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Maritimes Region

Canadian Science Advisory Secretariat
Science Response 2020/047

STOCK STATUS UPDATE FOR AMERICAN LOBSTER (*HOMARUS AMERICANUS*) IN LOBSTER FISHING AREA 33 FOR 2019

Context

The scientific basis for assessing the status of American Lobster stocks in Lobster Fishing Areas (LFAs) 27–33 was examined at a framework meeting on January 23–24, 2018 (Cook et al. 2020). This was followed by an assessment held on October 1, 2018, that provided advice only for LFA 33 to align timing of science advice with data availability and the fisheries management cycle (DFO 2019a).

The Framework review identified and agreed upon primary, secondary, and contextual indicators to be used for the assessment of this stock. Some indicators are directly linked to stock health and status (e.g., abundance), whereas others describe the population characteristics (e.g., size structure) or ecosystem considerations (e.g., temperature). For the purposes of a stock status update, only the primary and secondary indicators are reported.

This Science Response Report results from the Science Response Process of October 4, 2019, on the Stock Status Update for American Lobster Fishing Areas 33.

Background

Description of the Fishery

The commercial fishery for American Lobster has been active for over 100 years in LFA 33. This area covers 25,722 km^2 from Halifax to Shelburne County. Though the LFA extends out to 92 km (50 nautical miles), the fishery is primarily prosecuted within 15 km (100 m depth contour) on the eastern end and more recently in offshore areas on the western end (Figure 1). The fishery is effort controlled, with restrictions on the number of licences, number of traps per licence (250), season length, Minimum Legal Size (MLS), and retention of berried females (Cook et al. 2020, DFO 2019b). The fishing season begins on the last Monday in November and goes until May 31. The landings in LFA 33 for the 2018-19 fishing season were 8,155 mt (Table 1).

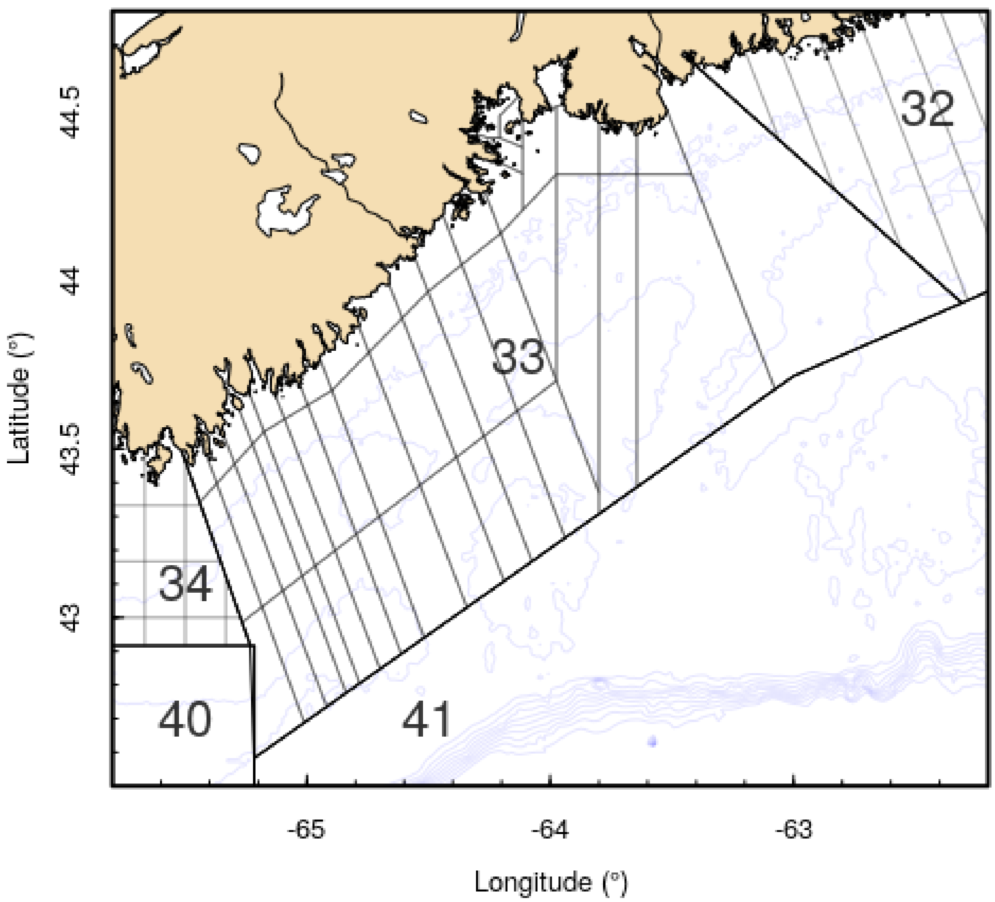

Figure 1. Map of Lobster Fishing Area (LFA) 33 showing reporting grids.

