Fisheries and Oceans Canada | Pêches et Océans Canada
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Maritimes Region

Canadian Science Advisory Secretariat
Science Advisory Report 2026/029

STOCK ASSESSMENT OF ARCTIC SURF CLAM ON THE GRAND BANKS TO THE END OF 2024

CONTEXT

Fisheries and Oceans Canada (DFO), Maritimes Region, Resource Management Branch has requested a stock assessment of Arctic Surf Clam on Banquereau and the Grand Banks. For more information on the fishery see the Offshore Clam – Maritimes and Newfoundland and Labrador Regions Integrated Fishery Management Plan (IFMP) (DFO 2020). The stock assessment advice will guide application of the Fish Stocks Provisions pursuant to the *Fisheries Act* and the DFO Precautionary Approach Framework. This is the first full stock assessment since a new science stock assessment framework was adopted for the fisheries on Banquereau and the Grand Banks (see: Nasmith et al. In press[1]). The advice will be used by DFO Resource Management to manage the Arctic Surf Clam fishery on the Grand Banks.

This Fisheries Science Advisory Report is from the regional peer review meeting of April 15–16, 2026, on the Stock Assessment for Arctic Surf Clam on Banquereau and Grand Bank. 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

- In 2024, there was a very high probability that the modeled-estimate of vulnerable biomass density was above the upper stock reference, placing the stock in the healthy zone according to the DFO Precautionary Approach Framework for fishery decision-making.

Trends

- In 2024, modeled-estimates of biomass of small clams increased by 13% compared to 2023. Modeled-estimates of biomass of large clams increased by 14% compared to 2023.
- Biomass estimates should improve as more harvest data are added to the model. The large relative difference between biomass estimates over the time series are likely due to underestimates at the beginning of the time series.
- In 2024, modeled-estimates of exploitation of small clams decreased by 5% compared to 2023. Modeled-estimates of exploitation for large clams decreased by 18% compared to 2023.
- In 2024, total exploitation was below the target removal rate.

[1] Manuscript has received peer-reviewed consensus and is undergoing approvals and publication. A copy of the manuscript was provided to peer reviews and meeting participants of the stock assessment for preparation purposes. The final manuscript will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule once approved.

- In 2024, all but one secondary indicator (i.e., Length Indicator 1 for the Southern portion of the Bank) were positive relative to their respective thresholds.

Ecosystem and Climate Change Considerations

- In 2024, the near-bottom temperature anomaly in Northwest Atlantic Fisheries Organization (NAFO) Divisions 3LNO were above normal after being normal in 2023 (Galbraith et al. 2025).
- In 2024, near-bottom measures of ocean acidification on the Grand Banks demonstrated a trend of normal to increasing acidification conditions (Galbraith et al. 2025).

Stock Advice

- To provide total allow catch advice, and in order to address uncertainty in modeled estimates, the target removal rate is applied to the three-year mean of model-derived median biomass. This results in an estimated total removal amount of 19,100 t for the 2026 fishing year.

BASIS FOR ASSESSMENT

Assessment Details

Year Assessment Approach was Approved

2026 (Nasmith et al. In press).

Assessment Type

Full Assessment: Full peer-review stock assessment.

Most Recent Assessment Date

1. Last Full Assessment: September 7–8, 2010 (Roddick et al. 2011, DFO 2010).
2. Last Interim-Year Update: August 29, 2023 (DFO 2023).

Stock Assessment Approach

1. Broad category: Single stock assessment model.
2. Specific category: High spatial resolution delay difference model that uses fishery-dependent data.

The fishery operates within a calendar year (i.e., January 1 to December 31). This stock assessment is to the end of the 2024 fishing year. This science advice applies to the 2026 fishing year.

The SpaceClam model is purpose-built for estimating biomass of sessile species, such as Arctic Surf Clam, at a high spatial resolution and for multiple size classes. The model estimates biomass at a resolution of 30.5 km^2 for multiple size classes: small (less than 78 g round weight) and large clams (equal to or greater than 78 g round weight) (Nasmith et al. In press). The model assumes that biomass changes at the modeled resolution are attributable to individual growth, natural mortality, removals due to fishing, and recruitment. Individual growth varies spatially depending on the local size class composition and the local growth rate. Each size class has its own natural mortality estimate that is considered constant across space and time.

Fishing removals are assigned across raster cells that are encountered in the fishing watch. Hourly fishing position data from the vessel monitoring system is used to assign catch to locations within the six-hour fishing watches. Catchability (q) is estimated in the model, with the estimate in 2024 being 0.64 (which is the same as that estimated in 2023). Changes in catchability from year-to-year will change biomass magnitude. Median and confidence interval (CI) estimates are based on 1,000 samples using the simulation techniques described in Nasmith et al. (In press). Secondary indicators are used to monitor the stock for changes. They can provide support or additional clarity to the interpretation of stock status inferred from the model.

Ecosystem and Climate Change Assessment Approach

Ecosystem variables are accounted for in the assessment though habitat suitability (Nasmith et al. In press). Habitat suitability on the Grand Banks is predicted by taking estimated environmental covariate effects from Banquereau and applying them to the environmental covariates on the Grand Banks. Habitat suitability at a location is defined as the expected proportion of fishing time near that location compared to total fishing time by the fleet. Habitat suitability is used as a proxy for environmental conditions in the estimation of the size composition across the Grand Banks, which provides the growth estimates used in the SpaceClam model.

