Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat
Maritimes Region | Science Response 2023/041

STOCK STATUS UPDATE OF LOBSTER (*HOMARUS AMERICANUS*) IN LOBSTER FISHING AREAS 36 AND 38 FOR 2023

Context

The scientific basis for assessing the status of American Lobster (*Homarus americanus*) in Lobster Fishing Areas (LFAs) 36 and 38 was reviewed at a framework meeting in September 2019 (Cook et al. 2023), followed by an assessment of the status of the Lobster resources in LFAs 35–38 in October 2019 (DFO 2021a), and yearly updates (DFO 2021b, DFO 2022a). One primary indicator and three secondary indicators that describe changes in Lobster abundance and biomass, along with reference points for the primary indicator were defined at the framework meeting. In this update, the suite of indicators from the 2019 assessment framework are applied to the 2022–2023 fishing season (where data are available).

This Science Response Report results from the Regional Peer Review of September 25, 2023, on the Stock status update of American Lobster in Lobster Fishing Areas (LFAs) 36 & 38.

Background

Description of the fishery

Commercial Lobster fishing in LFAs 36 and 38 occurs in the Bay of Fundy (Figure 1), with active fisheries for over 150 years. These two LFAs border either one (LFA 36) or both (LFA 38) of the two biggest Lobster fisheries in the Northwest Atlantic: LFA 34, with the highest Lobster landings in Canada; and Downeast Maine (Figure 1), with the highest landings in the United States of America (USA). Access to LFA 37 is provided to both LFAs 36 and 38 licence holders by way of licence conditions. Landings from LFA 37 are attributed to the respective LFA stated on the licence. A long-term increase in landings in LFAs 36 and 38 began in the mid-1990s, and current landings are above the long-term average. A similar increase in landings was also observed in most of the Gulf of Maine regions and other LFAs in Atlantic Canada (DFO 2022b, DMR 2022)

The fishery is managed by input controls including a Minimum Legal Size (MLS, 82.5 mm Carapace Length [CL]), prohibition on landing of both egg-bearing and v-notched (with no setal hairs) females, limited entry licensing, trap limits, and season length. LFA 36 has a split fishing season starting the second Tuesday in November to January 14th and from March 31st to June 29th, with a trap limit of 300 (per licence), while LFA 38 occurs from the second Tuesday in November to June 29th, with a trap limit of 375. Other management measures include the requirement of vents to allow sublegal-sized Lobster to escape and biodegradable trap mechanisms to mitigate ghost fishing by lost traps. As the fishing season spans two calendar years, each season is referred to using the year the season ended, i.e., the 2022–2023 season will be referred to throughout as the 2023 season.

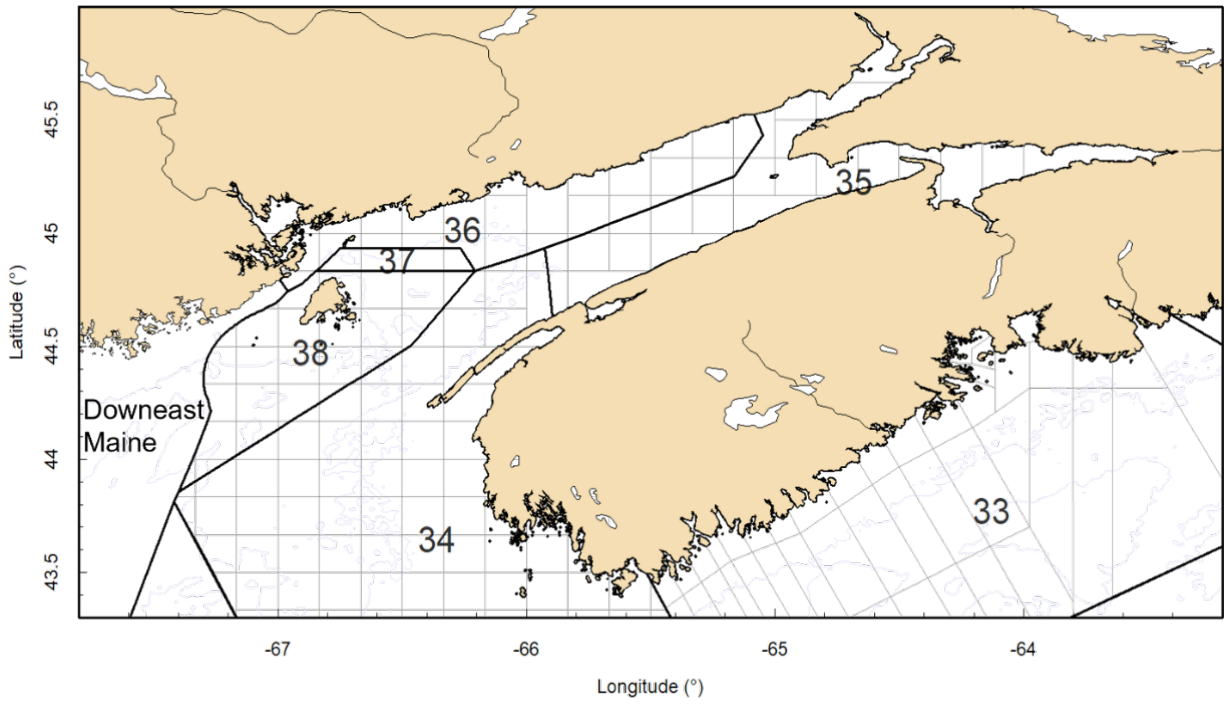

Figure 1. Map of Lobster Fishing Areas (LFAs) 33–38 with logbook reporting grids outlined in grey.

Analysis and Response

Indicators of Stock Status

The stock status of the Lobster in LFAs 36 and 38 is assessed using primary, secondary, and contextual indicators. This update includes the primary indicator that is used to define stock status in relation to reference points defined in Cook et al. (2023) and secondary indicators that display time-series trends but do not have reference points. The data sources available for establishing indicators for LFAs 36 and 38 come from both fishery-dependent and fishery-independent data. Fishery-dependent data consist of commercial logbooks that report information on date, location (grid), effort (number of traps hauled), and estimated catch. The fishery-independent data sources are from the Fisheries and Oceans Canada (DFO) Maritimes Region Summer Ecosystem Research Vessel (RV) Survey (herein RV survey), and the DFO Bay of Fundy Inshore Scallop Science Survey. Indicators from surveys are updated where data are available.

