Fisheries New Zealand

Tini a Tangaroa

Rapid update for the New Zealand rock lobster (*Jasus edwardsii*) in CRA 2 in 2024

New Zealand Fisheries Assessment Report 2025/11

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ISSN 1179-5352 (online)
ISBN 978-1-991345-16-5 (online)

February 2025

Te Kāwanatanga o Aotearoa
New Zealand Government

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Please cite this report as:

Pons, M.; Webber, D.N.; Rudd, M.B.; Starr, P.J.; Roberts, J. (2025). Rapid update for the New Zealand rock lobster (*Jasus edwardsii*) in CRA 2 in 2024. *New Zealand Fisheries Assessment Report 2025/11.* 21 p.

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PLAIN LANGUAGE SUMMARY

The red rock lobster supports the most valuable inshore commercial fishery in New Zealand. This fishery has been managed with catch quotas in nine Quota Management Areas (QMAs), which are usually treated as independent populations or stocks.

To estimate those quotas, each population is fully assessed every five years, requiring a lot of time and effort by a team of at least five researchers working on the review of the previous stock assessments and data inputs, the processing and addition of new data, and development of a new assessment.

Every year, instead of a full assessment, a rapid update assessment is done for some of the stocks that were not assessed that year. A rapid update repeats the previous full assessment model, only updating data inputs, which significantly speeds up the required process to provide advice about stock status in the interim years between full stock assessments.

This document describes the operation of the stock assessment rapid update completed in 2024 for CRA 2 which can be used to guide management decisions.

For the beginning of the 2024–25 fishing year, red rock lobster in CRA 2 was estimated to be above sustainable levels and projected to be above reference levels in five years under current catch limits.

EXECUTIVE SUMMARY

Pons, M.[1]; Webber, D.N.[2]; Rudd, M.B.[3]; Starr, P.J.1; Roberts, J.[4] (2025). Rapid update for New Zealand rock lobster (*Jasus edwardsii*) in CRA 2 in 2024.

***New Zealand Fisheries Assessment Report 2025/11*. 21 p.**

This document describes the operation of the stock assessment rapid update of the New Zealand red rock lobster (*Jasus edwardsii*) for CRA 2 which can be used to guide management decisions in this QMA.

Full stock assessments for each rock lobster stock are generally done once every five years. Full stock assessments require significant time and effort, including: a review of the previous stock assessment and data inputs, updates to data processing code, the addition of new data, implementation of new structural changes to the model, review of prior specifications for model parameters, and runs to investigate sensitivity to key model assumptions. For red rock lobsters, the last few stock assessments have required five stock assessment scientists working for over five weeks to complete one or two stock assessments, working under the guidance of the Rock Lobster Working Group.

Rapid updates differ from a full stock assessment because they repeat the previous base case stock assessment model(s), with the same model settings and assumptions, only updating inputs with new covariates and data (e.g., additional years of catch, length frequencies, sex ratios, and tag-recapture growth increment data). This significantly speeds up the required process, with the result being that every stock can potentially have a rapid update done each year. Rapid updates do not aim to replace full stock assessments, but complement them by providing inference about stock status in the interim years between full assessments.

This document presents a rapid update for CRA 2 only. Rapids updates were not done for CRA 3 and CRA 4 this year because they received a full stock assessment in 2024. CRA 1 and CRA 5 were not included because there has been no new information on catch per unit of effort (CPUE) for the last 4 to 5 years to contribute to reliable stock status estimates. CRA 7 and CRA 8 used management procedures in 2024, resulting in no need to produce rapid updates for these stocks. CRA 6 had no new relevant information to be assessed by a rapid update this year; and there is no accepted stock assessment for CRA 9, so it cannot be included in the rapid update system.

For the beginning of the 2024–25 fishing year, the adjusted vulnerable biomass for CRA 2 was estimated to be 154% of the reference level (B_R). Spawning stock biomass (SSB) indicators showed that the median SSB in 2024–25 was 38% of SSB_0, with a 100% probability of SSB being above the soft and hard limits at the beginning of the 2024–25 fishing year.