Stock Structure Assumption

The stock definition for the Grand Banks is restricted to the fished area. Any raster cell with one or more fishing records is included in the fished area. If new areas are fished, this will increase the fished area, resulting in increases in biomass as new areas are added. On the Grand Banks, the total area available to model is limited to the polygon defined in the stock assessment framework (see: Nasmith et al. In press), which used higher resolution data to define the fished area (15,368 km^2). The modeled area in 2024 (8,672 km^2) was 1.1% greater than the modeled area in 2023 (8,575 km^2).

Reference Points

- Limit Reference Point (LRP): 49 t/km^2, 40% of the B_{MSY} proxy (Nasmith et al. In press).
- Upper Stock Reference (USR): 86 t/km^2; 70% of the B_{MSY} proxy.
- Removal Reference (RR): 0.72%; mean long-term (2015–23) upper 90% CI of exploitation of total biomass (Nasmith et al. In press).
- Target Reference Point (TRP): Not applicable.

Other Stock Reference Points

- Target Removal Rate: 0.25%; mean long-term (2015–23) exploitation of total biomass (Nasmith et al. In press).

Data

Fishery Dependent

- Commercial catch, effort, location, meat weight size class data from the DFO Offshore Clam Data Archival (CLAM) database (1989–2024).
- Commercial shell-length frequency samples from the CLAM database (1999–2024).

- Catch profile (1989–2024) and length frequency (1989–2024) At-Sea Observer data from the Industry Surveys Database.

Fishery Independent

- Survey morphometric and location data from the CLAM data (2006–2009).

Commercial catch, effort, location, and meat weight size data is reported for each trip at the 6-hour watch level. Multiple commercial shell-length frequency samples are collected throughout each fishing trip. All data are used when possible. Incomplete records are excluded from analyses (i.e., those data records missing catch, meat size class, effort measures, and/or locations). Conversion and component factors used to convert landed products to round weights are documented in Nasmith et al. In press.

ASSESSMENT

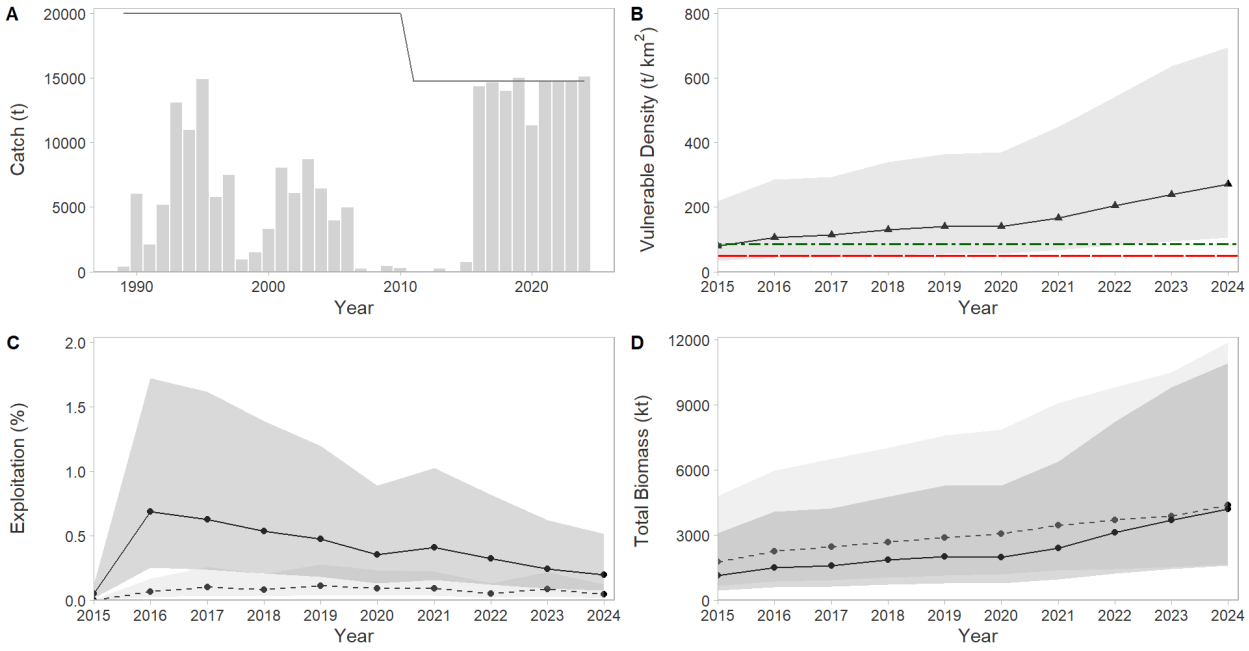

Figure 1. (A – upper left panel) Arctic Surf Clam catch (bars) and total allowable catch (solid line). (B – upper right panel) stock status indicator of median (± 90 confidence intervals) total vulnerable biomass density (solid line) with upper stock reference (USR) of 86 t/km^2 (dot-dashed green line) and limit reference point (LRP) of 49 t/km^2 (dashed red line). (C – bottom left panel) median (± 90% confidence intervals) exploitation for large (solid line) and small (dashed line) clams. (D – bottom right panel) median (± 90% confidence intervals) biomass of large (solid line) and small (dashed line) clams.

