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Canadian Science Advisory Secretariat
Maritimes Region **Science Response 2022/010**

STOCK STATUS UPDATE FOR AMERICAN LOBSTER (*HOMARUS AMERICANUS*) IN LOBSTER FISHING AREA 33 FOR 2021

Context

The scientific basis for assessing the status of American Lobster (*Homarus americanus*) 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 2019).

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. Contextual biological (maximum/median size, sex ratios, etc.) and environmental (bottom temperature) indicators are not presented here.

This Science Response Report results from the Regional Science Response Process of October 7, 2021, on the Stock Status Update of American Lobster in Lobster Fishing Area (LFA) 33. When this document was written, there were outstanding commercial fishing and recruitment trap project logs. As such, some results are preliminary as detailed below.

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 non-retention of berried females (Cook et al. 2020, DFO 2020). The fishing season begins on the last Monday in November (can be varied by inclement weather) and goes until May 31. The landings in LFA 33 for the

2020–2021 fishing season were 7,096 mt (Table 1), though not all logs[1] have been received at the time of this report.

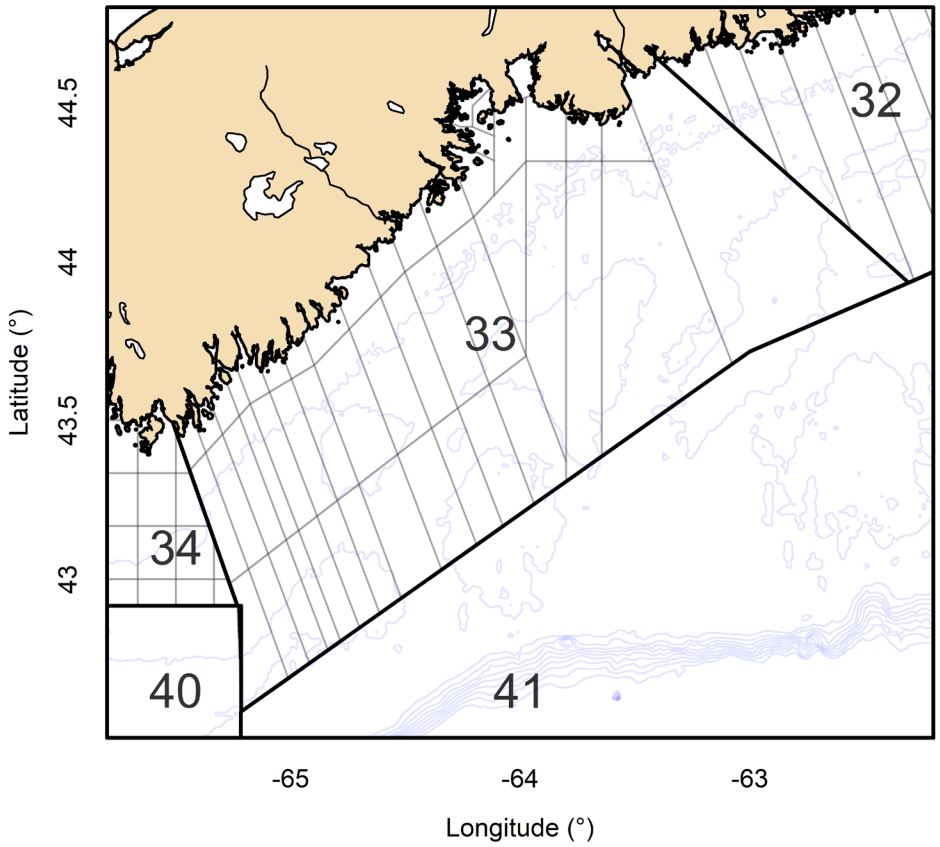

Figure 1. Map of Lobster Fishing Area (LFA) 33 showing logbook reporting grids in grey.

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
2016–2017	8,030	695
2017–2018	8,431	695
2018–2019	8,579	683
2019–2020	6,345	682
2020–2021	7,096[1]	680

[1] Preliminary total as of November 4, 2021; 93% of monthly logs received.

[1]As of November 4, 2021, 93% of monthly logs had been received.

Analysis and Response

Indicators of Stock Status

Primary indicators are used to define stock-status trends in relation to reference points. Secondary indicators are those in which time-series trends are displayed and provide additional information about the fishery without associated reference points.

