



STOCK ASSESSMENT FOR ARCTIC SURF CLAM ON BANQUEREAU 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 press¹). The advice will be used by DFO Resource Management to manage the Arctic Surf Clam fishery on Banquereau.

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 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 15% compared to 2023. Modeled-estimates of biomass of large clams decreased by 11% compared to 2023.
- In 2024, modeled-estimates of exploitation of small clams increased by 44% compared to 2023. Modeled-estimates of exploitation for large clams decreased by 10% compared to 2023.
- In 2024, total exploitation was below the target removal rate.
- In 2024, secondary indicators were all positive relative to their threshold levels.

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.

Ecosystem and Climate Change Considerations

- In 2024, the near-bottom temperature anomaly in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 4Vs was in the normal range (Layton et al. 2025).
- In 2024, near-bottom measures of ocean acidification on the Scotian Shelf demonstrated a trend of normal to increasing acidification conditions (Galbraith et al. 2025).

Stock Advice

- In 2024, the target removal rate applied to the median total modeled-estimates of biomass resulted in an estimated total removal amount of 20,700 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: April 20–21, 2017 (DFO 2017a;b).
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, modified 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 7.5 km² 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 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 six-hour fishing watches. Catchability (*q*) is estimated in the model, with the estimate in 2024 being 0.58 (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 through habitat suitability (Nasmith et al. In press). A habitat suitability map was developed using proxies for seafloor characteristics, depth, and fishing locations. 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 to model the size class composition across Banquereau, which provides the growth estimates used in the SpaceClam model.

Stock Structure Assumption

The stock definition for Banquereau is restricted to the fished area. Any raster cell with one or more fishing records is included in the fished area. On Banquereau, the total area available to the model is limited to the polygon defined in the stock assessment framework (see: Nasmith et al. In press), which used higher resolution fishing data to define fished area (7,489 km²). The modeled area in 2024 (6,689 km²) was 1.7% greater than the modeled area in 2023 (6,579 km²).

Reference Points

- Limit Reference Point (LRP): 49 t/km²; 40% of the B_{MSY} proxy (Nasmith et al. In press).
- Upper Stock Reference (USR): 86 t/km²; 70% of the B_{MSY} proxy.
- Removal Reference (RR): 1%; 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: 0.75%; mean long-term (2015–23) exploitation of total biomass (Nasmith et al. In press).

Data

Fishery Dependent

- Commercial catch, effort, location, and meat weight size class data from the DFO Offshore Clam Data Archival (CLAM) database (1987–2024).
- Commercial shell-length frequency samples from the CLAM database (1987–2024).
- Catch profile (1989–2023) and length frequency (1989–2024) At-Sea Observer data from the Industry Surveys Database.

Fishery Independent

- Survey morphometric and location data from the CLAM database (2010)