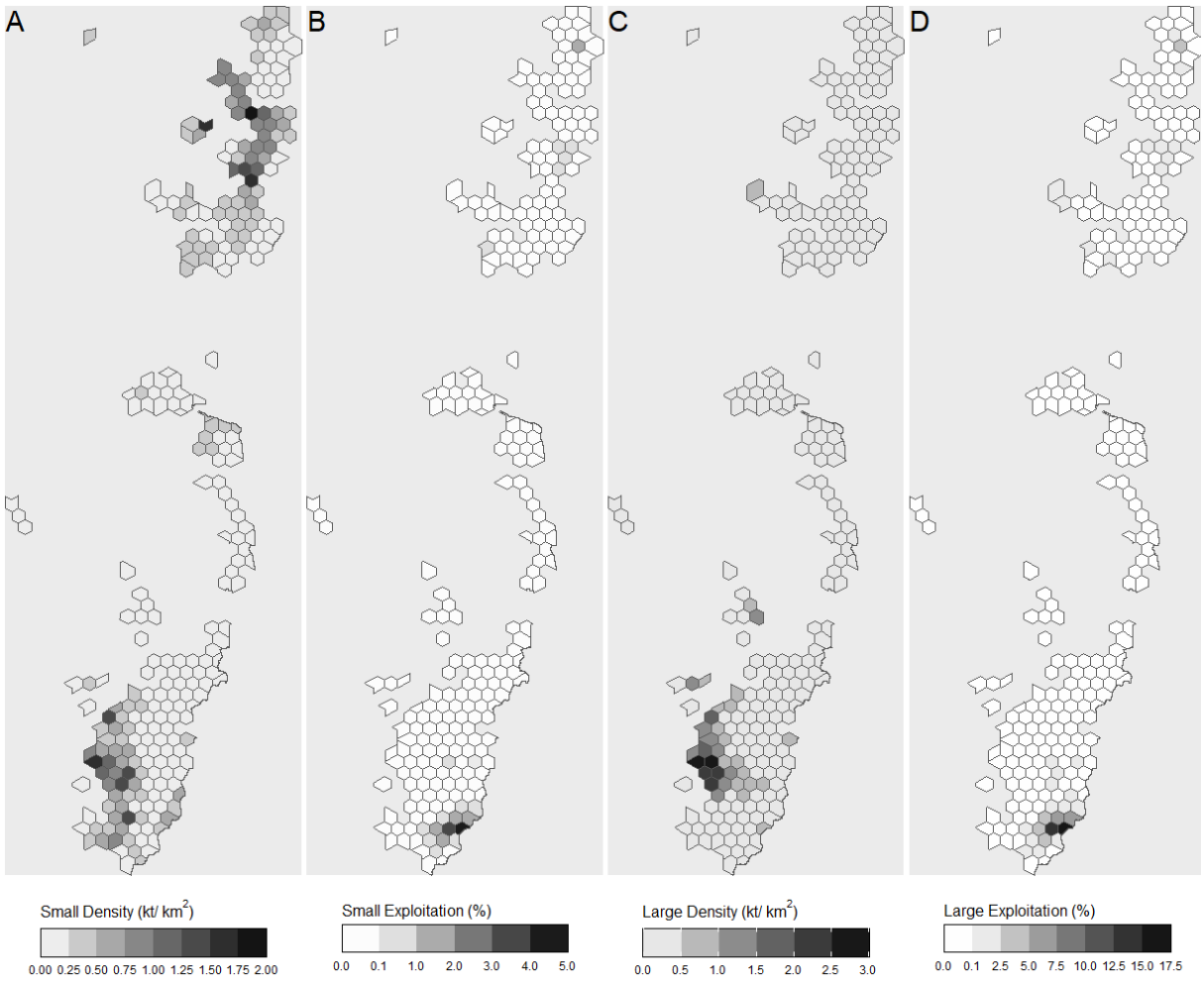

Figure 2. (A) Arctic Surf Clam small clam spatial density. (B) small clam spatial exploitation. (C) large clam spatial density. (D) large clam spatial exploitation.

Stock Status and Trends

Biomass

Small and large Arctic Surf Clam biomass on the Grand Banks has been increasing since the start of the modelling time series (Figure 1D). The increase from 2023 to 2024 was 13% for the small sized clam and 14% for the large sized clams. The estimates are highly variable, with the 90% CI range being 1,665–11,893 kt for the small size class and 1,606–10,927 kt for the large size class. There are large areas of high small clam density in the northern and southern portions of the fished area, with the highest concentrations of large clam density being on the southern portion of the Grand Banks (Figure 2A and 2C). In 2024, the total (large and small) bank-wide biomass estimate was 8,575 (3271 – 22,820 kt 90% CI). Biomass estimates should improve as more data are added to the model. The large relative difference between biomass estimates over the time series are likely due to underestimates at the beginning of the time series.

Exploitation

Exploitation in recent years has been low on both size classes. The time series low for both size classes was in 2015, which was a year with very low landings (737 t) relative to the rest of the years in the time series. In 2024, exploitation on the small size class was 0.05%, a decrease of 5% from 2023 and the second lowest exploitation in the time series (Figure 1C). In 2024, exploitation on the large size class was 0.2%, a decrease of 18% from 2023. Total exploitation in 2023 was 0.15%, which is below the target removal rate of 0.25%. Landings have been steady since 2016, with the exception of 2020 (Figure 1A), so decreases in exploitation are a function of increasing biomass estimates as opposed to decreased fishing activity The highest, localized exploitation for both size classes were constrained to a small area in the southern portion, and one raster cell in the northern portion, of the Grand Banks (Figure 2B and 2D).