Table 1. Landings and number of licences for recent fishing seasons in Lobster Fishing Area (LFA) 33. Number of licences is representative of the number as of December 31st of the fishing season start-year.

Season	Landings (mt)	Number of Licences
2014–2015	7,071	699
2015–2016	10,024	698
2016–2017	8,020	695
2017–2018	8,422	694
2018–2019	8,155	683

Analysis and Response

Indicators of the Stock Status

Primary indicators are used to define stock status in relation to the reference points, and secondary indicators are those in which time series trends are displayed but are not associated with reference points.

The data sources available for constructing indicators for LFA 33 are mainly fishery-dependent. Commercial logbooks report information on date, location (grid), effort, and estimated catch. At-sea samples are collected during normal commercial fishing operations and provide information on bycatch and Lobster caught, including carapace size, sex, egg presence, and stage; shell hardness; occurrence of culls and v-notches; and the number of traps, location, and depth. The Fishermen and Scientist Research Society (FSRS) are contracted to conduct a recruitment trap project involving volunteer fishermen who record data on Lobsters that are captured in standardized traps.

Primary Indicators

Primary indicators are the focus for defining stock status, by describing the time series trends relative to reference points. The primary indicator for describing stock status is the unmodelled commercial Catch Per Unit Effort (CPUE). Exploitation estimated using the Continuous Change In Ratio (CCIR) method from recruitment trap data is used as the primary indicator of fishing pressure that is independent of landings reported in the logs. The recruitment trap data for the 2018–19 fishing season were not available for this Science Response report.

Catch Per Unit Effort

The time series of commercial catch rates is made up of two data sources. The first was the voluntary log books, which began in the 1980s and continued until 2013 in LFA 33. Mandatory logs have been in place in LFA 33 since the mid 2000s and provide a more complete data set with which to evaluate changes in catch rates (Tremblay et al. 2012). In years where both voluntary and mandatory logs were available, the magnitude and trends over time were similar (Tremblay et al. 2013), so both logbook types were included together. In the current analysis, the two commercial catch rate series are treated as a single continuous time series beginning in 1990, when there was increased participation in the voluntary logbook program.

The combined catch rate data series from 1990–2016 was used to define the Upper Stock Reference (USR) and Limit Reference Point (LRP). The median of this time series was used as the proxy for Biomass at Maximum Sustainable Yield (B_{MSY}), 0.35 kg/Trap Haul (TH). Following the recommendations of DFO (2009), the USR and LRP were set to 80% and 40% of the B_{MSY} proxy. The value used to compare the commercial catch rates to the USR and LRP is the 3-year running median, as this dampens the impact of any anomalous years that may occur due to factors outside of changes in abundance.

The trend in CPUE indicates that a significant increase in the stock biomass has occurred in the last ten years (Figure 2). For most of the time series, CPUE has fluctuated just above the USR, substantially increasing after 2008 so that it is currently more than triple the USR. The 3-year running median value for CPUE for the 2018–19 fishing season is 1.05 kg/TH, which is well above the USR (0.28 kg/TH) and LRP (0.14 kg/TH).