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

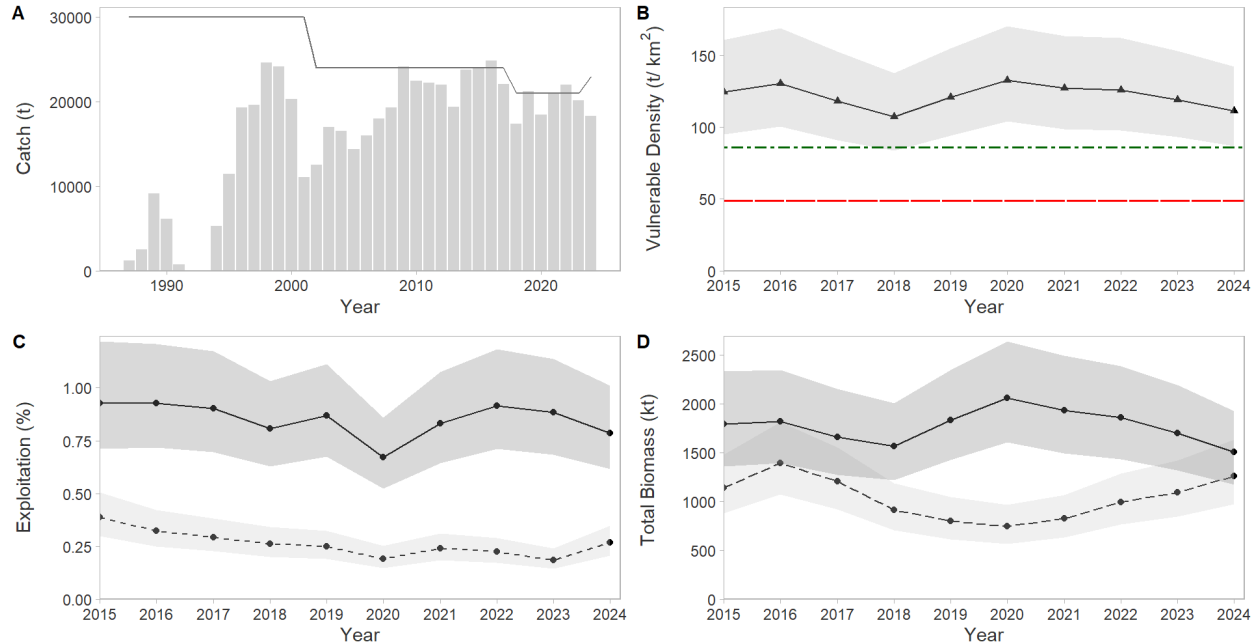


Figure 1. (A – upper left panel) Arctic Surf Clam catch (bars) and total allowable catch (solid line). (B – upper right panel) stock status indicator of median (± 90 confidence intervals) total vulnerable biomass density (solid line), with the upper stock reference (USR) of 86 t/km² (dot-dashed green line) and limit reference point (LRP) of 49 t/km² (dashed red line). (C – bottom left panel) median ($\pm 90\%$ confidence intervals) exploitation for large (solid line) and small (dashed line) clams. (D – bottom right panel) median ($\pm 90\%$ confidence intervals) total biomass of large (solid line) and small (dashed line) clams.