Primary Indicator

Stock status in LFAs 36 and 38 are evaluated separately through one primary indicator, which describes the time-series trends relative to reference points. The primary indicator for describing stock status is standardized commercial Catch Per Unit Effort (CPUE). There is currently no primary indicator of fishing pressure or exploitation in either LFA.

Catch Per Unit Effort

Commercial catch rates are a preferred indicator over landings data, as they are standardized to account for the level of fishing effort. This is especially important in effort-controlled fisheries. The commercial fishing data used to estimate CPUE were obtained from mandatory logbooks that have been implemented since the mid-2000s. It has been well documented that trap-based catch rates will vary throughout a fishing season due to factors apart from available biomass, including fishing behavior, localized depletion, and environmental conditions (Drinkwater et al. 2006, Miller and Rodger 1996). In an effort to account for these factors, CPUE data were standardized through generalized linear modelling with explanatory variables of Year, Day of Season, Temperature, and the interaction between Day of Season and Temperature. Year effects were treated as factors rather than a continuous variable to reduce smoothing across years and allow for data to better inform on inter-annual variability.

Model predictions were made for the first day of the fishing season at the median day-one temperature across all years. The available time series covers both a high-and low-productivity period. The median of the high-productivity period (2011–2018) was used as the proxy for the biomass at carrying capacity (*K*). Following the recommendations of DFO (2009), the Upper Stock Reference (USR) and Limit Reference Point (LRP) were set to 40% and 20% of the *K* proxy, respectively. A 3-year running median was used to smooth data points and to compare the standardized CPUE to the USR and LRP. This value will dampen the impact of any anomalous years, which may occur due to factors unrelated to changes in abundance.

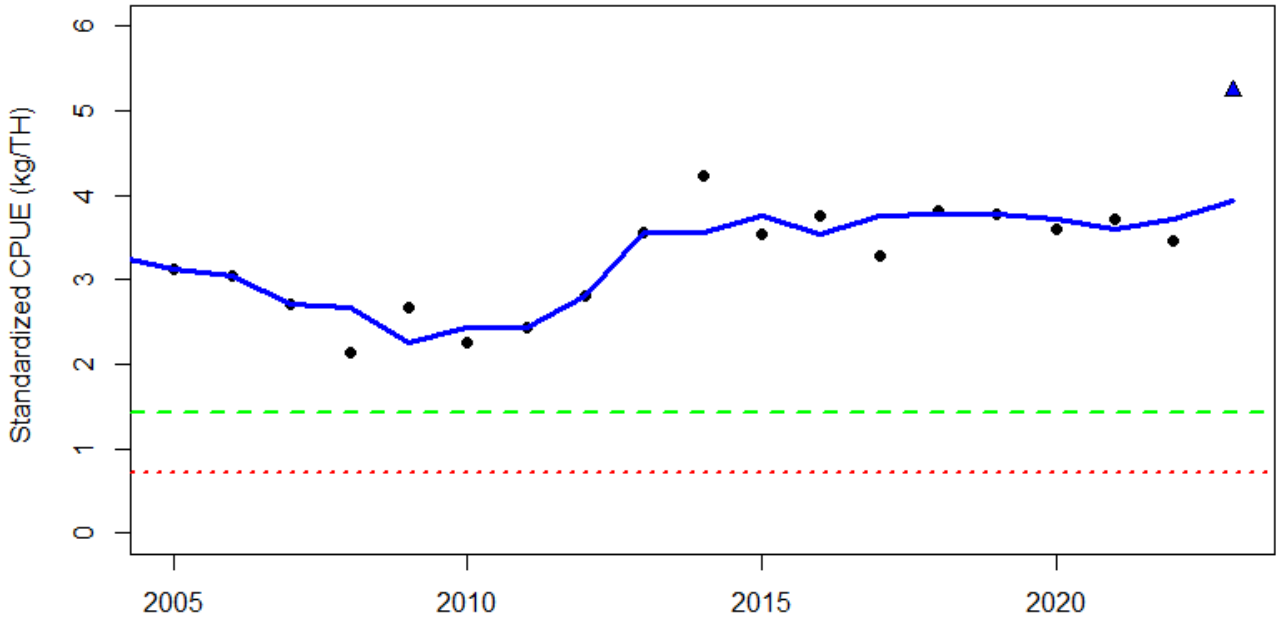

Figure 2. Time series of standardized commercial catch rates (kg/trap haul; black dots) for LFA 36, along with the 3-year running median (solid blue line). The horizontal lines represent the Upper Stock Reference (dashed green line) and Limit Reference Point (dotted red line). The data point for 2022–2023 is uncertain due to incomplete fishing data and lack of 2023 temperature data in the CPUE standardizations (blue triangle).