Catch per Unit Effort

The bank-wide and individual area indicator thresholds are provided in Table 1. In 2024, the catch per unit effort (CPUE) indicator was above the bank-wide threshold level and area-specific threshold levels. In 2024, the bank-wide CPUE decreased slightly from the recent time series high observed in 2023 (217 g/m^2) (Figure 3A). Densities expressed in g/m^2 are equal to densities expressed in t/km^2. In 2024, CPUE increased to 165 g/m^2 compared to 2023 on the northern area of the bank, which is the second highest in the time series (Figure 4A). In contrast, in 2024 the CPUE decreased (242 g/m^2) from the time series high in 2023 on the southern area of the Grand Banks (Figure 5A).

Table 1. Secondary fishery indicators and thresholds used on the Grand Banks: bank- wide and for the northern and southern assessment areas. < = less than; > = greater than.

Indicator	Bank-wide	Northern	Southern
Catch Per Unit Effort (g/m^2)	50	55	46
Footprint (km^2)	125	65	122
Length Indicator 1 (mm)	0.5%>105	0.5 %>99	0.5 %>116
length Indicator 2 (L_{max}; mm)	L_{max100}>0.8 L_{inf}	L_{max50}> 0.8 L_{inf}	L_{max50}>0.8 L_{inf}
Length Indicator 3 (39.9 mm)	<0.5%<39.9	<0.5%<39.9	<0.5%<39.9

Footprint

The bank-wide and individual area indicator threshold levels are provided in Table 1; the footprint indicator threshold level is a maximum. In 2024, the fishery footprint indicator was below the bank-wide threshold level and area-specific threshold levels, although the footprint indicator increased slightly to 70 km^2 compared to 2023, but is similar to recent years (Figure 3B). In the northern area, the footprint indicator decreased to 23 km^2, but remained within the range seen in recent years (Figure 4B). In the southern area, the footprint indicator generally decreased from 2017 to 2023, although in 2024 it increased to 47 km^2 (Figure 5B).

Length Indicator 1

The first length indicator is a minimum of 0.5% of clams in the unsorted commercial catch being above a certain size. The bank-wide and individual area threshold levels are provided Table 1. In 2024, the values for first length indicator were above the bank-wide and northern area thresholds, but below the southern area threshold. Bank-wide, 6,946 clams were measured in 2024, with 3.9% being greater than 105 mm (Figure 3C). In the northern area, 1,999 clams were measured, with 18.7% being greater than 99 mm (Figure 4C). In the southern area, 4,947 clams were measured, with 0.2% being greater than 122 mm (Figure 5C).

Length Indicator 2 (L_{max})

The second length indicator is L_{max} (the mean total length of the largest 50 or 100 individuals caught), with the threshold level for this indicator being 78 mm (Table 1). In 2024, L_{max} was above the bank-wide threshold level and the area-specific threshold levels. Bank-wide, the L_{max100} indicator from the onboard sampling was 116 mm and 114 mm from the At-sea Observer data (Figure 3D). In the northern area, the L_{max50} indicator from the onboard sampling was 116 mm, although there was no At-sea Observer length frequency samples from this area in 2024 (Figure 4D). In the southern area, the L_{max50} indicator from the onboard sampling was 114 mm and 115 mm from the At-sea Observer data (Figure 5D).

Length Indicator 3 (39.9 mm)

The third length indicator is a maximum of 0.5% of the unsorted catch being smaller than the size at 50% sexual maturity (39.3 mm). It is the same bank-wide and for each area. In 2024, no clams sampled were below the small size threshold (n=6,946).

