

Fisheries and Oceans Canada

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Gulf Region

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SOUTHERN GULF OF ST. LAWRENCE (CFAs 12, 12E, 12F, 19) SNOW CRAB (*CHIONOECETES OPILIO*) STOCK ASSESSMENT IN 2024

CONTEXT

The Fisheries and Harbour Management Branch of Fisheries and Oceans (DFO) has requested an assessment of the southern Gulf of St. Lawrence (sGSL) snow crab (*Chionoecetes opilio*) stock for Crab Fishing Areas (CFAs) 12, 12E, 12F and 19. This Science Advisory Report is from the regional peer review of January 22-23, 2025 on the Southern Gulf of St. Lawrence (CFAs 12, 12E, 12F, 19) Snow Crab (*Chionoecetes opilio*) Stock Assessment in 2024. Additional publications from this meeting will be posted on the <u>Fisheries and Oceans Canada</u> (DFO) Science Advisory Schedule as they become available.

SCIENCE ADVICE

Status

• The 2024 sGSL snow crab commercial stock biomass, estimated at 51,786 tonnes (t), is above the Upper Stock Reference (USR), placing the stock in the Healthy Zone of the Precautionary Approach (PA) Framework.

Trends

- Snow crab are known to go through cycles of abundance.
- After a period of high biomass from 2018 to 2022, the commercial biomass index decreased by 21% in 2023 and a further 24% in 2024.
- Pre-recruits (> 56 mm carapace width) have declined from high levels in 2019 to 2021 and are currently below average levels.
- Female spawning stock abundance remains high, although abundance of new mature females is low.
- A strong cohort resulted in the highest population recruitment index in 2021 and it has decreased below average levels in 2024.

Ecosystem and Climate Change Considerations

- The area of suitable snow crab habitat rose in 2024 from 2023 and is above the long-term average.
- However, water temperature in the core snow crab habitat is warmer than average in the sGSL, which may impact the snow crab population dynamics and distribution.

Stock Advice

- Based on the harvest decision rule, the 2024 commercial biomass index corresponds to a target exploitation rate of 35.73% and a catch option of 18,503 t for the 2025 fishery.
- A risk analysis indicates that for this catch option, there is a moderate likelihood (40%) that the commercial stock would be below the upper stock reference and in the cautious zone of the PA after the 2025 fishery.

BASIS FOR ASSESSMENT

Assessment Details

Year Assessment Approach was Approved

November 21-25, 2011 (DFO 2012)

Assessment Type

Full peer-reviewed stock assessment

Most Recent Assessment Date

1. Last Full Assessment – January 23-24, 2024 (DFO 2024)

Stock Assessment Approach

- 1. Broad category: Index-based (trends in empirical indices only).
- 2. Specific category: Index-based (fishery-independent).

Stock, Ecosystem and Fishery Overview Information

The sGSL snow crab stock details are in Surette and Chassé (2024), ecosystem conditions in Galbraith et al. (2024), and the 2023 fishery review in Landry et al. (2024).

Stock Structure Assumption

The Snow crab stock in the sGSL is considered as a single biological unit. The snow crab trawl survey covers the majority of crab habitat in the sGSL.

Reference Points

One Limit Reference Point (LRP) and Upper Stock Reference (USR) point were developed for the sGSL snow crab stock.

- Limit Reference Point (LRP): 10,000 t of residual crab biomass.
- Upper Stock Reference (USR): 41,400 t of total commercial crab biomass.

Harvest Decision Rule



Figure 1. Harvest decision rule used for the southern Gulf St. Lawrence snow crab fishery (DFO 2014), which maps survey total commercial biomass to a target exploitation rate (solid blue line). The red line shows the limit reference point (LRP) for the residual biomass and the green line shows the upper stock reference (USR) point for the total commercial biomass. *F*_{max} represents the maximum allowed exploitation rate. The blue dashed line shows the projected commercial biomass for 2025 and its corresponding target exploitation rate. Dotted blue lines indicate inflection points in the harvest decision rule.