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[3] Scaleability LLC, USA.
[4] Anemone Consulting Ltd, Wellington, New Zealand.

1. INTRODUCTION

The red rock lobster (*Jasus edwardsii*) supports the most valuable inshore commercial fishery in New Zealand, with exports worth NZD$300 million in 2019 (Seafood New Zealand 2020) and it is also valuable to customary Māori, recreational fishers, and non-extractive stakeholders. Commercial red rock lobster fisheries have been managed with Individual Transferable Quotas (ITQs) in nine Quota Management Areas (QMAs) since April 1990, which are usually treated as independent stocks for stock assessment (Breen et al. 2016a, Figure 1).

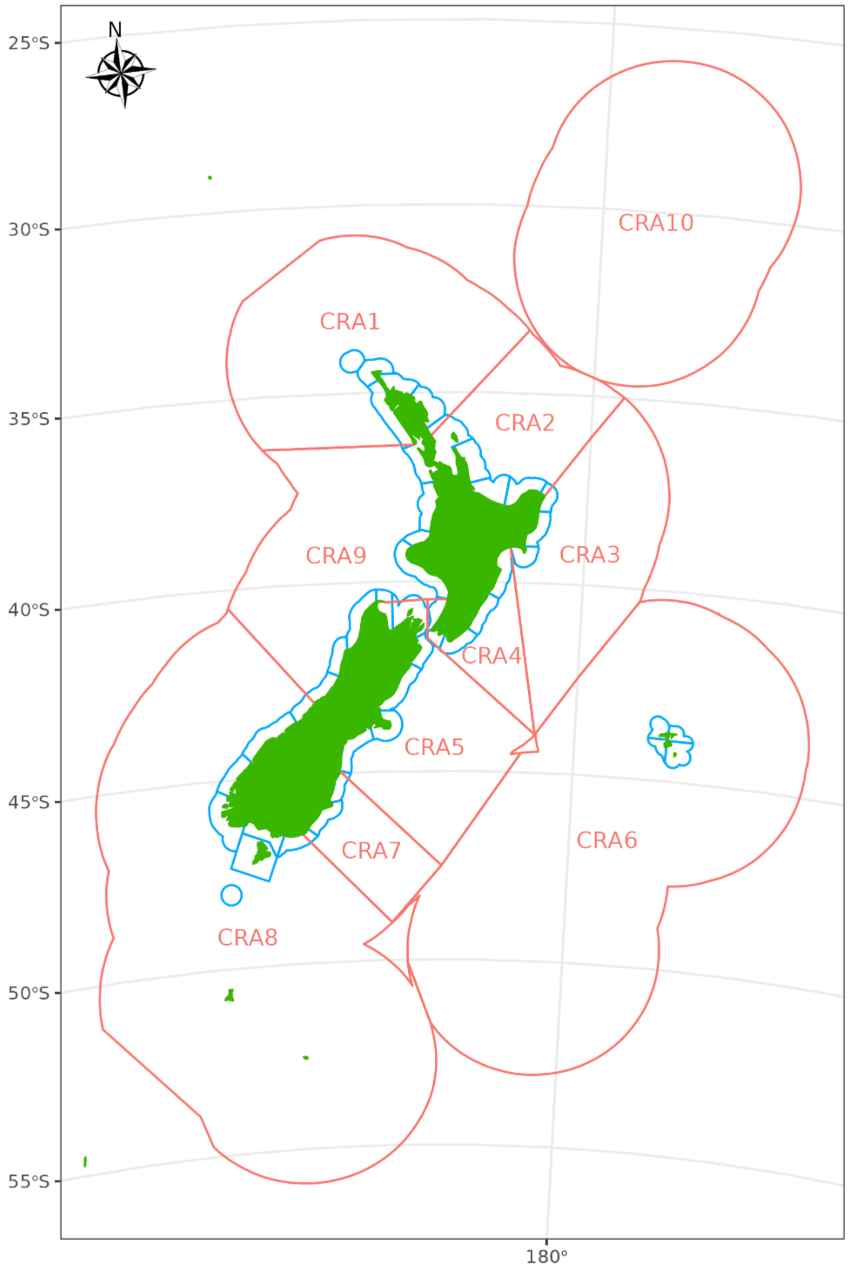

Figure 1: New Zealand red rock lobster (*Jasus edwardsii*) Quota Management Areas (QMAs) in red and statistical areas in blue. CRA 10 is not fished commercially.