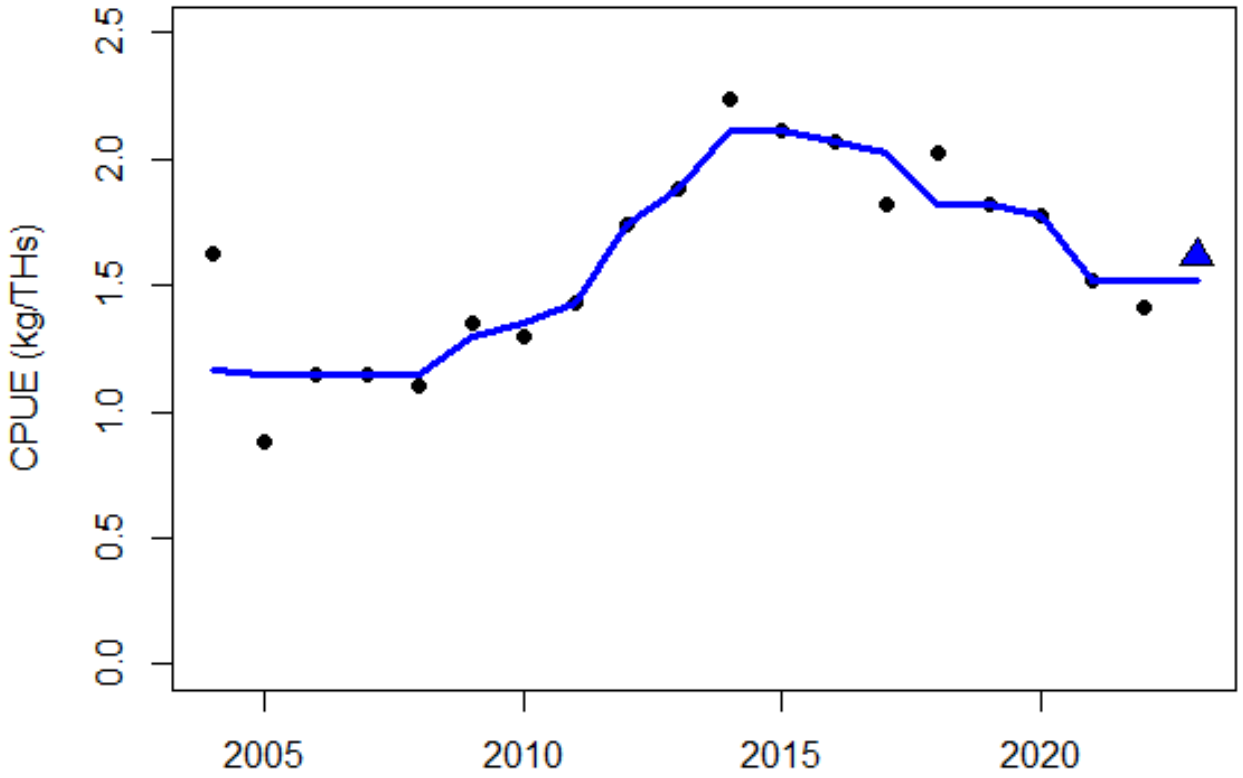

Figure 3. Time series of unstandardized commercial catch rates (kg/trap haul; black dots) for LFA 36. The data for 2022–2023 fishing season are incomplete (blue triangle).

The trend in the standardized CPUE for LFA 36 indicates that an increase in stock biomass occurred between 2009–2012 (Figure 2). Standardized CPUE has remained high (more than twice the USR) since 2013. The 3-year running median for CPUE for the 2023 season is 3.93 kg per Trap Haul (kg/TH), which is above the USR (1.42 kg/TH) and LRP (0.71 kg/TH). There are uncertainties in the Standardized CPUE estimate for 2023. These estimates are considered preliminary due to outstanding logs; as of September 9th, 2023, the monthly reporting rate was between 63% to 77% for the 2022–2023 fishing season. In addition, temperature data incorporated into the standardized CPUE estimates were unavailable for 2023 at the time of the update so the standardized CPUE only includes temperature data up to 2022. To account for this, the average daily temperatures from the previous 3-years were used for the 2023 standardized CPUE (Figure 2). Unstandardized CPUE, calculated from logbook data and included for comparison purposes (Figure 3), shows an overall decline in the last 10 years and is currently below the median value from 2004–2018 (1.57 kg/TH).

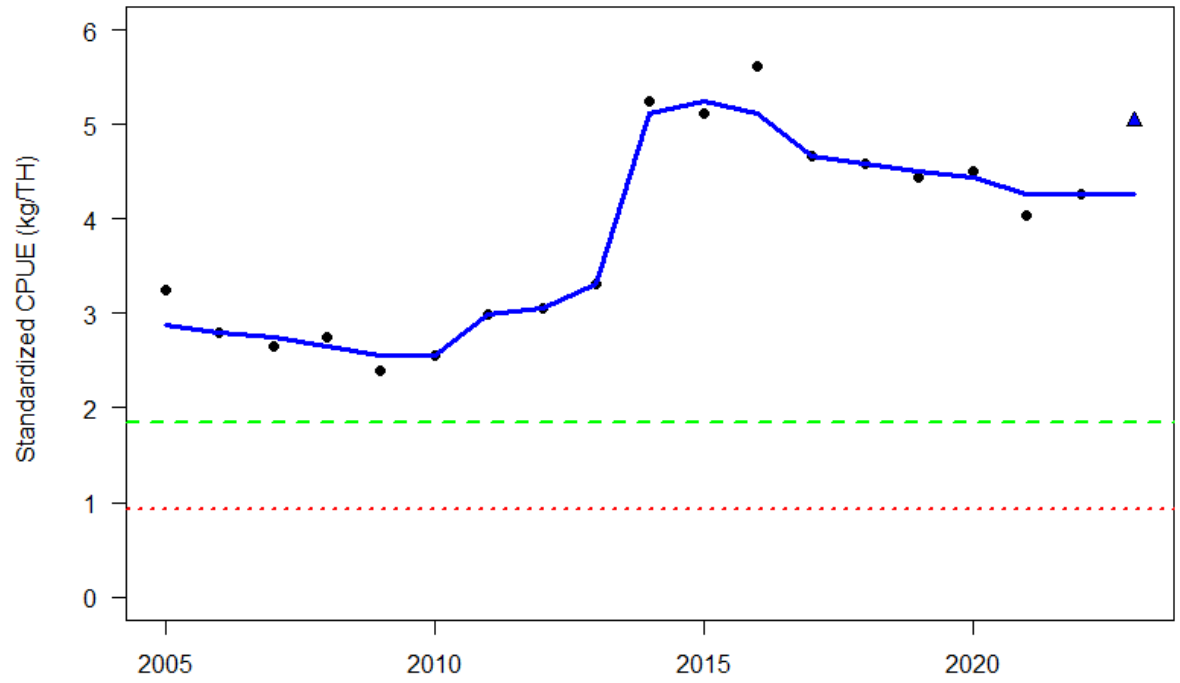

Figure 4. Time series of standardized commercial catch rates (kg/trap haul; black dots) for LFA 38, along with the 3-year running median (solid blue line). The horizontal lines represent the Upper Stock Reference (dashed green line) and Limit Reference Point (dotted red line). The data point for 2022–2023 is uncertain due to incomplete fishing data and lack of 2023 temperature data in the CPUE standardizations (blue triangle).