The data sources informing indicators for LFA 33 are mainly fishery dependent. Commercial logbooks report information on date, location (grid), effort, and estimated catch. The Fishermen and Scientist Research Society (FSRS) conducts a recruitment-trap project involving volunteer fishermen who record detailed data on Lobsters that are captured in standardized traps.

Primary Indicators

The primary indicator for describing stock status is the unmodelled commercial Catch Per Unit Effort (CPUE) in kilograms per Trap Haul (kg/TH). Relative exploitation is estimated using the Continuous Change In Ratio (CCIR) method from FRSR recruitment trap data. This CCIR is used as the primary indicator of fishing pressure and is independent of fishery logs.

Catch Per Unit Effort

The time series of commercial catch rates is made up of two data sources. The first was the voluntary logbooks, 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 the current analysis, the two commercial catch-rate series are treated as a single, continuous time series since 1990, when voluntary logbook program participation increased.

The 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/TH. Following reference point guidance of DFO (2009), the USR and LRP were set to 80% and 40% of this B_{MSY} proxy. The 3-year running median of commercial catch rates is compared to the USR and LRP. Use of the running median dampens the impact of anomalous years that are potentially unrelated to changes in abundance.

For much of the early time series, CPUE fluctuated just above the USR (Figure 2). CPUE trends from 2007–2015 indicate a significant increase in the stock biomass occurred, peaking between 2015–2016 and 2017–2018 fishing seasons. It has been in decline since the 2017–2018 fishing season. The 3-year running median CPUE for the 2020–2021 fishing season is 0.89 kg/TH, which remains well above the USR (0.28 kg/TH) and the LRP (0.14 kg/TH).