Full stock assessments are generally done once every five years for eight of the nine rock lobster QMAs (i.e., all except CRA 9, which is deemed to be data deficient for stock assessment). Full stock assessments require significant time and effort, including: a review of the previous stock assessment and data inputs, updates to data processing code, the addition of new data, implementation of new structural changes to the model, review of prior specifications for model parameters, and runs to investigate sensitivity to key model assumptions. The last few red rock lobster stock assessments have required five stock assessment scientists working for over five weeks to complete one or two stock assessments, under the guidance of the Rock Lobster Working Group (RLWG).

Up to the 2020–21 fishing year[5], management procedures (MPs), using standardised commercial fishery catch per unit effort (CPUE) as the input and a catch limit as the output, were used to manage New Zealand stocks of red rock lobsters (Bentley et al. 2003, Bentley & Stokes 2009, Breen et al. 2009, 2016a, 2016b, Webber & Starr 2020).

MPs, often referred to as harvest control rules, are simulation-tested decision rules or functions (Butterworth & Punt 1999) that specify one or more inputs and return an output value. MPs are an important fisheries management tool globally (Edwards & Dankel 2016). They are used to manage rock lobsters in South Africa (Johnston & Butterworth 2005, Johnston et al. 2014), South Australia (Punt et al. 2012), and Victoria (Punt et al. 2013).

The 2019–20 fishing year marked the transition of rock lobster catch and effort data collection from the paper-based Catch Effort Landing Return (CELR) system to an electronic reporting (ER) system dependent on a user interface operated from tablets or smart phones. Presently, there are three ER reporting 'platforms', each with different user interfaces and different underlying software. Preliminary analyses of the 2019–20 data indicated that the reported estimated catches using the new ER system differed from the equivalent estimates generated by the previous CELR forms (see appendix B of Starr 2024). Therefore, the RLWG agreed to temporarily suspend updating CPUE indices based on the statutory catch and effort data beginning with the 2019–20 spring/summer (SS) season. The RLWG concluded that, apart from CRA 7, there remained sufficient CELR data for each of the QMAs to ensure comparability with previous indices for the 2019–20 autumn/winter (AW) data. This meant that, after 2019–20 AW, statutory CPUE was no longer available to monitor the abundance of New Zealand rock lobster and was not available for use in MPs. This issue has since been reviewed several times by the RLWG without observing any reason to change the initial conclusion (see table 4 in the introductory Rock Lobster chapter of Fisheries New Zealand 2023). However, for CRA 2, an alternative CPUE series was developed based on voluntary logbook data reported by the CRA 2 fleet since 1993, and these data were used in the 2022 CRA 2 stock assessment (Webber & Starr 2022).

With the loss of MPs, status in New Zealand rock lobster stocks are now monitored using current estimates of vulnerable biomass relative to a vulnerable biomass reference level (B_R) and estimates of female spawning stock biomass (SSB) relative to the Harvest Strategy Standard (HSS) default hard (10% SSB_0) and soft (20% SSB_0) limits. While this evaluation is straight-forward for years when a full stock assessment is done, this evaluation can also be made based on the stock status estimates generated by the rapid updates in the years between full stock assessments. The reference level (B_R) is estimated for each stock using the procedure developed by Rudd et al. (2021) and remains unchanged until the next full stock assessment.