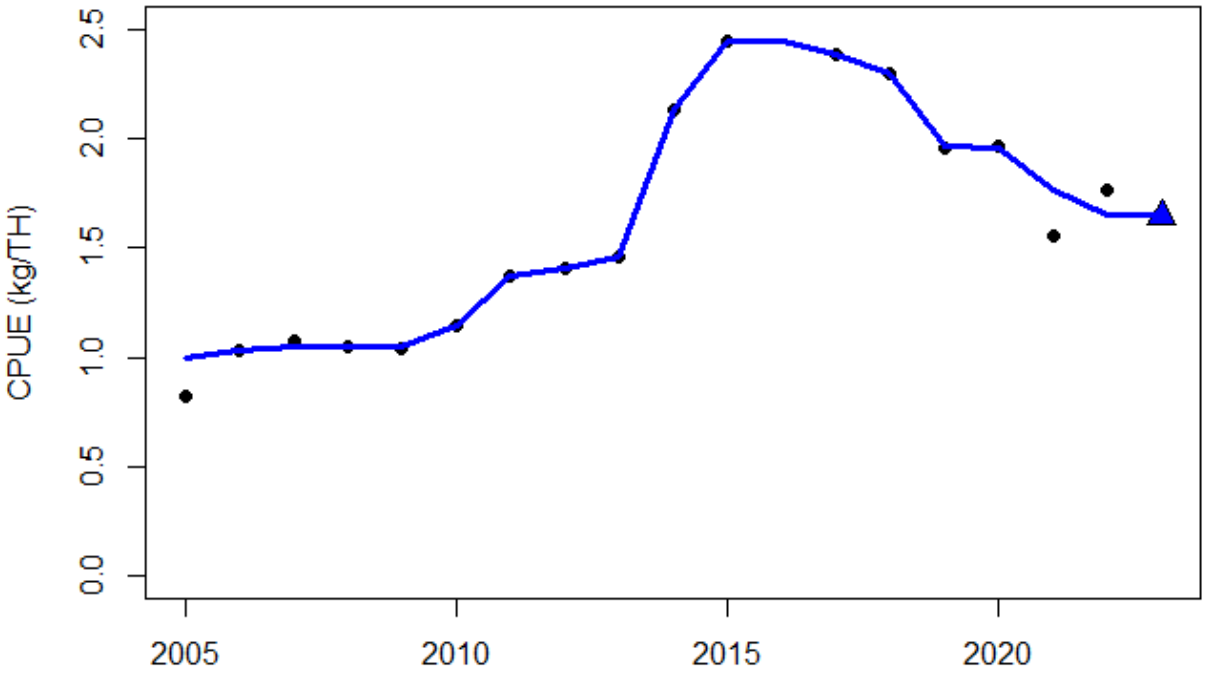

Figure 5. Time series of unstandardized commercial catch rates (kg/trap haul; black dots) for LFA 38. The data for 2022–2023 fishing season are incomplete (blue triangle).

The trend in the standardized CPUE for LFA 38 indicates an increase in stock biomass occurred between 2013 and 2014 (Figure 4). The CPUE time-series has remained high (more than twice the USR) since 2014. The 3-year running median for CPUE for the 2022–2023 season is 4.26 kg/TH. This is above the USR (1.85/TH) and the LRP (0.92/TH). Similar to LFA 36, uncertainties in the LFA 38 estimates for 2023 CPUE are considered preliminary due to outstanding logs; as of September 9th, 2023, the monthly reporting rate was between 72% to 90% by month for the 2022–2023 fishing season. Temperature data incorporated into the standardized CPUE estimates were unavailable for 2023 at the time of the update so the modelled CPUE only includes temperature data up to 2022. In the standardized CPUE model, the average daily temperatures from the previous 3-years were used for 2023 (Figure 4). Unstandardized CPUE, calculated from logbook data and included for comparison purposes (Figure 5), shows an overall decline in the last 8 years and currently remains above the median value from 2005–2018 (1.39 kg/TH).

Secondary Indicators

Secondary indicators represent time-series trends that are tracked individually, without defined reference points. The secondary indicators for LFAs 36 and 38 include the LFA-specific landings and total effort, as well as recruit abundance, commercial biomass, and relative fishing mortality estimates from the RV survey Bay of Fundy region (strata 484, 490–495 with sets occurring within the boundaries of LFAs 35–38). This update does not include total commercial and recruit abundance from the RV surveys due to incomplete surveys (COVID-19 global pandemic), and available survey data cannot be used until calibration coefficients for the new research vessel and gear are generated. However, recruit abundance from the Bay of Fundy Inshore Scallop Science survey was available at the time of this update and is included for the first time since the framework assessment (DFO 2021a).

Landings and Effort

Commercial landings are related to population biomass, as fishery controls are input- (effort controls) rather than output-based (e.g., total allowable catch). There are many factors that can affect this relationship, including changes in levels of fishing effort, catchability (including the effects of environment, and gear efficiency), Lobster size distribution, and the spatial overlap between distribution of Lobster biomass and effort.

Fishing effort, recorded as the number of THs in the Lobster fishery, is controlled by fishing season length, trap limits, and limited number of fishing licences. Consequently, there is a maximum fishing effort that can be deployed; however, this maximum is never met as factors such as weather conditions, seasonally variable catch rates, and fishing partnerships limit the total number of THs. Total fishing effort is calculated from mandatory logbooks.