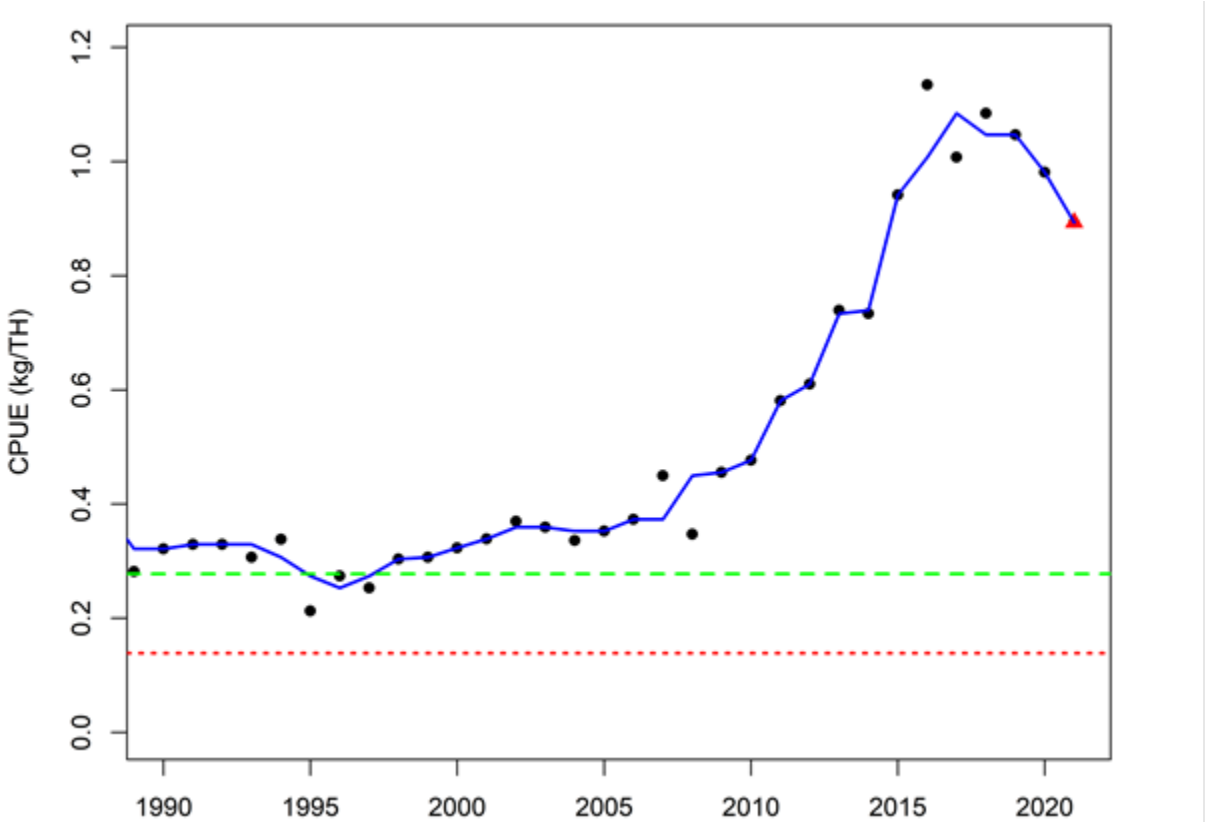

Figure 2. Time series of commercial catch rates (black points) with the 3-year running median (blue line). The red triangle indicates an incomplete data point as all commercial logbooks for this season have not yet been received and entered. The horizontal lines represent the Upper Stock Reference (dashed green line) and Limit Reference Point (dotted red line).

Exploitation

The CCIR method provides estimates of population parameters based on the changes in observed proportions of size components within the population; the proportion of reference individuals (sublegal-sized Lobster) increases with the cumulative removals of the exploitable component (Claytor and Allard 2003). In LFA 33, these exploitation trends are more representative of inshore areas where the majority of the recruitment traps are fished.

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 near the RR. Since 2013, exploitation (3-year running median) was relatively stable at about two-thirds of the level of the RR. The 3-year running median value of CCIR exploitation for the 2020–2021 fishing season is 0.47, which is again below the RR (0.83).

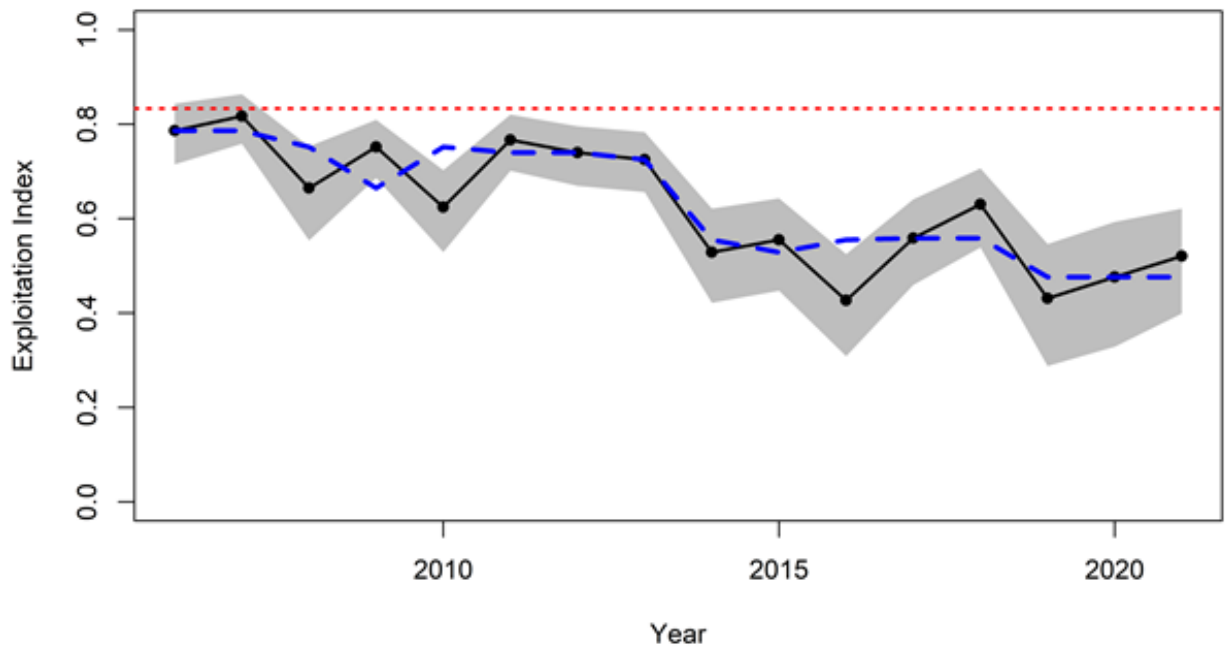

Figure 3. Time series of continuous change in ratio-method exploitation estimates (black line) with 95% credible intervals (grey shading), 3-year running median (short blue dashed line), and the removal reference (dotted red line).

Secondary Indicators

Secondary indicators represent important time-series trends that are tracked individually without defined reference points. The secondary indicators for LFA 33 are landings and total effort (trap hauls), as well as the recruitment-trap legal and sublegal catch-rate time series.