Rapid updates differ from full stock assessments because they repeat the previous base case stock assessment model(s) with identical model settings and assumptions, only updating inputs, including additional years of catch, length frequencies (LFs), and tag-recapture data. This significantly speeds up the assessment process, so that every stock not undergoing a full stock assessment can potentially have a rapid update done each year. The rapid update system has been designed to provide fishery advice even in the absence of a recently updated CPUE series (the main abundance index) and serves to temporarily replace the MPs previously used to manage these stocks (Webber & Starr 2020). However, retrospective analyses for some QMAs have shown systematic biases in stock status estimates

[5] Most years in this document refer to the 1 April to 31 March statutory fishing year, for example, 1 April 2020 to 31 March 2021 is designated the 2020–21 fishing year. Two seasons are defined per fishing year: 1 April to 30 September is referred to as autumn/winter (AW) and 1 October to 31 March is referred to as spring/summer (SS). Sometimes specific seasons within a fishing year are referred to, for example, 2020–21 AW refers to 1 April 2020 to 30 September 2020 or 2020–21 SS refers to 1 October 2020 to 31 March 2021. Calendar years are simply referred as usual (e.g., 2020).

when missing more than 4–5 years of CPUE data (Pons et al. 2022). Rapid updates do not aim to replace full stock assessments but complement them by providing inference about stock status in the interim years between full assessments. Rapid updates could also form the basis for developing new MPs in the future.

The rapid update framework for New Zealand rock lobster stocks is described in Webber et al. (2021), Rudd et al. (2022), and Pons et al. (2023 and 2024). This document provides a 2024 rapid update for CRA 2 only. CRA 3 and CRA 4 were not included in the rapid updates because they received a full stock assessment in 2024. In addition, CRA 1 and CRA 5 were not included because they have been missing new information on catch per unit of effort (CPUE) for the last 4 to 5 years to contribute to reliable stock status estimates (Pons et al. 2022). CRA 7 and CRA 8 used management procedures in 2024, resulting in no need to run a rapid update for these stocks. CRA 6 had no new significant information in 2024 to be included in the rapid update system, and there is no accepted stock assessment for CRA 9.

The CRA 2 fishery extends from Te Arai Point, south of Whangarei, to East Cape at the easternmost end of the Bay of Plenty (Figure 1, Figure 2). This QMA includes the Hauraki Gulf, both sides of the Coromandel Peninsula, and all of the Bay of Plenty up to East Cape.