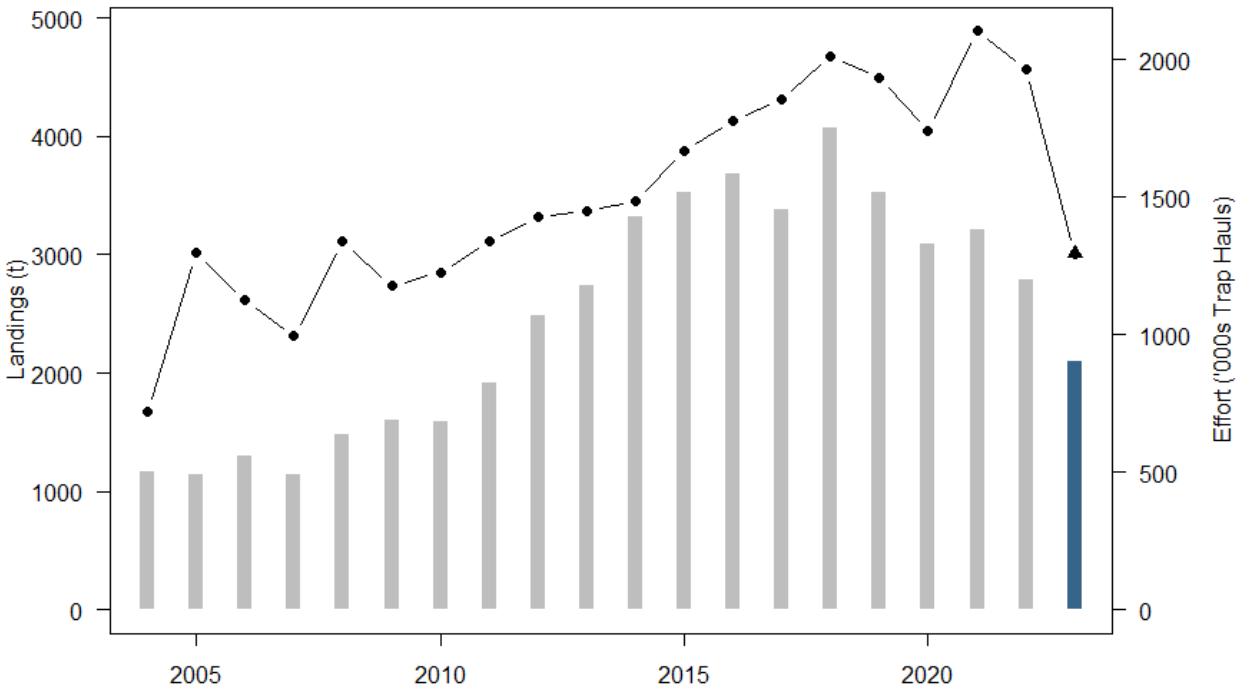

Figure 6. Time series of landings (bars), and effort (sold line with points) for LFA 36. The data for 2022–2023 fishing season are incomplete (blue bar for landings, black triangle for effort).

The historical landings in LFA 36 between 1947 and 1980 had a median of 227 t with a range of 47–338 t, then increased slightly between 1981 and 1996 to a median of 268.5 t (range of 156–427 t), and again from 1997 to 2010 there was a steady increase in landings to 1,594 t (Cook et al. 2023). From 2010–2022, median landings were 3,205 t (range of 1,594–4,073 t). In recent years, LFA 36 landings have varied and, despite a decline since 2018, remain relatively high for the time series. The landings for 2022–2023 season are 2,093 t but do not represent the total for the season due to the outstanding logs (Figure 6).

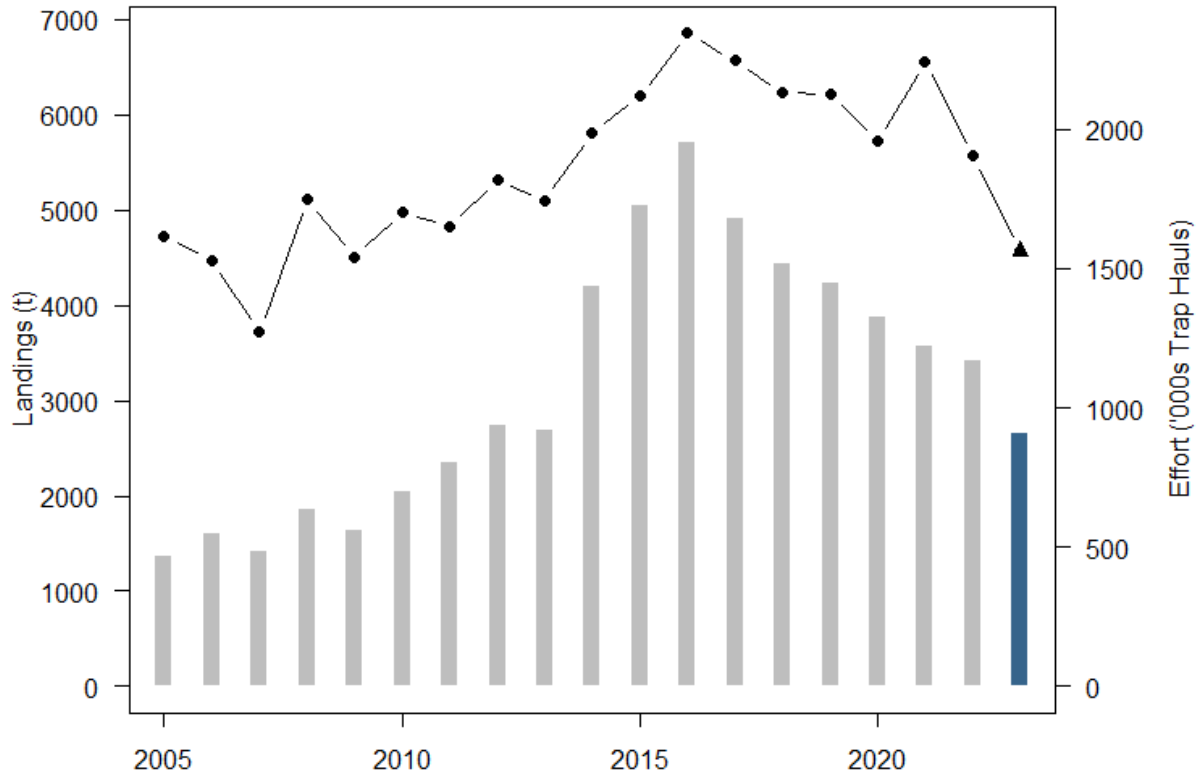

Figure 7. Time series of landings (bars), and effort (sold line with points) for LFA 38. The data for 2022–2023 fishing season are incomplete (blue bar for landings, black triangle for effort).

The historical landings in LFA 38 between 1947 and 1988 had a median of 325 t with a range of 170–450 t, then increased between 1989 and 1997 to a median of 512 t (range 467–661 t), and again from 1997–2013 there was a steady increase in landings to 2,682 t (Cook et al. 2023). From 2010–2022, median landings were 3,882 t (range of 2,035–5,711 t) and, in the more recent years, LFA 38 landings have varied. Despite a decline since 2016, landings remain relatively high for the time series. The landings for 2022–2023 season are 2,655 t but do not represent the total for the season due to the outstanding logs (Figure 7).

Scallop Survey Recruit Abundance

Annual DFO surveys for Sea Scallops have been conducted since the early 1980s to assess abundance (Sameoto et al. 2012, Smith et al. 2012). These surveys started in the Bay of Fundy in 1981 and were extended into southwest Nova Scotia in 1991. Lobster caught as bycatch are measured prior to being released. Scallops are typically found on gravel sea bottoms, a habitat not favored by Lobster (Tremblay et al. 2009), but the two species do overlap in some areas. The surveys are primarily conducted between May and September for the Bay of Fundy (LFAs 35 and 36) and Grand Manan Island (LFA 38). Scallop dredges tend to capture Lobster that are under the legal size and the survey is a useful index of recruitment.