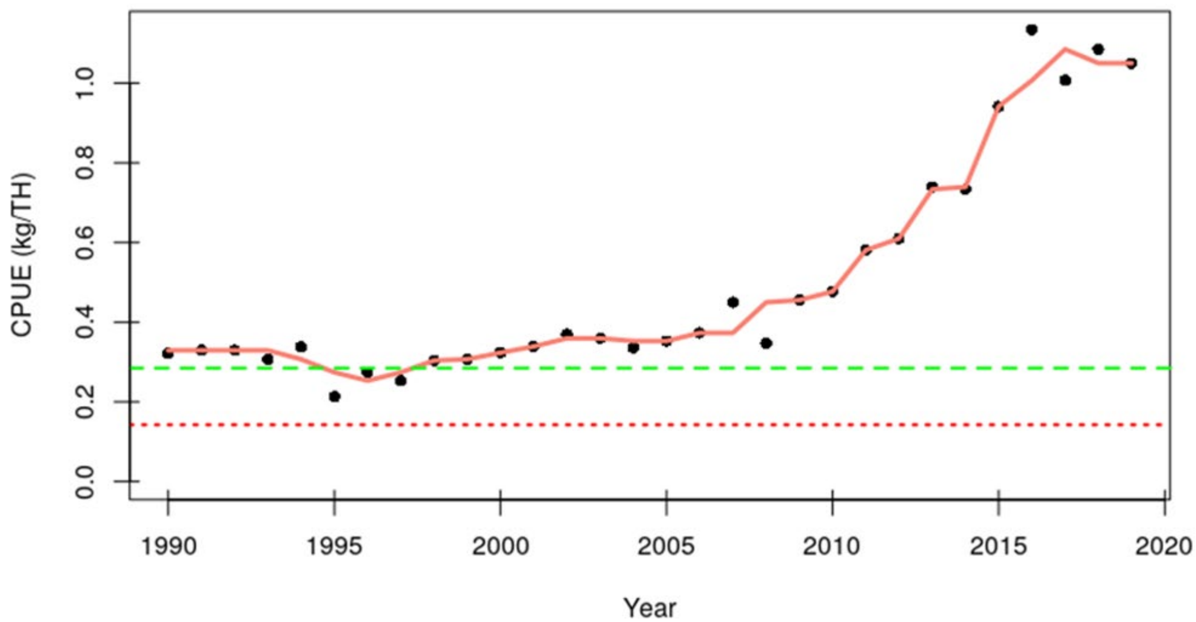

Figure 2. Time series of commercial catch rates (black dots), three-year running median (solid orange line) with Upper Stock Reference (horizontal dashed green line) and Limit Reference Point (horizontal dotted red line).

Continuous Change in Ratio Method Exploitation Estimates

The CCIR method is used as an indicator of fishing pressure. It is based on the recruitment trap data, so reflects trends in exploitation in the inshore portion of the LFA, where the majority of the fishery occurs.

The CCIR method provide estimates of population parameters based on the changes in observed proportions of components within the population. Estimating exploitation using CCIR relies on defining and monitoring two (or more) components of the population, consisting of a reference (non-exploited) component and an exploited component. The premise of this method is that the proportion of reference individuals within the population will increase with the cumulative removals from the exploitable component (Claytor and Allard 2003). The strength of this approach is that it does not rely directly on fishery-dependant landings data, so the CPUE indicator and CCIR exploitation estimates are based on independent time series.

The implicit assumptions of the CCIR include that, over the sampling period, the population is closed, the ratio of catchability of the two components is constant, the ratio of the catchability of the monitoring traps and the commercial traps is constant, and the monitoring effort is directly proportional to harvesting effort. The recruitment trap catch data provide information on the changes in the pre-exploitable reference group (sub-legal-sized Lobsters) relative to the exploitable group (legal-sized Lobsters) needed to estimate exploitation. The Removal Reference (RR) was defined as the 75th quantile of the posterior distribution of the maximum modeled CCIR exploitation rate. Given that regional Lobster stocks are currently in a highly productive state and population growth has not decreased under the range of estimated exploitation, it is reasonable to assume the RR is less than the fishing mortality corresponding to maximum sustainable yield, F_{MSY}.

The time series of exploitation estimates is shown in Figure 3. For the first half of this time series, exploitation estimates were fairly high—just below the RR. Since 2013, exploitation has declined to about two-thirds of the level of the RR. In the last two years, exploitation has increased but the running median remains near two-thirds of the RR. The 3-year running median value of CCIR exploitation for the 2017-18 fishing season is 0.56, which is below the RR (0.81).