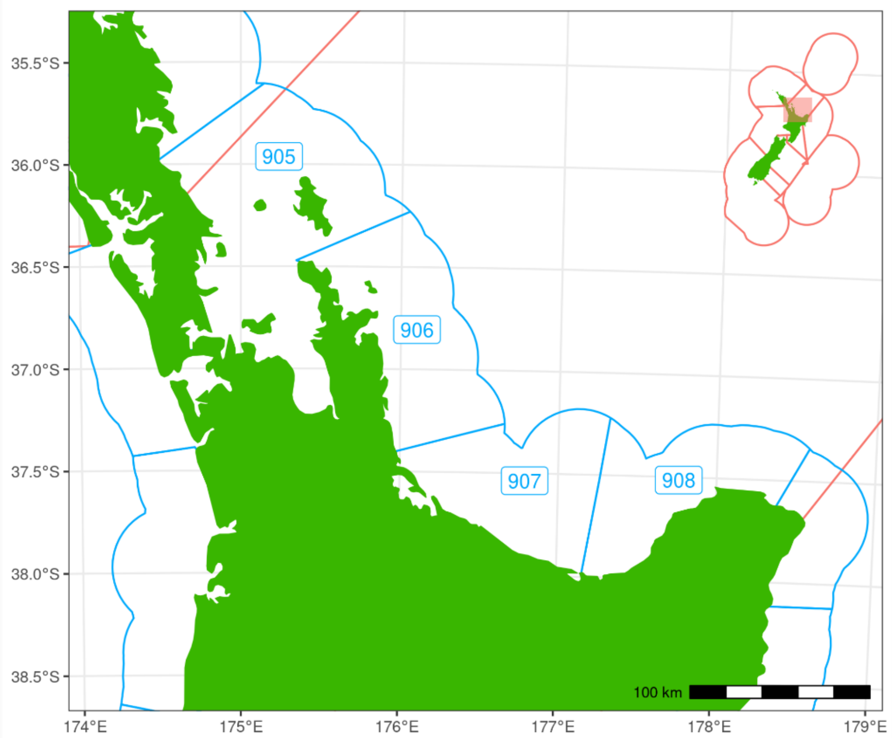

Figure 2: The extent of the CRA 2 QMA (bounded by red lines) and of the statistical areas included in this QMA (bounded by blue lines).

The CRA 2 stock assessment was last done in 2022 (Rudd et al. 2023) as a single-region assessment using the LSD model (Webber et al. 2023). This model used a non-equilibrium start to model the stock reconstruction beginning with the 1979–80 fishing year. The model was fitted to three standardised CPUE index series, LFs, sex ratio, and tag-recapture data. The model estimated growth by sex (male and female), vulnerability by sex (male, immature female, and mature female) and season (AW and SS), and selectivity by sex (male and female). It estimated three catchability coefficients (for FSU, CELR, and logbook CPUE) and used a new procedure to standardise the LFs and sex ratio inputs (Webber 2022). The model removed catch from CRA 2 using seasonal exploitation rate (U) instead of instantaneous fishing mortality (F) and recruitment deviates were estimated up to three years before the last assessment year (Webber et al. 2023).

2. METHODS

The additional covariates and data that were used in the CRA 2 rapid update include: commercial and non-commercial catch data, standardised length frequency (LF) series, standardised sex-ratio series, tag-recapture data, and an updated logbook CPUE index series. Data requests are the first step in the operation of this rapid update and were submitted to Fisheries New Zealand for monthly harvest returns (MHRs) (replog 15830), observer catch sampling (replog 16093), and tag-recapture data (replog 15841). Observer catch sampling data were extracted from the Fisheries New Zealand Rock Lobster Catch Sampling (*rlcs*) database (Mackay & George 2018). The voluntary logbook data extract came directly from FishServe (John Olver, October 2024). Although the standardisation of CPUE indices based on statutory commercial catch and effort data has been temporarily discontinued[6], commercial catch and effort data were requested from Fisheries New Zealand (replog 15830) because these data were used to rescale the LF data (e.g., see section 5 of Starr et al. 2020).

All CPUE standardisations were done using the *R* package *brms* (Bürkner 2017). All CPUE standardisations had been done for all QMAs in 2020, up to the 2019–20 fishing year, for either full assessments or rapid updates (Webber et al. 2021; Rudd et al. 2022; Pons et al. 2023; Pons et al. 2024). Therefore, no revisions were made to the CELR based CPUE indices. In addition, for CRA 2, a CPUE series was developed using voluntary logbook data reported by the CRA 2 fleet since 1993 (Webber & Starr 2022).

Commercial catches were updated by season for each fishing year using the MHR data extract.

Non-commercial catches were updated using the procedures developed for the base case model. As in 2023 (Pons et al. 2024), the following steps were taken to scale recreational catch in CRA 2:

1) Recreational catches CRA 2 were assumed to be proportional to the SS abundance as reflected in the SS CPUE, using the FSU and CELR CPUE series prior to 1993 and the logbook CPUE series from 1993 onwards.
2) A scalar quantity to relate SS CPUE and recreational catch was estimated by obtaining the best fit to four survey estimates when minimising a lognormal distribution using the coefficient of variation for each survey. This estimated scalar quantity was multiplied by the mean SS CPUE to obtain an estimated recreational catch series from 1979 to 2023.
3) Recreational catch in 1945 was assumed to be 20% of the 1979 estimated recreational catch, increasing linearly from 1945 to 1979.
4) Recent survey estimates were considered to be absolute estimates of recreational catch for 2011, 2017, and 2019–2023 (see Maggs et al. 2024).
5) The maximum section 111 catches during the CELR period (2.04 tonnes) was added to the entire time series.