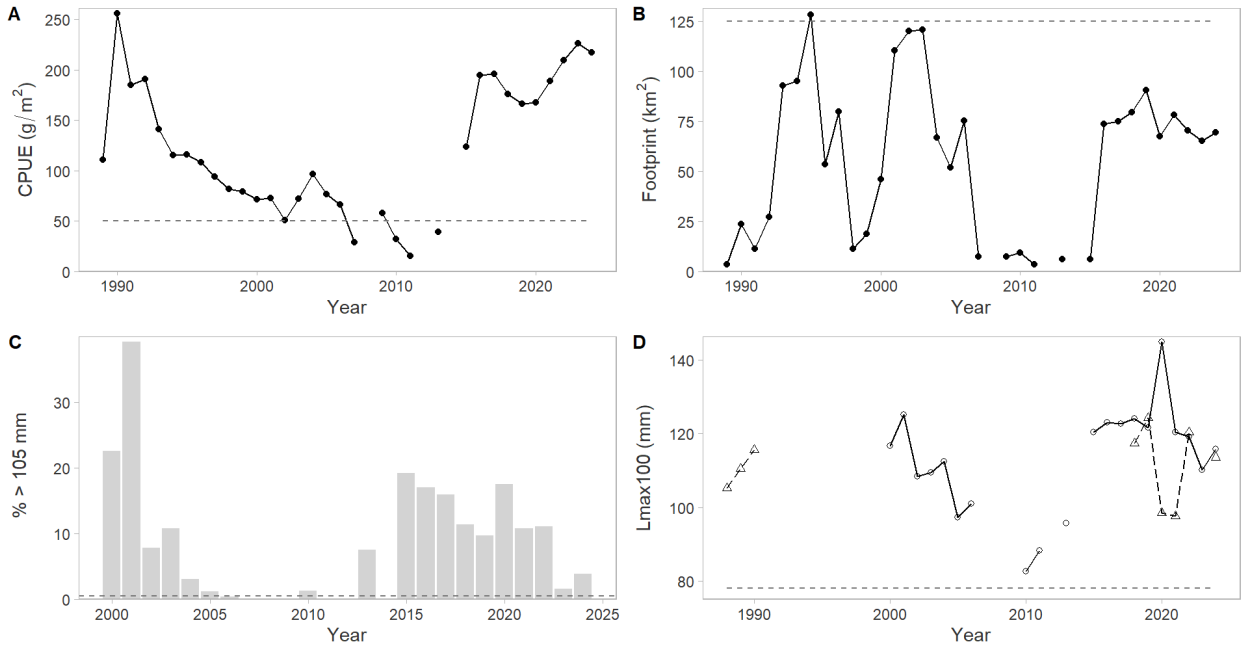

Figure 3. (A – upper left panel) Arctic Surf Clam bank-wide catch per unit effort (CPUE) indicator (dashed line is threshold level of 50 g/m^2). (B – upper right panel) fishing footprint (effort in km^2) indicator (dashed line is threshold level of 125 km^2). (C – bottom left panel) length indicator 1, the percent of the unsorted catch greater that 105 mm (dashed line is threshold level of 0.5%). (D– bottom right panel) length indicator 2 (L_{max100}) with onboard sampling data (circles) and At-sea Observer data (triangles; dashed line is threshold level of 78 mm).

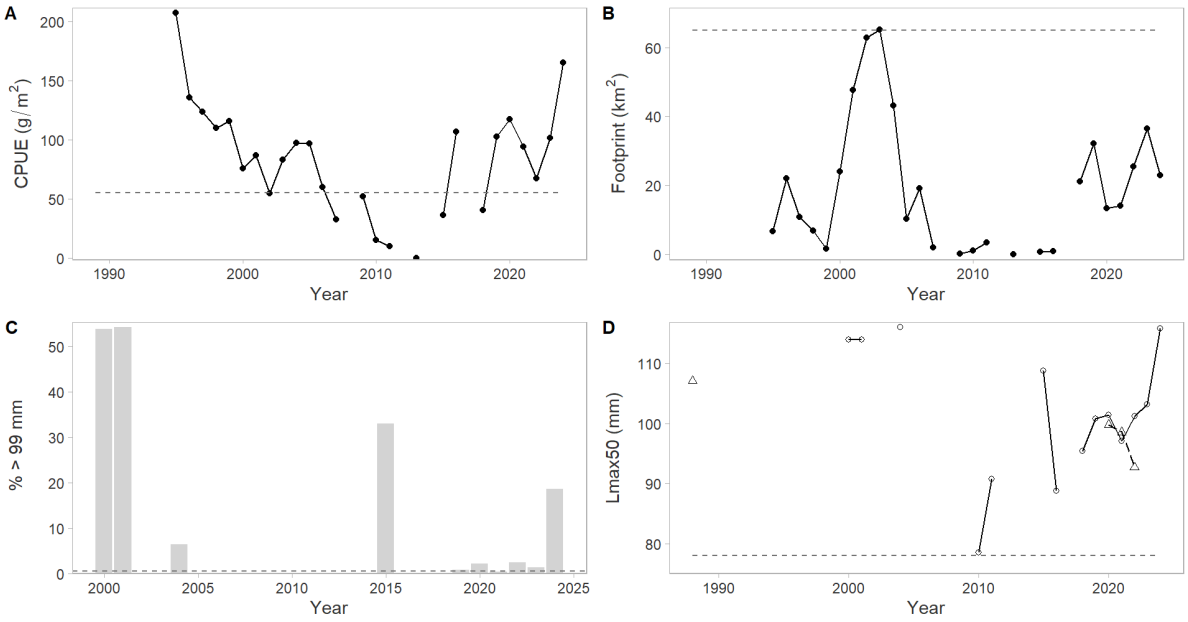

Figure 4. (A – upper left panel) Arctic Surf Clam Grand Banks northern area catch per unit effort (CPUE) indicator (dashed line is threshold level of 65g/m^2). (B – upper right panel) fishing footprint (effort in km^2) indicator (dashed line is threshold level of 65 km^2). (C – bottom left panel) length indicator 1, the percent of unsorted catch greater than 99 mm (dashed line is threshold level of 0.5%). (D– bottom right panel) length indicator 2 (L_{max50}) with onboard sampling data (circles) and At-sea Observer data (triangles; dashed line is threshold level of 78 mm).