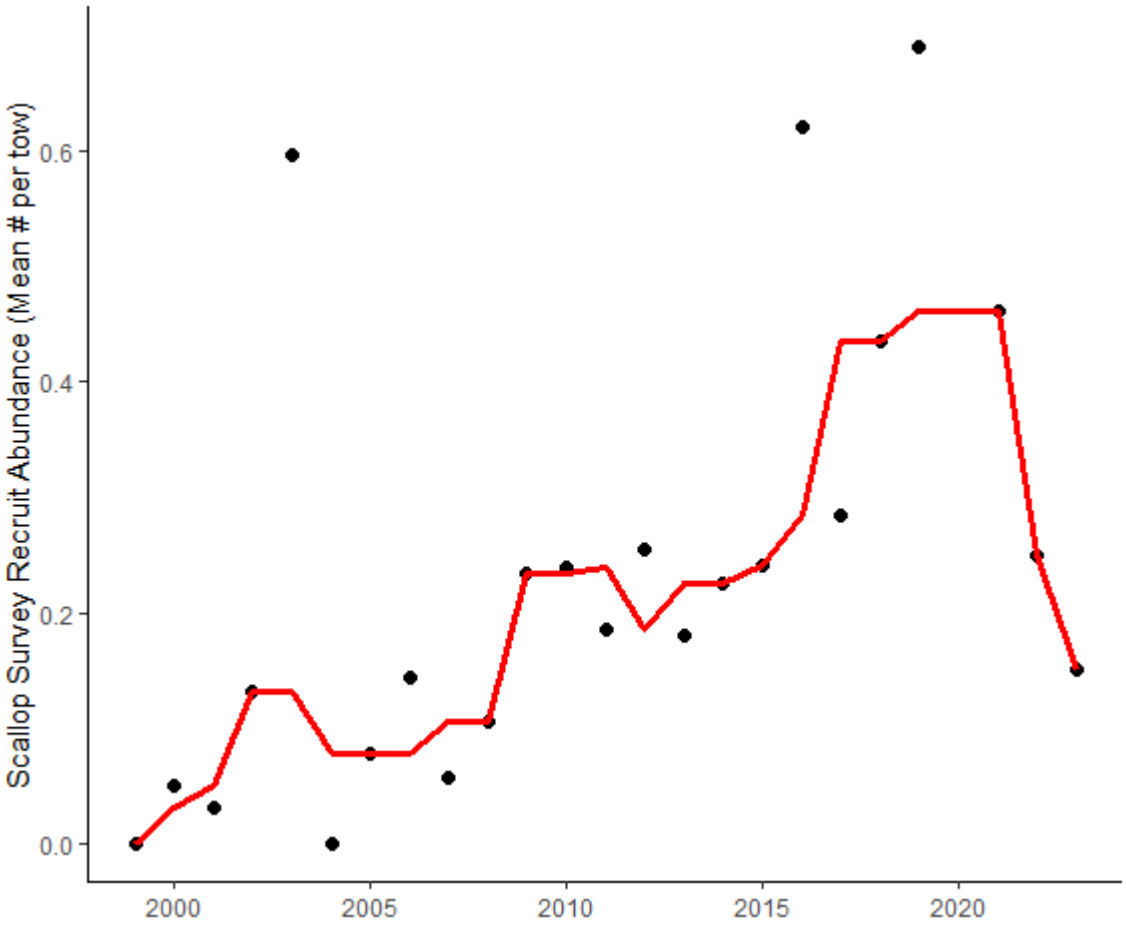

Figure 8. Time series of recruit abundance from the Bay of Fundy Inshore Scallop Survey in LFA 36. Black dots represent recruit abundance The red line represents the 3-year running median, no data were available in 2020.

The abundance index of Lobster recruits (70–82 mm carapace length) from Bay of Fundy Inshore Scallop Survey tows within LFA 36 increased after 2005 but have declined in recent years. The most recent data points from 2022 and 2023 show a decline from 2019. Surveys were not completed in 2020 due to constraints in human resources (Figure 8).

