensitive to other climate change related processes such as ocean acidification, with acidification having negative effects on scallop physiology and growth; however, direct climate change research on sGSL stocks is lacking. Climate change effects are thus inferred for sGSL scallops based on effects reported in published literature for scallops in other areas and current temperature data for the sGSL.

Rock crabs (*Cancer irroratus*) are the most efficient predator of Sea Scallops and are of most concern in the core area of the sGSL. Research survey data suggests that rock crab abundance on the scallop beds increased between 2019-2023 in the northeastern part of the core area; however, the reasons for this are not clear. Rock crab abundance thus should continue to be monitored.

### Projections

Projections are not available.

## SOURCES OF UNCERTAINTY

Missing and inaccurate data in commercial fishery logbooks is the main driver of uncertainty of the landings and the effort data that are used in this assessment. Anecdotal reports suggest that there may be an increase in unreported logbook entries due to a shift to local sales since the early 2000s. The assumption is made that catch rates and fishing locations for complete logbook records are representative of incomplete records. Improved monitoring of commercial landings would improve the confidence of future assessments. There is also a substantial amount of unrealized effort (53% of licences were inactive in 2022, amounting to 483 licences across the core area of the sGSL) that presents a concern for future management decisions, particularly given that this is a competitive fishery without quota. The reactivation of these licences could lead to overfishing and further depletion of the stock.

Effects of changing environmental conditions (e.g., ocean warming, acidification, deoxygenation, among others) will affect the sGSL Sea Scallop stock. The magnitude and severity of these effects is unknown, making the estimation of these effects difficult. Importantly, effects of these stressors on Sea Scallops are inferred from other areas and direct research on sGSL scallops is absent.

There are uncertainties around using clappers as a quantitative index of natural mortality (Hart and Chang 2022). The proportion is based on the time in weeks that clappers remain attached and is highly variable. Clapper integrity, beyond natural deterioration of the hinge membrane, can be compromised by disturbance events (e.g., interactions with the fishing gear, storms, etc.), making the clapper proportion inappropriate in cases when data are collected after the fishery as it would underestimate natural mortality. Nonetheless, clapper proportions do represent a reasonable qualitative indicator of changes in natural mortality over time.

The CPUE from the commercial fishery may be hyperstable (i.e., CPUE remains high as true biomass decreases) due to seasonal and annual changes in the spatial distribution of fishing effort. This may introduce bias in the CPUE indices and has ramifications for methodology and survey design. This is mostly an issue in SFA 24 because the survey is not capturing potential spatial shifts around the Pictou bed. The survey strata associated with the Pictou bed may need to be revised accordingly.

Annual variations in condition may affect interpretation in variations of biomass and violate an important assumption in assessments that biomass is proportional to abundance. The higher condition observed in the sGSL in 2023 compared to previous years, which has also been observed in other regions (DFO 2024), highlights this potential issue and the need for ongoing monitoring efforts. The risk here is that if condition increases, seemingly healthy levels of biomass will yield lower estimates of abundance.

### Research Recommendations

As effort in this fishery is documented to shift between beds within the core area, altering the scientific survey strata could improve our understanding of this stock.

Conducting research to better quantify the disarticulation of the resilium could be valuable in reducing uncertainty around clapper index and therefore natural mortality.

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## SOURCES OF INFORMATION

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