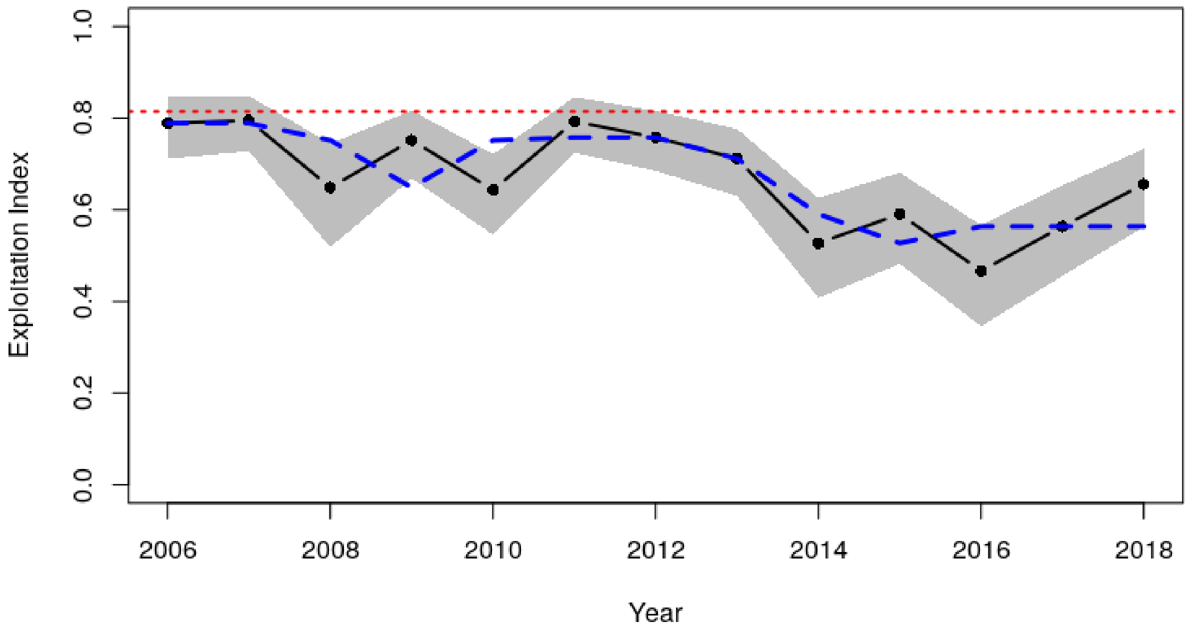

Figure 3. Time series of continuous change in ratio method exploitation estimates (black long dash) with 95% credible intervals (grey shading), three-year running median (short blue dash), and the removal reference (dotted red line).

Secondary Indicators

Secondary indicators represent important time-series trends that are tracked individually, but no reference points are defined. The secondary indicators for LFA 33 are landings and total effort (trap hauls), as well as the recruitment trap legal and sub-legal catch rate series. The recruitment trap data for the 2018–19 fishing season were not available for this report.

Landings and Effort

Levels of commercial landings are related to population abundance, as fishery controls are input-based (effort controls) rather than output-based (e.g., total allowable catch). Changes in levels of fishing effort, catchability (including the effects of environment, gear efficiency), Lobster size distribution, and the spatial overlap between distribution of Lobster and effort will impact landings, thereby weakening the relationship with abundance.

Fishing effort can be used as a proxy for fishing pressure. It is an important indicator for fishery performance, as increases in landings may be due to increases in commercial sized biomass, or increased fishing effort, or both. Fishing effort, number of trap hauls, in the Lobster fishery is controlled by fishing season length, trap limits, and a limited number of fishing licences. Consequently, there is a maximum fishing effort that can be deployed. This maximum is never met as factors such as weather conditions, seasonally variable catch rates, and fishing partnerships all limit the total number of trap hauls.

Generally, the trend in landings is similar to the trend in the primary indicator, CPUE, as effort has remained fairly consistent over the time series (Figure 4). There has been a significant increase in landings over the last ten years that corresponds with an increase in CPUE. There are some annual fluctuations in effort, with a slight increasing trend over time.