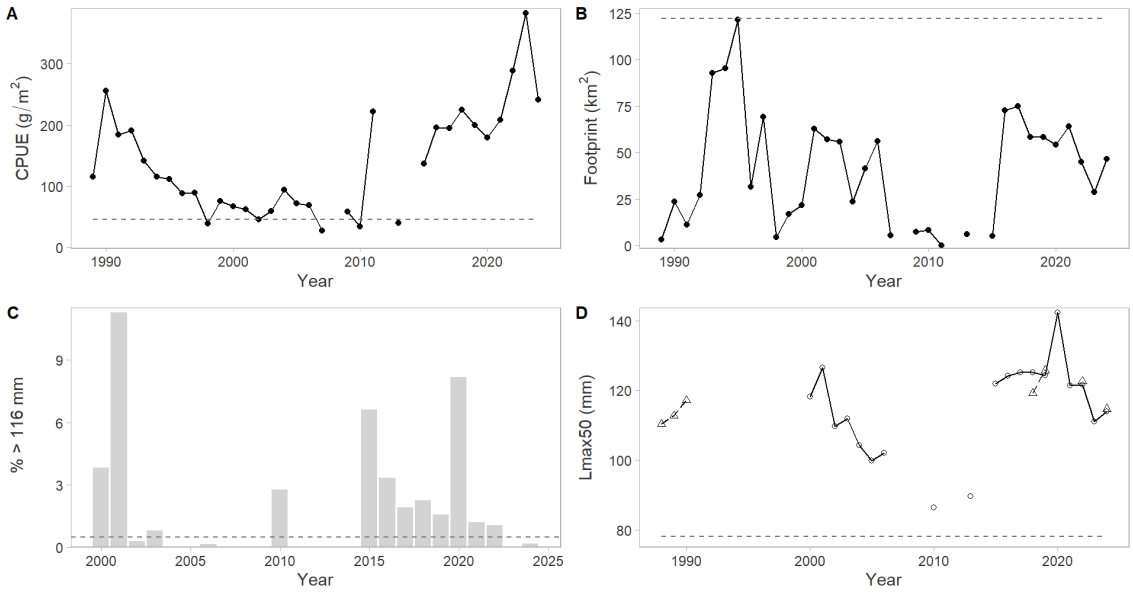

Figure 5. (A – upper left panel) Arctic Surf Clam Grand Banks southern assessment area catch per unit effort (CPUE) indicator (dashed line is threshold level of 46 g/m^2). (B – upper right panel) fishing footprint (effort in km^2) indicator (dashed line is threshold level of 122 km^2). (C – bottom left panel) length indicator 1, the percent of unsorted catch greater than 116 mm (dashed line is threshold level of 0.5%). (D– bottom right panel) length indicator 2 (L_{max50}) with onboard sampling data (circles) and At-sea Observer data (triangles; dashed line is threshold level of 78 mm).

Current Status

The stock status indicator is the total vulnerable biomass density (i.e., biomass adjusted for catchability and selectivity) (Figure 1B). In 2024, the stock was in the healthy zone according to the DFO Precautionary Approach Framework for fishery decision-making. The probability that the vulnerable biomass density was above the LRP was greater than 0.99. The probability that the vulnerable biomass density was above the USR was 0.98. In 2024, all but one of the secondary indicators (i.e., Length Indicator 1 for the Southern portion of the Bank) were all positive relative to their respective thresholds.

History of Landings

The Grand Banks fishery began in 1988, although fishing was sporadic until 2016 (Figure 1A). For a detailed history of landings in the fishery see Nasmith et al. (In press). Since 2016, the fishery on the Grand Banks has been consistent, generally catching the total allowable catch (TAC). The relatively lower landings seen in 2020 were due to external pressures caused by the COVID-19 pandemic. The TAC on the Grand Banks has not changed since 2011 when it was set at 14,756 t (Figure 1A; Table 2). A three-year quota flexibility provisions went into effect at the start of the 2024 fishing year and goes until the end of the 2026 fishing year. In that timeframe, up to 15% of the quota can be borrowed from a future year, or transferred to a future year, as long as the three-year total landings do not exceed the three-year total TAC.

Table 2. Total allowable catch (TAC) and landings for the Grand Banks, with values rounded to the nearest tonne (t). Fishing years are in calendar years. Data is from the CLAM database.

Metric	Average (1989-2016)	2017	2018	2019	2020	2021	2022	2023	2024
TAC (t)	18,876	14,756	14,756	14,756	14,756	14,756	14,756	14,756	14,756
Landings (t)	5,047	14,662	13,977	15,024	11,341	14,763	14,764	14,774	15,133

Ecosystem and Climate Change Considerations

Effects of the ecosystem on the stock were considered using two indicators: bottom temperature and ocean acidification, in addition to suitable habitat being incorporated into the model. This independent information is used to help contextualize the assessment results and to provide an assessment of the environmental drivers that may be affecting stock status. Annual near-bottom temperature anomalies and annual near-bottom measurements of ocean acidification (i.e., pH, aragonite and calcite saturation, and substrate-inhibitor ratio), as measured and reported by the Atlantic Zonal Monitoring Program (AZMP), were identified as being the most relevant to Arctic Surf Clam (Nasmith et al. In press).

In 2024, the near-bottom temperature anomaly in Northwest Atlantic Fisheries Organization (NAFO) Divisions 3LNO were above normal after being normal in 2023 (Galbraith et al. 2025). AZMP uses a critical threshold of 0.1 mol µmol-1 for the substrate-inhibitor ratio (SIR), which is defined as the ratio of the substrate (bicarbonate ions) to the waste product (hydrogen ions); SIR is a metric used to assess the influence of changing carbonate chemistry on biocalcification (Galbraith et al. 2025). Below this threshold it is expected that calcification in certain marine organisms may decline. For aragonite and calcite saturations, thresholds of less than 1 are used to indicate conditions that support dissolution of structures composed of these materials, while thresholds of less than 1.5 are used to indicate conditions that may have physiological effects

(Galbraith et al. 2025). In 2024, near-bottom measures of ocean acidification on the Grand Banks demonstrated a trend of normal to increasing acidification conditions (Galbraith et al. 2025).