Data

- Commercial landings/sales slips: 1967-2024.
- Fishery logbooks: 1987-2024.
- Snow crab trawl survey: 1997-2024.
- Oceanographic data from September research vessel (RV) survey: 1971-2024.

Data changes:

- Survey design changes in 2006 and 2012, including expansion of the survey area and survey station redistribution.
- The survey vessel changed in 1999, 2003, 2013 and 2019 with possible changes in survey catchability.



ASSESSMENT

Figure 2. (Top left) Landings (in tonnes) of snow crab in the southern Gulf of St. Lawrence by fishing area, (Top right) Commercial recruitment and residual biomass in relation to the Upper Stock Reference (USR) (dashed line) and Limit Reference Points (LRP) (solid line), (Bottom left) Natural mortality and exploitation rate for commercial snow crab, (Bottom right) Observed (open circles and 95% confidence interval error bars) and predicted (black squares and shaded 95% confidence intervals) commercial recruitment by survey year.



Figure 3. (Top left) Surface area within the polygon used for the biomass estimation and with bottom temperatures between -1° C to 3° C, an index of snow crab habitat, along with the mean temperature within the area. Horizontal dashed lines are the averages over the time series (1991-2020). (Top right) Abundance (in millions; means with 95% confidence intervals) of female spawners (primiparous and multiparous) and (Bottom left) population recruits (male instar VIII, 34 to 44 mm of carapace width), based on the trawl survey data. The red dashed line shows the average for the series. (Bottom right) Density contours (number per km²) of commercial crab in the southern Gulf of St Lawrence in 2024.

Stock Status and Trends

Biomass

The 2024 sGSL snow crab commercial stock biomass, estimated at 51,786 t, is above the USR, placing the stock in the Healthy Zone. The residual component of the biomass is 17,091 t, which is above the LRP (Figure 2, Top right). The spatial distribution of commercial snow crab biomass in the sGSL in 2024 is presented in Figure 3 (Bottom right). Recent decreases in commercial crab biomass are driven by decreases in population and fishery recruitment.

Abundance

After a period of high abundance in the early 2000's, the female spawning stock declined to low levels in 2006 and has gradually increased to high levels and presently stands at 502 million in 2024, although primiparous abundance is low (Figure 3, Top right).

Natural Mortality

Over the time series, natural mortality of the commercial snow crab varied from 19% to 50%, with an average of 33%. In recent years, natural mortality stood at about 40% from 2020-2022, decreased to 30% in 2023 and increased to 38% in 2024 (Figure 2, Bottom left).

Recruitment

Population recruitment indices, which were at record levels in 2021, have decreased to below average level in 2024 (Figure 3, Bottom left). A fishery recruitment model is projecting a further 15% decrease in 2025 (Figure 2, Bottom right).

History of the Snow Crab Fishery

Snow crab landings from the sGSL were low in the early 1970s but increased more than threefold from 1975 to 1982. There were four periods of high landings (exceeding 20,000 t): 1981 to 1986, 1994 and 1995, 2002 to 2009, and the current period, from 2012 to 2024, the longest in the series (Table 1, Figure 2, Top left).

Catch per unit effort (CPUE) values in CFA 12 decreased from 72.2 kg/th in 2023 to 60.3 kg/th 2024, which is similar to the most recent average. CPUE values 12E and 12F slightly decreased in 2024, to 78.2 kg/th and 90.0 kg/th, respectively, but are still higher than the most recent average. The CPUE value for CFA 19 was similar to 2023 at 136.5 kg/th in 2024. CPUE values for CFA 19 are typically much higher than those of other CFAs.