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). Landings are impacted by changes in levels of fishing effort, catchability (including the effects of environment, gear efficiency, etc.), Lobster size distribution, and the spatial overlap between distribution of Lobster and effort. These additional factors weaken the direct relationship between landings and 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.

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). The post-2005 period of increasing CPUEs was coupled with increasing landings. The spring portion of the 2019–2020 fishing season was affected by the COVID-19 pandemic that severely impacted global Lobster markets and fishing operations. Fewer fishing days (and associated trap hauls) occurred in almost all weeks of the 2019–2020 season as compared to the previous year. The return to

more normal fishing operations and markets saw increased effort and landings for the 2020–2021 fishing season.

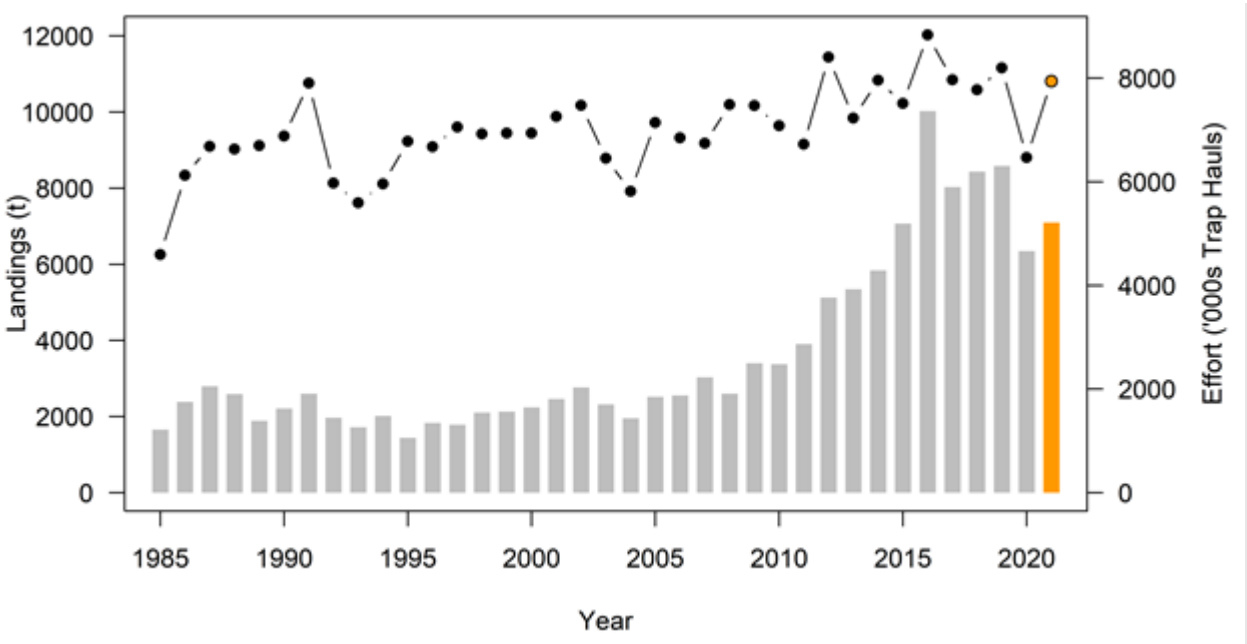

Figure 4. Time series of landings (bars) and effort (sold line with points) by fishing season. Year refers to end year of season. Data (in orange) for the 2020–2021 fishing season are incomplete due to outstanding fishing logs.

Recruitment Trap Legal and Sublegal Catch Rates

The recruitment-trap survey provides the best information on the abundance of under-sized Lobsters. The catches of legal- (≥ 82.5 mm) and sublegal-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. Methods are described in the 2018 Framework Assessment (Cook et al. 2020).

The results from the recruitment-trap models showing the median number of legal- and sublegal-sized Lobsters per trap with their 95% credible intervals are presented in Figure 5. Both legal- and sublegal-sized classes were showing a gradual increasing trend over the course of the time series but have declined in both of the past two seasons mirroring the decreasing trend in commercial catch rates. It is important to note that the recruitment traps are mainly located close to shore where smaller Lobsters are more often present. The full spatial extent of the LFA 33 fishery (and associated catches) is not fully represented in these data.