Stock Advice

To provide TAC advice, and in order to address uncertainty in modeled estimates, the target removal rate is applied to the three-year mean of model-derived median biomass. This results in a total removal amount of 19,100 t for the 2026 fishing year. This approach is more conservative than applying the target removal rate to the model-derived terminal year median biomass which results in a removal amount of 21,400 t. Removal amounts are rounded to the nearest 50 t.

PROCEDURE FOR INTERIM-YEAR UPDATES

Interim stock updates can be provided upon request by DFO Resource Management and supported by DFO Science. Interim stock updates could include updates on key stock information, including time series of catch, effort, footprint, CPUE, secondary indicators, other retained species, bycatch, as well as results of the SpaceClam model, including stock status and TAC at the target removal rate.

Evaluation of Assessment Triggers

In 2024, no conditions were observed that would trigger a new assessment; this is the first full stock assessment since a new science stock assessment framework was adopted for the fishery on Banquereau and the Grand Banks (see: Nasmith et al. In press). Triggers to consider a new stock assessment framework or full stock assessment of the Grand Banks include:

1. issues that may arise with the SpaceClam model (e.g., model non-convergence);
2. a stock status indicator(s) (e.g., vulnerable biomass) has a greater than 50% chance of being in the cautious zone;
3. an unexplained 30% increase in the annual fishery footprint indicator;
4. the CPUE indicator falls below the threshold; and/or
5. if the modeled fished area increases by 50% from the 2023 modeled fished area, as this would indicate a large expansion of the fishery that should be examined in more detail.

BYCATCH

The Offshore Clams IFMP (DFO 2020) allows for the retention of other clam species. There are no limits on the bycatch of Northern Propeller Clam or Greenland Cockle. On the Grand Banks, Ocean Quahog bycatch is limited as a proportion of the Arctic Surf Clam catch. In August 2021, the fishery switched from a practice of partial retention to one of 100% retention for Greenland Cockle and Northern Propeller Clam. Comparison of data before and after this time should take that into consideration.

In 2024, no Ocean Quahog were landed and have not been landed since 2019. In 2024, Northern Propeller Clam landings decreased slightly from 2023 (Figure 6A). The CPUE in 2024 (33 g/m^2) decreased from 2023, but was still high relative to the time series (Figure 6B). Greenland Cockle landings decreased almost 50% from 2023 (Figure 6C). Greenland Cockle CPUE decreased from 41 g/m^2 in 2024 to 20 g/m^2 in 2023 (Figure 6D). Cockle landings and CPUE are within the range seen since 2016. Interannual changes of this magnitude have been

seen before and are in part a function of the distribution of Greenland Cockle in the areas targeted for Arctic Surf Clam. In 2024, Cockle landings from the southern area increased relative to 2023. The bank-wide decrease is being driven by the northern area, where fishing was focused in areas of low and patchy Cockle abundance (Roddick et al. 2011, DFO 2022).

At-sea Observer requirements are one trip on Banquereau and one trip on the Grand Banks per year (DFO 2020). Previous observer data (up to 2023) and analysis methods are summarized in Nasmith et al. (In press). In 2024, there was one observed trip on the Grand Banks (Table 3). On that trip, 51% of the effort was observed, with the observer data overestimating the Arctic Surf Clam catch by 50%.