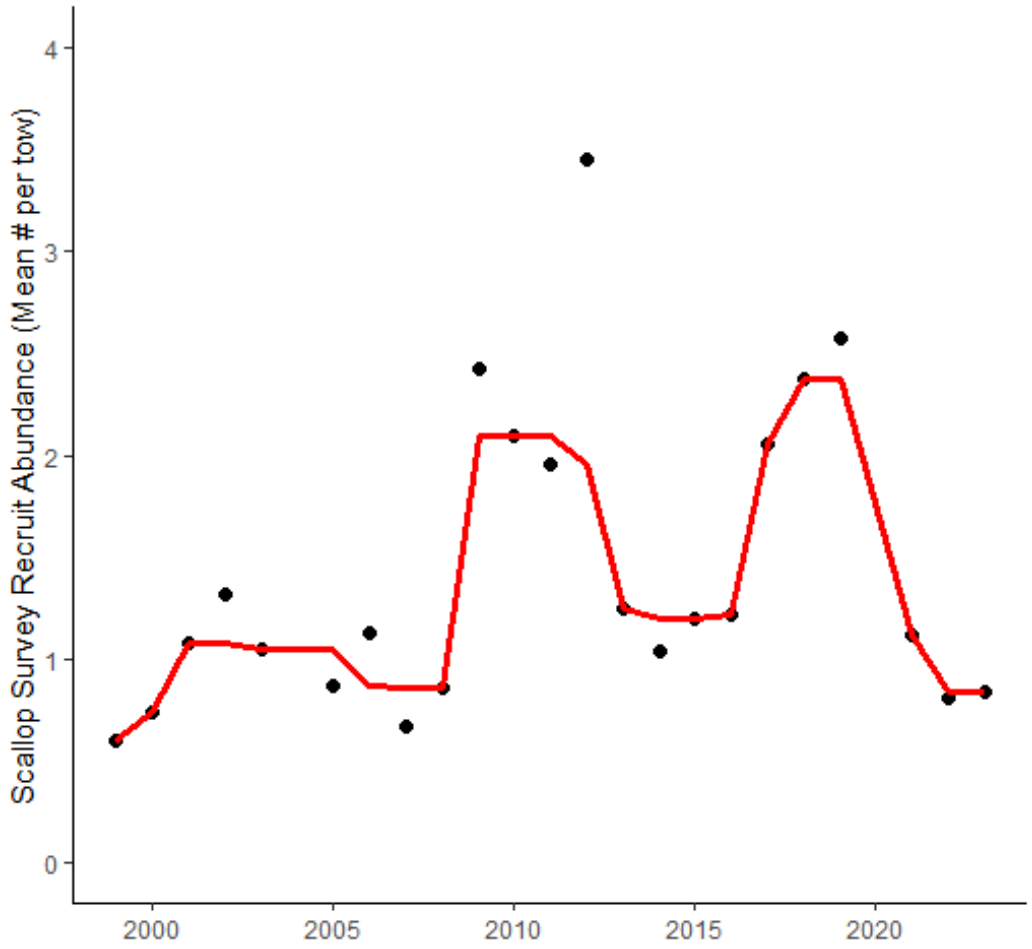

Figure 9. Time series of recruit abundance from the Bay of Fundy Inshore Scallop Survey in LFA 38. The red line represents the 3-year running median, no data were available in 2020.

The abundance index of Lobster recruits (70–82 mm carapace length) from Bay of Fundy Inshore Scallop Survey tows within LFA 38 have been variable. The early 2000s showed low index of recruit abundance followed by 4 years of a high index (2009–2012), and then 4 years of low recruitment (2013–2016). Abundance indices increased until 2019 with a return to low recruit abundance from 2021 to 2023. Surveys were not completed in 2020 due to the COVID-19 global pandemic (Figure 9).

DFO RV Survey Commercial Biomass and Recruit Abundance

Despite strata boundaries from the RV survey having significant overlap with LFAs 35–38, there were few (< 20 per year) sets within each LFA, suggesting that the value of indicators derived from these data was limited. Extending the commercial survey biomass index to years prior to 1999, when size information was not collected, was performed using the ratio of commercial to total biomass estimated between 1999 and 2018 (0.746). The time series of commercial biomass showed a pulsed increase from 2000–2004, with a variable but increasing trend from 2010–2018; however, survey catch rates in the last three years were the lowest in the last 10 years, but have been increasing over the last 3 (Figure 10). The size-at-maturity for Lobster in the Bay of Fundy is greater than the MLS, and, as such, the commercial biomass available post-

fishery will constitute those individuals entering the spawning population in the upcoming year. Figures 10, 11, and 12 include results where data were available; data from 2021 are unavailable and data from 2023 are not available at the time of this update. Continued monitoring of fisheries-independent data sources is a high priority for DFO Science.

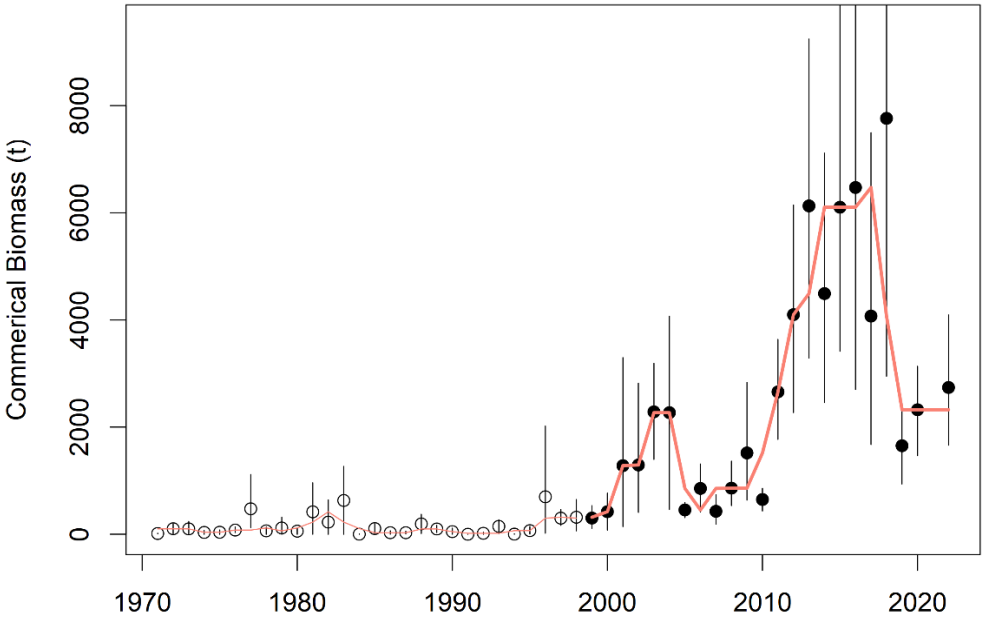

Figure 10. Index of commercial lobster biomass for LFA 35–38 estimated from the RV survey. Values prior to 1999 (open circles) were derived using the mean proportion of commercial to total biomass between 1999 and 2018 (0.746), error bars are 95% bootstrapped confidence intervals. The red line represents the 3-year running median.

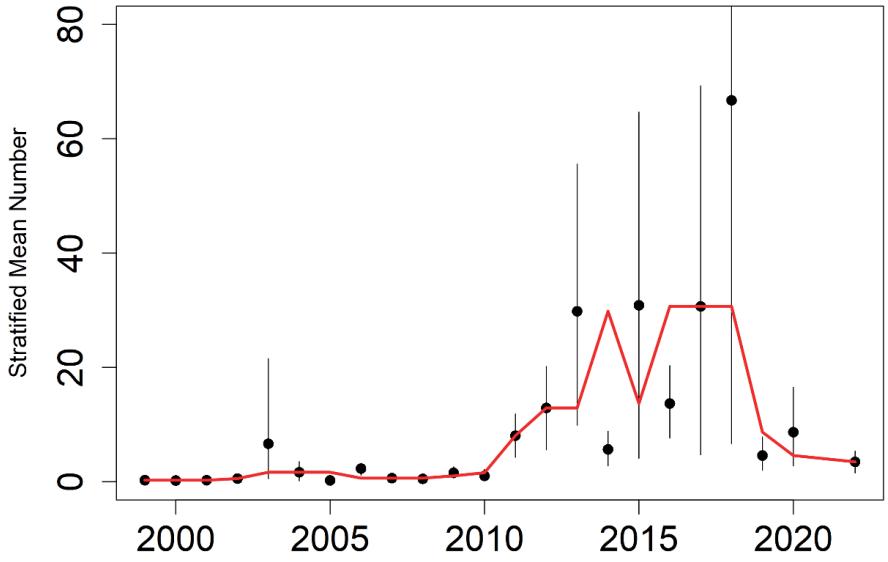

Figure 11. Time series of RV Survey trends for LFAs 35–38 recruit abundance (70–82 mm carapace length). Y-axis represents the stratified mean number of recruits per tow from the RV Survey. The red line represents the 3-year running median. Error bars are 95% bootstrapped confidence intervals.