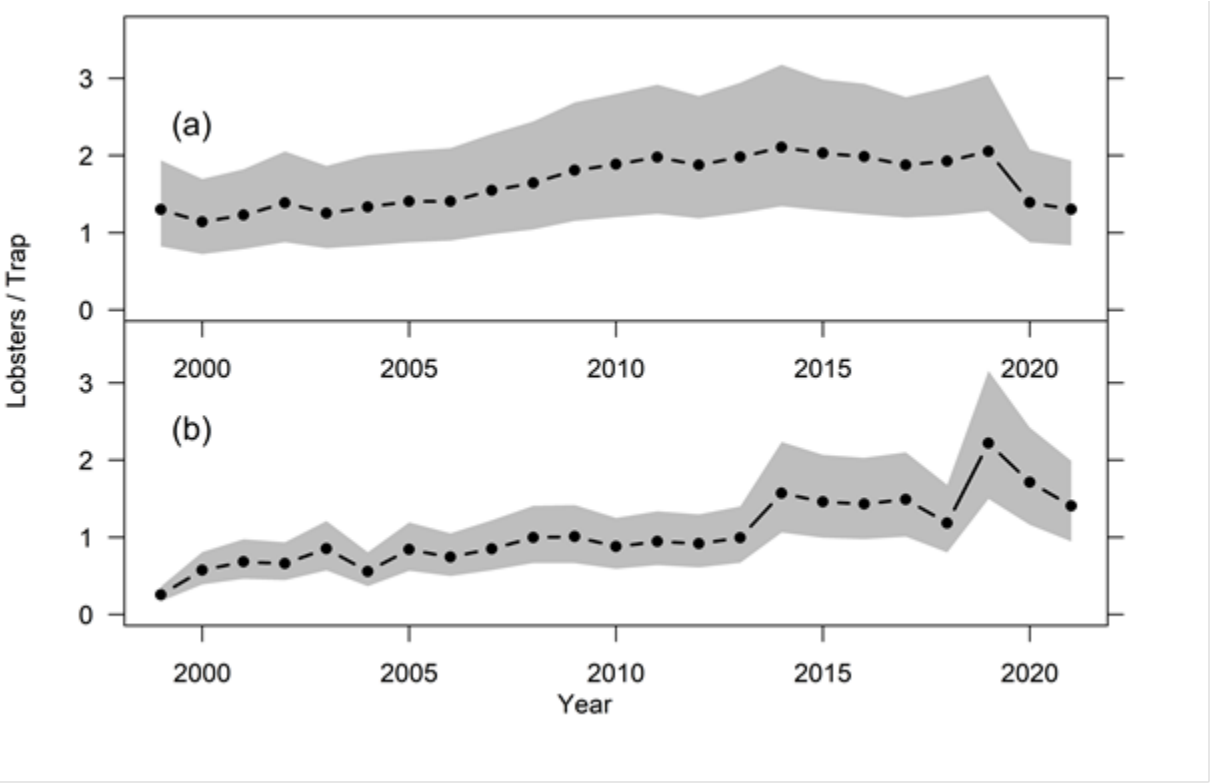

Figure 5. Time series of recruitment-trap catch rates (black points), with 95% credible intervals (grey shading) from modelled results for (a) legal-sized (≥ 82.5 mm) and (b) sublegal-sized (70 mm to 82.5 mm) Lobsters from 1999–2020.

Conclusions

The primary indicators continue to show positive signals for this stock. The stock status indicator, CPUE, remains high relative to pre-2007 levels. The primary indicator for exploitation, the CCIR models from the recruitment trap data, indicates that exploitation remains well below the RR. It should be noted that fishing effort has shifted to more offshore areas that were not previously heavily exploited and are not effectively monitored for exploitation, increasing the uncertainty in the exploitation index.

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 (a defined size range above MLS) Lobster, returning large females, and v-notching programs, have increased reproductive potential and productivity in respective LFAs. The positive impacts of some conservation measures can be detected in some of the biological indicator trends (Cook et al. 2020). Such conservation measures should be encouraged, as protecting the reproductive components of the stock will potentially buffer the impacts of years with suboptimal environmental conditions for Lobster production. The larvae produced during the 2012 warm water event (Zisserson and Cook 2017) are now recruiting to the fishery. Juvenile lobster have specific habitat and temperature preferences (Neilsen and McGaw 2016). Decreased catch rates (both in commercial and recruitment traps) may be a result of decreased survival, or over-crowding of

juveniles, resulting from reduced habitat availability in anomalously warm environmental conditions.