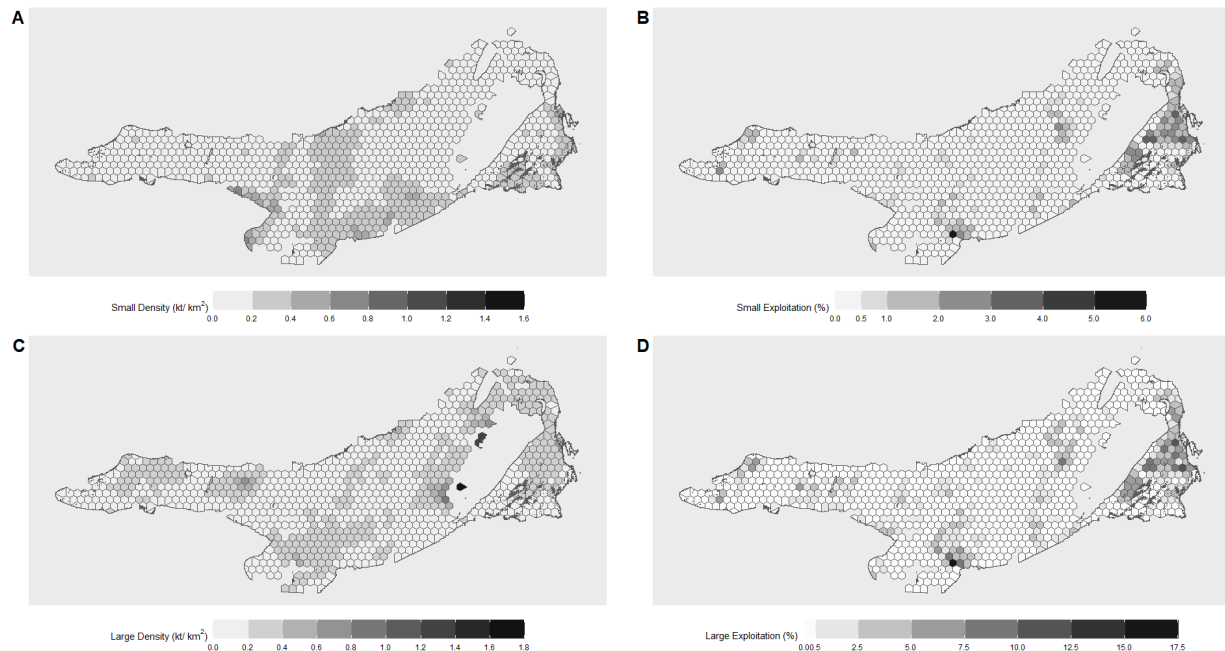


Figure 2. (A – upper left panel) Arctic Surf Clam small clam spatial density. (B – upper right panel) small clam spatial exploitation. (C – bottom left panel) large clam spatial density. (D – bottom right panel) large clam spatial exploitation.

Stock Status and Trends

Biomass

Biomass of small clams has been increasing since 2020. In 2024, small biomass was 1,259 kt (974–1,635 kt 90% CI), increasing 15% from 2023 to 2024 (Figure 1D). Small clam density is highest along the southern and central portions of Banquereau, as well as the eastern edge of the bank (Figure 2A). Biomass of large clams has been decreasing since 2020, declining 11% from 2023 to 2024 (declining 37% from 2020 to 2024) (Figure 1D). In 2024, large was 1,509 kt (1,173–1,930 kt 90% CI). Large clam density is highest around the eastern shoal, with concentrations of high densities distributed across Banquereau (Figure 2C). In 2024, the total (large and small) bank-wide biomass estimate was 2,768 (2,148–3,564 kt 90% CI).

Exploitation

In 2024, exploitation of small clams was 0.27%, increasing 44% from 2023 to 2024 (Figure 1C). Localized exploitation of small clams ranged from 0 to 6% across Banquereau (Figure 2B). In 2024, exploitation of large clams was 0.79%, decreasing 11% from 2023 to 2024 (and decreasing over the past three years) (Figure 1C). Localized exploitation of large clams ranged from 0 to 17.5% across Banquereau (Figure 2D). In 2024, total exploitation was 0.66%, which is below the target removal rate of 0.75%.

Catch per Unit Effort

The catch per unit effort (CPUE) indicator threshold level for Banquereau is set at 70 g/m². Densities expressed in g/m² are equal to densities expressed in t/km². In 2024, CPUE was 126 g/m², which is above the threshold level (Figure 3A). CPUE declined from 2023 to 2024 from a time series high observed in 2022.

Footprint

The fishery footprint indicator threshold level is set at an annual maximum of 250 km². In 2024, footprint was 145 km², which is below the threshold level (Figure 3B).

Length Indicator 1 (120 mm)

The first length indicator threshold level is a minimum of 1% of clams in the unsorted commercial catch being above 120 mm. In 2024, 12,398 clams were sampled, with 1.9% being above the threshold level (Figure 3C).

Length Indicator 2 ($L_{\max}$)

The second length indicator is $L_{\max100}$, which is the mean total length of the largest 100 individuals caught. The indicator threshold level is 89 mm. In 2024, $L_{\max100}$ for the onboard sampling was 131 mm and the Observer data $L_{\max100}$ was 120 mm, with both being above the threshold level (Figure 3D).

Length Indicator 3 (45.2 mm)

The third length indicator threshold level is a maximum of 0.5% of the unsorted catch being smaller than the size at 50% sexual maturity (45.2 mm). In 2024, 0.01% of the clams sampled were below the small size threshold level.