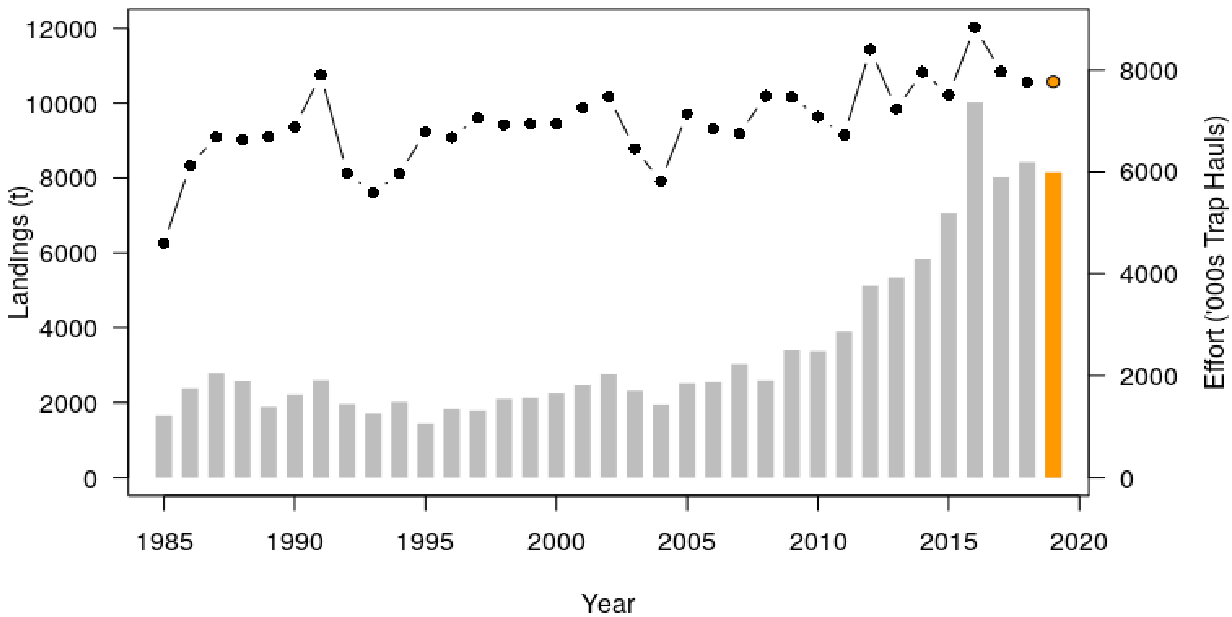

Figure 4. Time series of landings (bars) and effort (sold line with points). Landings data for the 2018–19 fishing season do not represent a full accounting due to outstanding logs.

Recruitment Trap Legal and Sub-legal Catch Rates

The recruitment trap survey provides the best information on the abundance of under-sized Lobsters. It is also the only source of data on abundance for LFA 33 that is collected in a standardized manner. The catches of legal- (≥82.5 mm) and sub-legal-sized (70–82.5 mm) Lobsters were modelled with a Bayesian approach in order to characterize the credible intervals of the predicted time series used as the indicator. The numbers of legal- and sub-legal-sized Lobsters were assumed to follow a negative binomial distribution with the log number of traps used as an offset. For sub-legal-sized Lobsters, the predictors included temperature, the number of legal-sized Lobsters caught, and year. For legal-sized Lobsters, the predictors were temperature, the day of the season, and year. All of these effects were significant. Temperature is assumed to affect catch rates of all Lobsters, while larger Lobsters (legal-sized) are assumed to reduce entrance of smaller Lobsters (sub-legal-sized) into traps. The resultant models were used to predict the number of Lobsters (for each size class) per trap for each year at a common temperature, date, and number of legal-sized Lobsters per trap.

The results from the recruitment trap models showing the median number of legal- and sub-legal-sized Lobsters per trap with their 95% credible intervals are presented in Figure 5. Both legal and sub-legal size classes show a gradual increasing trend, which is not as dramatic as the increase in landings and CPUE over the last ten years. It is important to note, however, that the recruitment traps are mainly located close to shore, where smaller Lobsters are more often present, and do not cover the whole range where Lobster are fished in LFA 33.