Precautionary approach reference points that were adopted following the 2018 Framework Assessment 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 in the healthy zone, and exploitation was below the RR for the 2020–2021 fishing season.

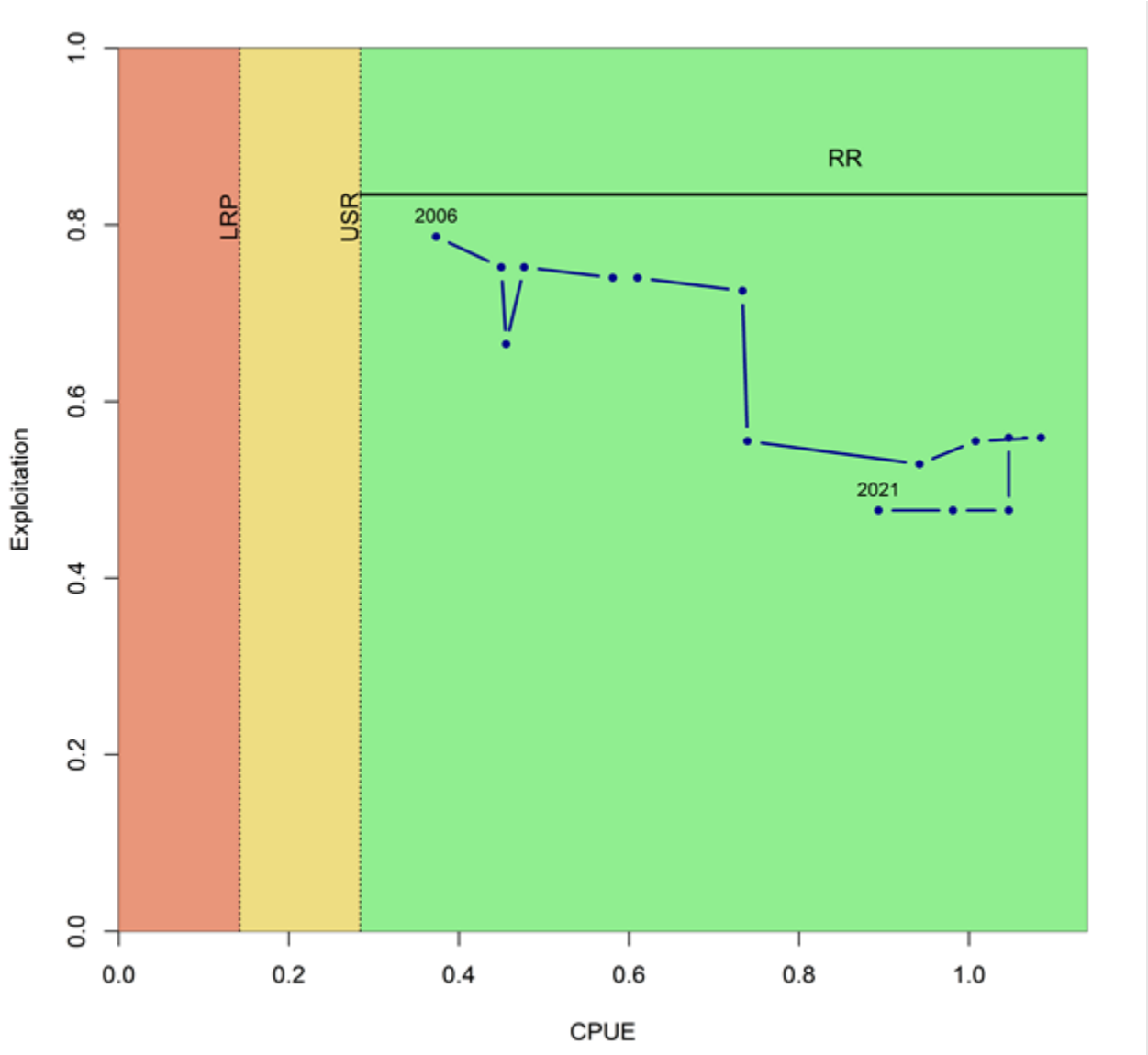

Figure 6. Phase plot using the 3-year running median of Catch Per Unit Effort and 3-year running median of Continuous Change in Ratio exploitation index compared against the proposed Upper Stock Reference (USR) and Limit Reference Point (LRP) based on commercial catch rates. The Removal Reference (RR) is the 75th quantile break of the posterior distribution for the maximum exploitation index.

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