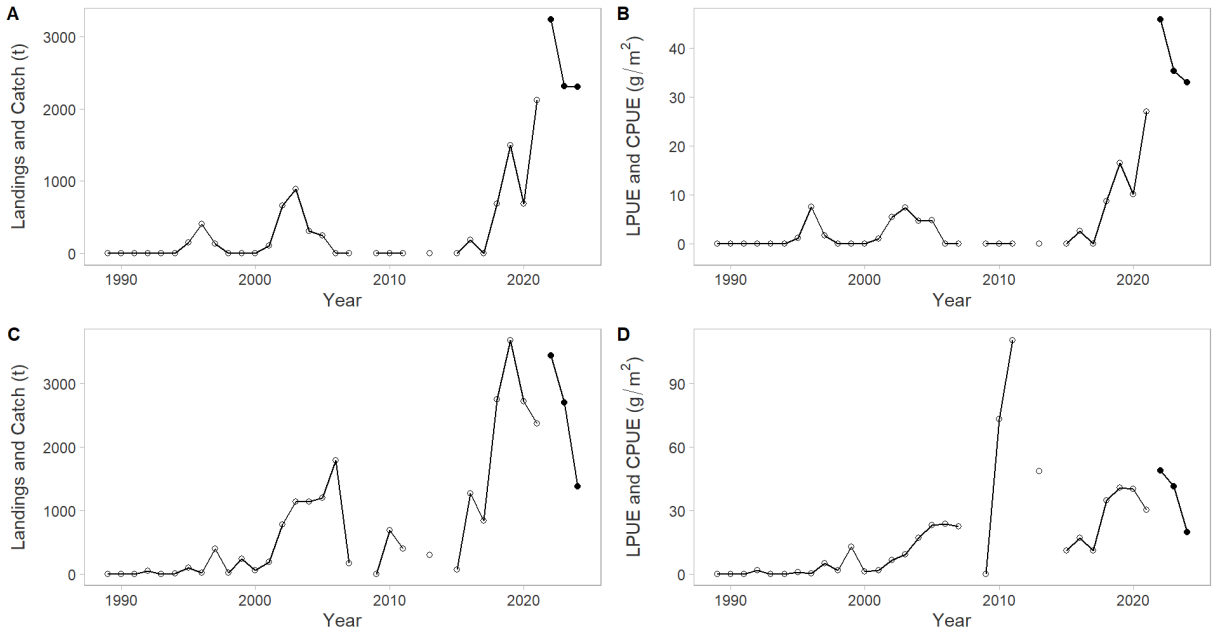

Figure 6. (A – upper left panel) Northern Propeller Clam landings (open circles) and catch (solid circles) in tonnes (t). (B – upper right panel) Northern Propeller Clam landings per unit effort (LPUE; open circles) and catch per unit effort (CPUE; solid circles) in g/m^2. (C – bottom left panel) Greenland Cockle landings (open circles) and catch (solid circles) in tonnes (t)(D– bottom right panel) Greenland Cockle LPUE (open circles) and CPUE (solid circles) in g/m^2.

Table 3. Observed catch (t) and effort values (km^2) for the Grand Banks in 2024 used to expand observed catch to trip catch. The last two columns represent the percentage relative to total trip catch and Arctic Surf catch for the trip. Both values based on effort-expanded observed catch (see Nasmith et al. In press for methods). Taxa/objects are listed in order of descending observed catch. Observed effort was 4.06 km^2 and trip effort was 8.19 km^2. NS = non-specified; < = less than. F. =Family. P.=Phylum.

Taxa/Object	Observed Catch (t)	Observed Rate (Catch/Effort)	Trip Catch (t)	% Total Trip Catch	% Arctic Surf Catch
Arctic Surf Clam	1,318.43	324.74	2,659.59	47.65	100.00
Shells	868.51	213.92	1,751.99	31.39	65.87
Northern Propeller Clam	300.30	73.97	605.79	10.85	22.78
Greenland Cockle	101.72	25.05	205.19	3.68	7.72
Sand Dollar	72.05	17.75	145.35	2.60	5.47
Sea Cucumber NS	56.98	14.03	114.93	2.06	4.32
Buccinidae F.	18.83	4.64	37.99	0.68	1.43
Rocks	7.70	1.90	15.53	0.28	0.58
Asteroidea.	6.95	1.71	14.02	0.25	0.53
Sea Mouse	5.60	1.38	11.29	0.20	0.42

Taxa/Object	Observed Catch (t)	Observed Rate (Catch/Effort)	Trip Catch (t)	% Total Trip Catch	% Arctic Surf Catch
Razor Shell Clam	3.74	0.92	7.54	0.14	0.28
Eggs NS	2.00	0.49	4.04	0.07	0.15
Snow Crab	1.33	0.33	2.67	0.05	0.10
Seasnail NS	0.74	0.18	1.48	0.03	0.06
Acanthocephala P.	0.34	0.08	0.70	0.01	0.03
Debris/Foreign Material	0.26	0.06	0.53	0.01	0.02
Mussel NS	0.23	0.06	0.45	0.01	0.02
Anemone	0.21	0.05	0.43	0.01	0.02
Yellowtail Flounder	0.18	0.04	0.37	0.01	0.01
Hermit Crab	0.17	0.04	0.34	0.01	0.01
Toad Crab	0.14	0.03	0.28	<0.01	0.01
Ocean Quahog	0.10	0.02	0.20	<0.01	0.01
Sand Lance	0.09	0.02	0.18	<0.01	0.01
Sea Urchin	0.08	0.02	0.16	<0.01	0.01
Thorny Skate	0.07	0.02	0.15	<0.01	0.01
Seaweed	0.05	0.01	0.10	<0.01	<0.01

SOURCES OF UNCERTAINTY

SpaceClam model results when applied to the Grand Banks are highly uncertain. Parameter estimates suggest that there is currently not enough data to fully inform the model. The 90% confidence interval for natural mortality includes virtually all possible values, and catchability also has a large confidence interval indicating an uncertain estimate. The modelled time series is short and the low landings in the first year are not representative of the fishery. Modeled estimates should improve as more data are added.

The increasing trend in biomass estimates may be a result of fishing behaviours and/or reflect changes in fishing effort instead of a real biomass trend. The large relative difference between biomass estimates over the time series are likely due to underestimates in the earlier years.

There are no recent fishery independent data sources available to estimate biomass, stock indicators, or to ground truth modeled results. The fishery is increasing its catch efficiency, which is evident in the relationship between CPUE and effort; this is also of the opinion of Industry members. Efficiencies have been gained in vessel capacity and in an improved use of technology to locate, sort, and process catch. Such increases in efficiency and catchability can obscure actual biomass trends.

There is a risk that catch rates may remain high as beds are depleted (i.e., hyperstability), with any improved ability for Industry to maximize catchability not being accounted for in the SpaceClam model approach. In addition, there is a lag in reporting of catch and effort for the fishery. Due to processing timelines, catch reported in one watch could be from the effort of a previous watch. Since biomass is assigned to raster cells, this could cause catch from one location to be assigned to another location. The impact of this on the total biomass estimates remains unknown.

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