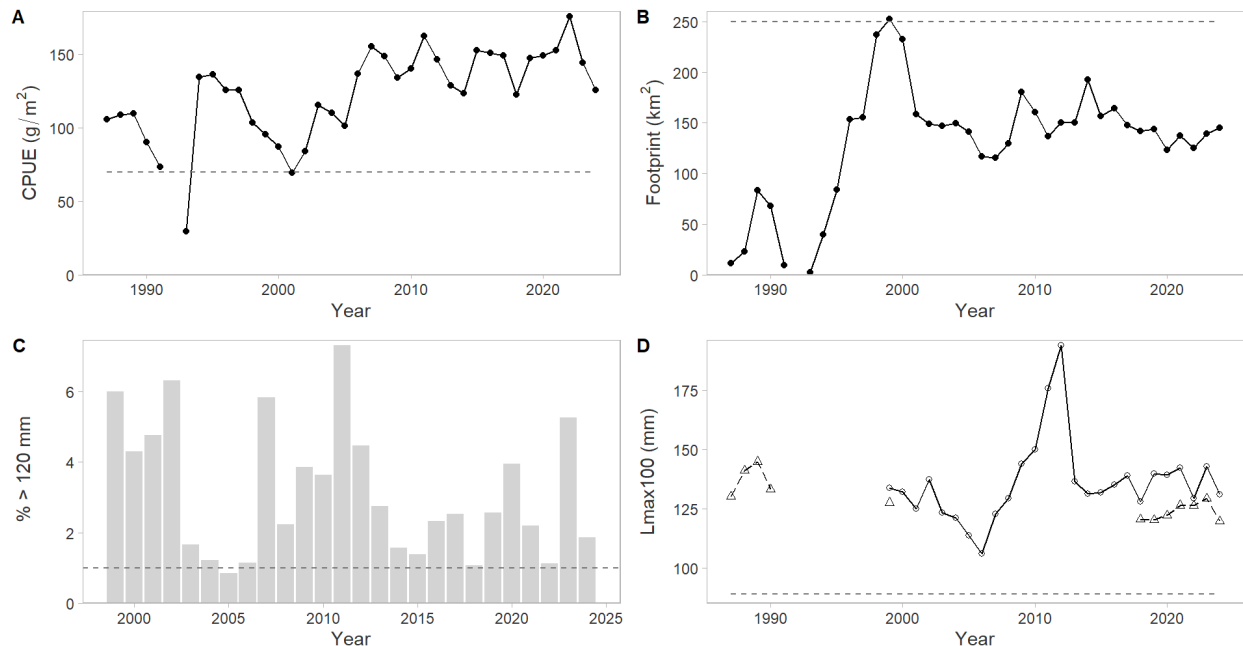


Figure 3. (A – upper left panel) Arctic Surf Clam catch per unit effort (CPUE) indicator (dashed line is threshold level of 70 g/m²). (B – upper right panel) fishing footprint (effort in km²) indicator (dashed line is threshold level of 250 km²). (C – bottom left panel) length indicator 1, the percent of the unsorted catch greater than 120 mm (dashed line is threshold level of 1%). (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 89 mm). Length indicator 3 is not shown.

Current Status

The stock status indicator is the total vulnerable biomass density (i.e., biomass adjusted for catchability and selectivity) (Figure 1D). 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 of 49 t/km² is greater than 0.99. The probability that the vulnerable biomass density is above the USR of 86 t/km² was 0.98. Additionally, the secondary indicators are all positive relative to their respective threshold levels (Figure 3).

History of Landings

The total allowable catch (TAC) on Banquereau was 20,943 t from 2018 to 2023 before increasing to 23,000 t for 2024 (Figure 1A; Table 1). For a detailed history of landings in the fishery see Nasmith et al. (In press). 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. Over 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 1. Total allowable catch (TAC) and landings for Banquereau, with values rounded to the nearest tonne (t). Fishing years are in calendar years (i.e., January 1 to December 31). Data is from the CLAM database.

Metric	Average (1987–2016)	2017	2018	2019	2020	2021	2022	2023	2024
TAC (t)	27,000	24,000	20,943	20,943	20,943	20,943	20,943	20,943	23,000
Landings (t)	15,465	22,032	17,379	21,174	18,401	20,930	21,969	20,107	18,249

Ecosystem and Climate Change Considerations

Ecosystem effects on the Banquereau 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 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 ecosystem indicators to Arctic Surf Clam (Nasmith et al. In press).

In 2024, the near-bottom temperature anomaly NAFO Subdivision 4Vs was in the normal range (Layton et al. 2025). The 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 level it is expected that calcification in certain marine organisms may decline. For aragonite and calcite saturations, threshold levels 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 Scotian Shelf demonstrated a trend of normal to increasing acidification conditions (Galbraith et al. 2025).