Year	Landings (t)					Effort (number of trap hauls)			Catch per unit effort (kg/trap haul)				
	12	12E	12F	19	Total	12	12E	12F	19	12	12E	12F	19
2018	20,769	260	1,183	2,048	24,260	469,887	5,579	17,120	13,120	44.2	46.6	69.1	156.1
2019	27,554	224	1,166	2,763	31,707	496,468	3,415	18,083	24,518	55.5	65.7	64.5	112.7
2020	24,554	234	1,084	2,284	28,156	556,780	5,098	22,168	22,458	44.1	45.9	45.2	101.7
2021	21,423 ¹	223	592	2,241	24,479	363,136	5,314	18,612	18,384	57.4	55.7	59.1	121.0
2022	27,620 ¹	197	1,173	2,671	31,661	537,820	2,509	15,240	23,690	51.4	78.5	76.5	112.6
2023	32,084 ¹	291	1,329	1,700	35,404	444,480	3,678	13,718	12,088	72.2	79.1	96.9	140.6
2024	22,560	203	1,431	1,422	25,616	374,043	2,588	15,896	10,420	60.3	78.2	90.0	136.5

Table 1. Landings, fishing effort and catch per unit effort from logbooks in the southern Gulf of *St. Lawrence snow crab*, Chionoecetes opilio, fisheries (Crab Fishing Areas 12, 12E, 12F and 19) from 2018-2024 (note: landings for 2024 are preliminary).

¹Total landings in CFA 12 include landings allocated to CFAs 12E (2021, 2022, 2023) and 12F (2021) that were fished in CFA 12.

Stock Advice: Projections and Risk Analysis for 2025 sGSL snow crab fishery

Table 2. Risk analysis for different catch options for the 2025 southern Gulf of St. Lawrence snow crab fishery showing the probability that the residual biomass (B_{res}) would be below the limit reference point (LRP), and the probability that the total commercial biomass (B) would be below the upper stock reference (USR), and the predicted biomass for the 2025 survey. In bold is the catch option corresponding to an exploitation rate of 35.73%, the rate as per the harvest decision rule.

Catch	Proba	ability	Predicted survey biomass for 2025 (t)			
option (t)	B _{res} < LRP	B < USR				
15,000	0.0%	16.9%	46,729 (36,877 – 58,842)			
16,000	0.1%	22.6%	45,729 (35,877 – 57,842)			
17,000	0.4%	29.0%	44,729 (34,877 – 56,842)			
18,000	1.7%	35.9%	43,729 (33,877 – 55,842)			
18,503	3.3%	39.6%	43,226 (33,374 – 55,339)			
19,000	5.8%	43.2%	42,729 (32,877 – 54,842)			
20,000	14.7%	50.5%	41,729 (31,877 – 53,842)			
21,000	29.5%	57.6%	40,729 (30,877 – 52,842)			
22,000	48.2%	64.3%	39,729 (29,877 – 51,842)			

Ecosystem and Climate Change Considerations

Water temperature can affect several physiological and biological aspects of snow crab. Bottom temperatures in the core snow crab habitat are typically between -1 and 3 °C. Overall, bottom temperatures for the sGSL during 2024 remained warmer than average time-series (0.74 °C). In CFA 12, temperatures were 0.5 to 1 °C (or more) above average.

The surface area with bottom temperatures between -1 and 3 °C in September, and within the polygon used for the estimation of the commercial biomass, rose significantly in 2024 from 2023 and was above the long-term average (48,651.77 km²) (Figure 3, Top left). The average temperature within that area (1.31 °C) is still well above the long-term average (0.74 °C) and is similar to the temperature observed in 2023. The 2024 average temperature is the fifth highest of the 1971-2024 time series.

SOURCES OF UNCERTAINTY

Changes in sampling design and trawling protocols have led to improvements in the survey over the years. However these changes, particularly the expansion of the survey area, the relocation of survey stations and variations in the survey's timing, may have led to variations in survey catchability. In addition, trawl catchability is known to vary with bottom type, sea conditions, current, vessel type and trawl geometry.

Fishery pre-recruits (R-4, R-3, R-2) have decreased substantially from 2020 to 2022. R-3s and R-2s continued their downward trend in 2023 and are below average levels in 2024. R-1s, which remained relatively stable from 2020 to 2022, have since decreased to below average levels in 2024.

Skip-moulting proportions among R-2s were high in 2023 and remain high in 2024. This adds to the prediction uncertainty in the fishery recruitment model, which neither accounts for annual variations in mortality, nor accounts for variations in skip-moulting rates.

There is continued evidence of warming conditions in the sGSL that can impact snow crab population dynamics and distribution.

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