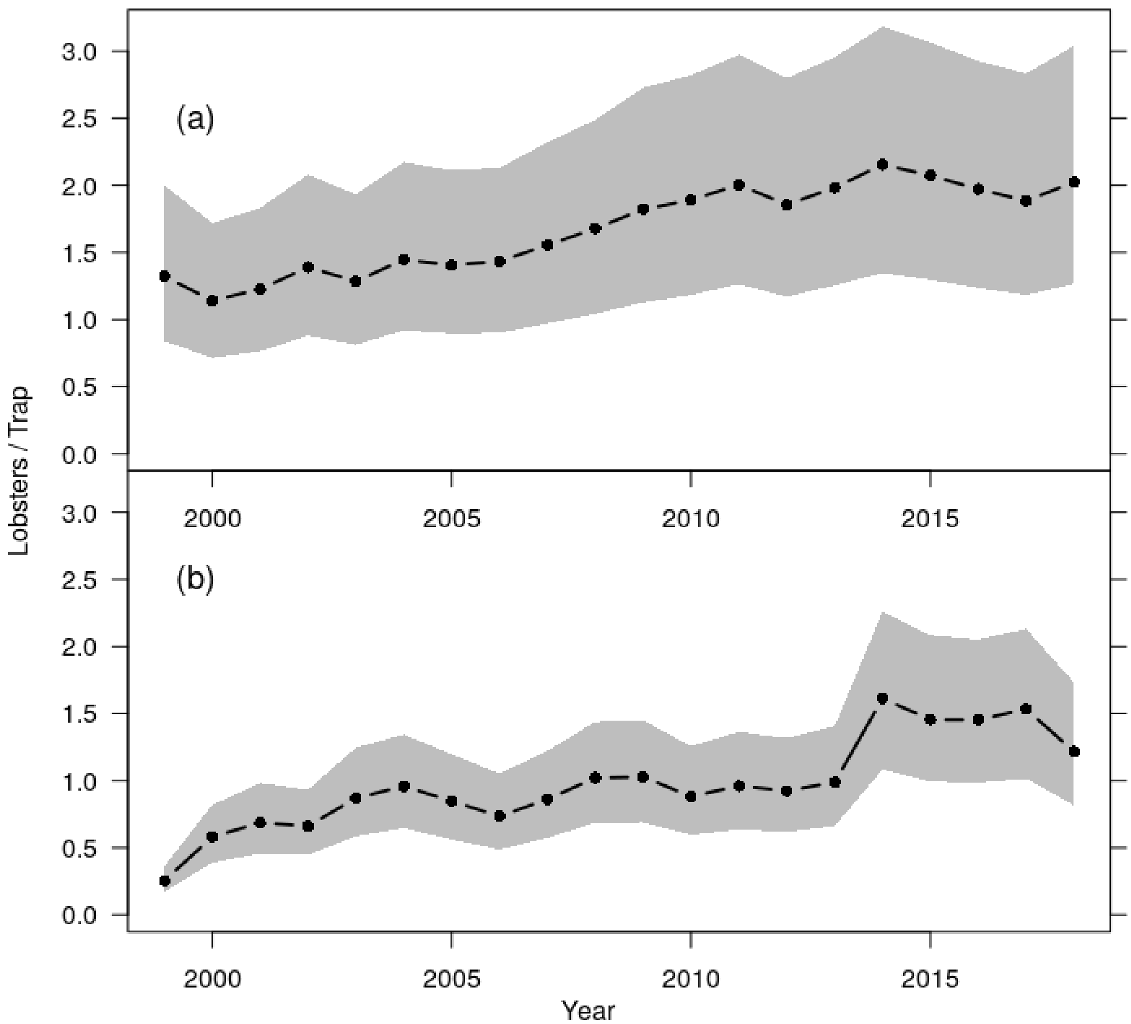

Figure 5. Time series of recruitment trap catch rates (black points), with 95% credible intervals (grey shading) from modelled results for (a) legal-sized (≥82.5 mm) and (b) sub-legal-sized (70 mm to 82.5 mm) Lobsters.

Conclusions

The primary indicators show strong positive signals for this stock. The stock status indicator, CPUE, has increased dramatically in the last ten years. The primary indicator for exploitation, the CCIR models from the recruitment trap data, indicates a reduction of exploitation in the inshore areas where this data is available. It should be noted that fishing effort has moved to more offshore areas that were not previously heavily exploited and are not monitored for exploitation. The recruitment trap data for the 2018–19 fishing season was not available for this report.

The conservation measures that have been put in place in other LFAs since the late 1990s and early 2000s, including increasing MLS, protecting window-sized Lobster, returning large females, and v-notching programs, have increased reproductive potential and productivity in respective LFAs. The impacts of some conservation measures can be detected in some of the biological indicator trends (Cook et al. 2020). These conservation measures should be encouraged, as protecting the reproductive components of the stock will buffer the impacts of years with suboptimal environmental conditions for Lobster production.

Precautionary approach reference points that were adopted following the 2018 Framework review are illustrated in Figure 6. The phase plot shows the relationship between commercial catch rates and CCIR exploitation rate in relation to the reference points USR, LRP, and RR. The trend shows increasing catch rates and decreasing exploitation in recent years. The CPUE index is well above the USR, suggesting the current status of LFA 33 is well within the healthy zone, and exploitation was below the RR for the 2017-18 fishing season.