Stock Advice

In 2024, the target removal rate applied to the median total model-estimates of biomass resulted in an estimated total removal amount of 20,700 t for the 2026 fishing year. Removal amount is 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 Banquereau 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; and/or
4. the CPUE indicator falls below its threshold level.

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 Banquereau, there is an Ocean Quahog TAC of 800 t. 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 this into consideration.

In 2024, no Ocean Quahog were landed from Banquereau, with no Ocean Quahog being landed from Banquereau since 2007. In 2024, Northern Propeller Clam landings decreased from the time series high in 2023 (Figure 4A). In 2024, the CPUE (36 g/m²) decreased from 2023, but still high relative to the time series (Figure 4B). In contrast, Greenland Cockle landings increased slightly from 2023 (Figure 4C) and the Greenland Cockle CPUE increased slightly from 2023 to 2024 to 0.66 g/m² (Figure 4D).

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 analyses are summarized in Nasmith et al. (In press). In 2024, there was one observed trip on Banquereau. Complete trip data were not available in time for this assessment, but will be included in a future update.

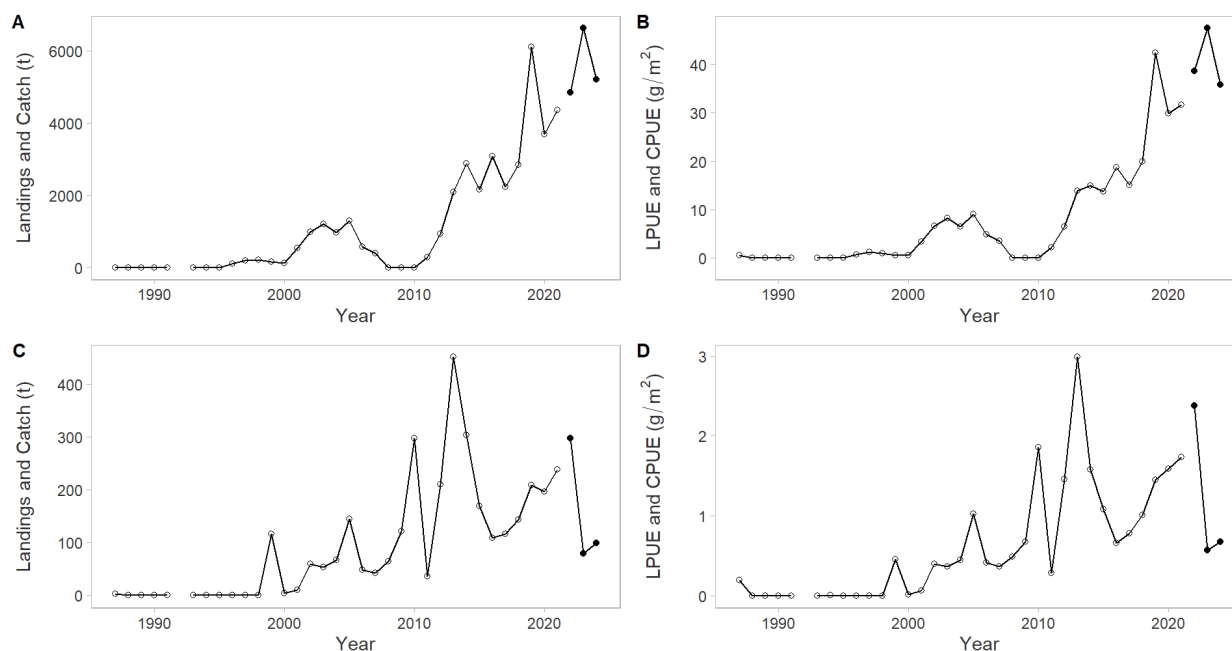


Figure 4. (A – upper left panel) Northern Propeller Clam landings (open circles) and catch (solid circles) in tonnes (t). (B – upper right panel) Northern Propeller Clam landings per unit effort (LPUE; open circles) and catch per unit effort (CPUE; solid circles) in g/m². (C – bottom left panel) Greenland 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/m².

SOURCES OF UNCERTAINTY

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 risk that catch rates may remain high as beds are depleted (i.e., hyperstability), with 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 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 total biomass estimates remains unknown.

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