RV survey recruit abundance (70–82 mm CL) increased from 2010–2013, followed by variable catch rates at a substantially higher level than has been observed in the time series (Figure 11). Recruit abundance in recent years (where data were available) shows a decrease from the 2018 estimate.

Relative Fishing Mortality

Relative fishing mortality (relF) at time *t* uses both the RV survey commercial biomass estimates and landings from LFA 35–38 to show the changes in removals (C_t) relative to the survey indices (I_t; assuming a catchability of 1). As the RV survey occurs after the fishery is complete, the estimation of relF was adjusted by the landings as:

$$relF_t = \frac{C_t}{(I_t + C_t)}$$

Assuming that survey catchabilities were constant and the index of commercial biomass was proportional to true commercial biomass, relF is an index of fishing mortality (F). The 3-year running median of relF reflects the variation in the commercial biomass index (Figure 12). A dramatic decline in the early 1980s is a result of few sampling stations with low and variable catches in the RV survey. RelF decreased between the late 1990s and early 2000s, increases to 2010, then decreases to 2013 with variable but low estimates since 2013 (Figure 12). Tracking the relF for the Bay of Fundy provides a depiction of the patterns observed across the larger area. RelF has been higher since 2018 than in the previous 8 years.

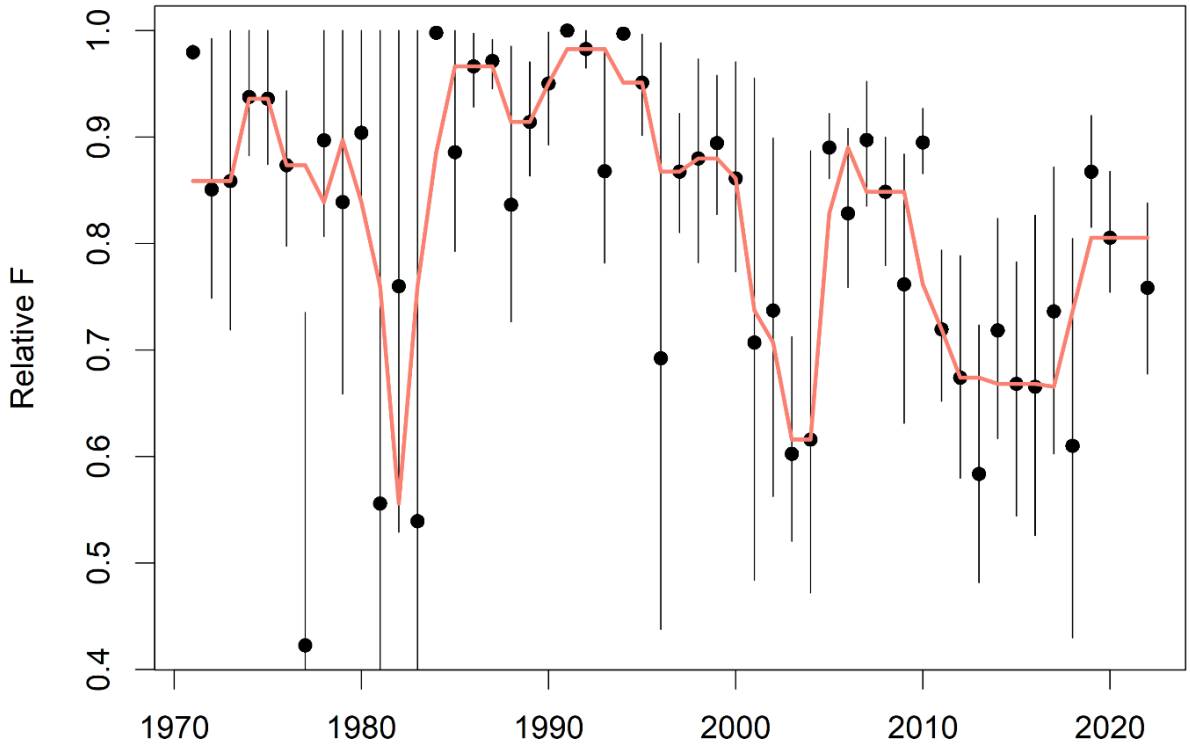

Figure 12. Relative fishing mortality (F) from the RV survey commercial biomass estimates and the landings in LFA 35–38. Red line represents the 3-year running median, error bars are 95% bootstrapped confidence intervals.

Conclusions

The primary indicator of stock status, standardized CPUE, remains well above the USR in both LFAs 36 and 38. Given the reporting rate from commercial logbooks are currently between 63% to 77% by month for LFA 36 and between 72% to 90% by month for LFA 38, annual landings appear to be on track with recent years. Landings in LFA 36 have been declining since 2018 and in LFA 38 declining since 2016. Recruit abundance index from the scallop survey shows declines for both LFA 36 and 38, particularly in the last 3 years of available data. Both the LFA 36 and LFA 38 stocks remain in the healthy zone.

From the fisheries-independent RV survey, there was an increase in the Index of Commercial Biomass after 2010 followed by a decrease in 2017 to present. Recruit abundance shows high variability since 2010. Recruitment has been highly variable and decreased in recent years. The index of Commercial Biomass from the RV surveys in the Bay of Fundy experienced a large decline in 2019 and have remained low but increasing. Relative fishing mortality from the RV survey has been variable in recent years.

The contrasting trends seen in the standardized estimates of CPUE with declines in landings and survey indices is currently unexplained. This uncertainty will be addressed with a full evaluation of the stock assessment and indicators of stock status at the next framework review meeting.

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Sources of Information

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