The removal reference is to be adjusted depending on the stock's abundance and its location in the three stock status zones. In the cautious zone, the adjustment of the RR does not have to follow a linear relationship, but a progressive reduction in removals is required.

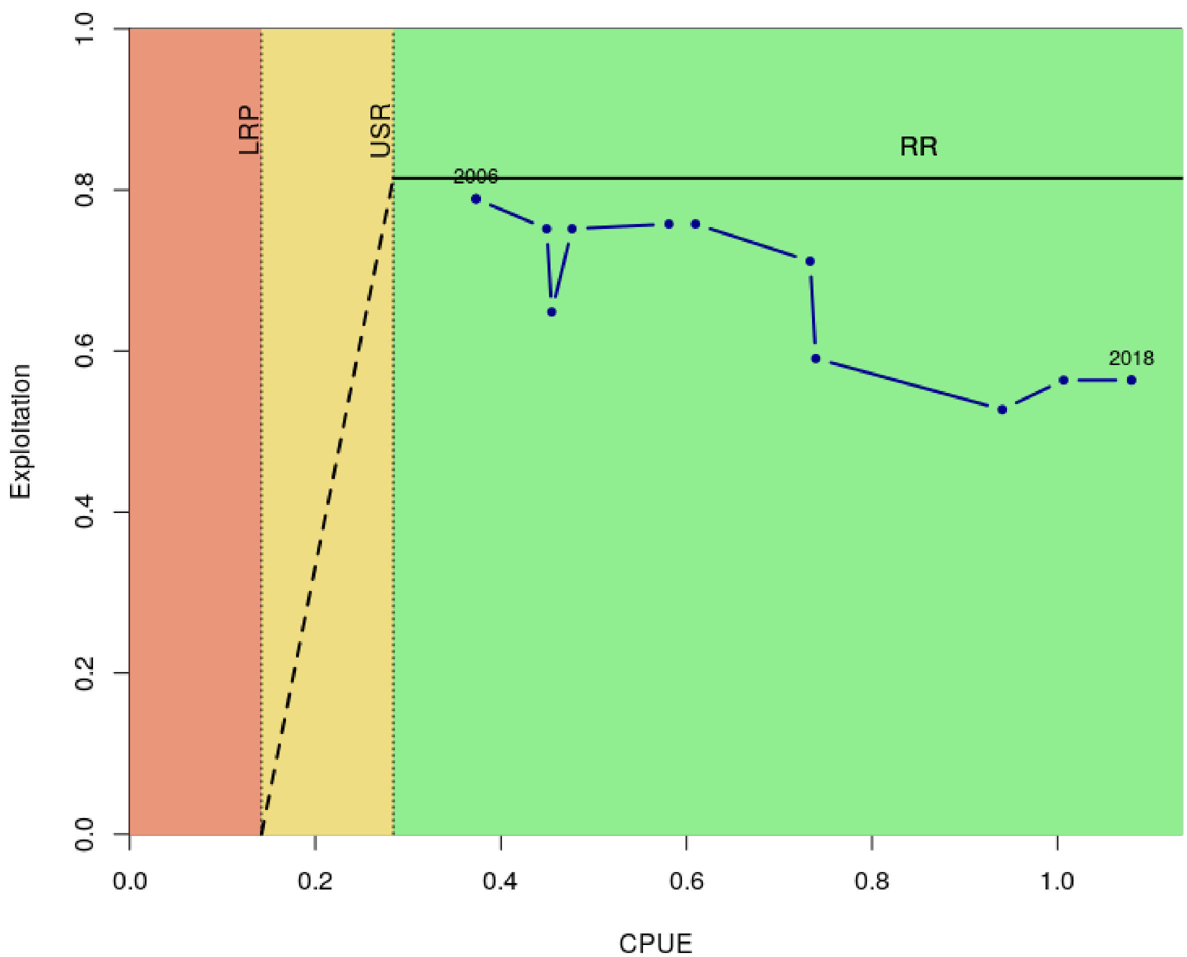

Figure 6. Phase plot using the three-year running median of Catch Per Unit Effort and three-year running median of Continuous Change in Ratio exploitation index compared against the proposed Upper Stock Reference (USR) and Limit Reference Point (LRP) based on commercial catch rates. The Removal Reference (RR) is the 75th quantile break of the posterior distribution for the maximum exploitation index.

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Sources of Information

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