For assessments since 2006, the RLWG has included recreational landings by commercial vessels under section 111 of the Fisheries Act. By agreement within the RLWG, the maximum annual catch with destination code ‘F’ was included as a constant addition to the recreational catch trajectory for each year.

The illegal catch assumptions reflect the changes in approach adopted by the RLWG over the past six years, transitioning from using a poorly documented ‘export discrepancy’ procedure for the early

[6] Offset year standardised CPUE, incorporating ERS data, was developed and reviewed by the RLWG for CRA 7 in September 2023 for use in a management procedure.

years and uncertain fisheries compliance estimates from 1990–91 onwards, to using fixed percentages of the commercial catches. The approach used to set the illegal catches in CRA 2 was:

1) 1979–80 to 1989–90: 20% of total commercial catch from the period.
2) 1990–91 to 2022–24: 10% of total commercial catch from this period scaled by annual CPUE from 1979–80 to 2018–19. Assumed CPUE in 2019–20 to 2023–24: average of 2016–17 to 2018–19.

The recreational and customary catches were split between seasons from 1979–80 by assuming that 90% was taken in the SS and the remainder taken in the AW. Illegal catch was assumed to have the same seasonal split by fishing year as the commercial catch.

LF data were derived from individual lobster tail-width (TW) measurements and came from both the observer catch sampling and the voluntary logbook programmes. The updated observer catch sampling LFs were corrected, after discovering that calliper offset adjustments had not been applied to catch sampling data collected since July 2020, as had been done previously. Although the model runs from 2022 and 2023, are shown here for comparison, these were informed by previously uncorrected catch sampling TW data since 2020. It should be noted, however, that the CRA 2 LF data are primarily informed by logbook data, and were therefore less affected by the previously incorrect catch-at-sea sampling length data than would have been the case for other stocks. For the 2023 rapid update, the logbook LF data arrived too late to be incorporated in the assessment and, so, the 2022 LFs were omitted (Pons et al. 2024). However, in the 2024 rapid update, the standardised LFs for 2022 and 2023 were included. The LF standardisation followed the procedure documented by Webber (2022).

Tag-recapture growth increment data were extracted from the Fisheries New Zealand tag database and processed up to 2023–24, in the CRA 2 2024 rapid update (see Roberts et al. 2023).

Even though two years of additional data were included in the models, no data re-weighting was done for CRA 2 rapid update compared to the 2022 full assessment. All other model specifications remained as they were in the original base case stock assessment models. Fixed values and assumptions were continued from the previous full stock assessment, including priors and bounds for estimated model parameters; the reference level B_R (Rudd et al. 2021), and all structural assumptions which applied to growth, maturity, selectivity, and vulnerability. Recruitment deviations were estimated from the first model year through to three years prior to the final model year as in the 2022 full assessment (Rudd et al. 2023). The rapid update model was run using the lobster stock dynamics (LSD) model coded in Stan (Stan Development Team 2017, Webber et al. 2018, Webber et al. 2023). Lists of parameter and derived quantity definitions are provided in Table 1 and Table 2.

Table 1: Definitions of parameters. CR = historical catch rate; FSU= Fisheries Statistics Unit.

Parameter	Definition
R_0	initial numbers recruiting
M	instantaneous rate of natural mortality
Rdevs	annual recruitment deviations
sigmaR	standard deviation of *Rdevs*
qCR	catchability coefficient (relationship between vulnerable biomass and CR series)
qFSU	catchability coefficient (relationship between vulnerable biomass and FSU CPUE series)
qCELR	catchability coefficient (relationship between vulnerable biomass and CELR CPUE series)
qLB	catchability coefficient (relationship between vulnerable biomass and logbook CPUE series)
mat50	TW at which 50% of immature females become mature
mat95	difference between *mat50* and the TW at which 95% of immature females become mature
Galpha	annual growth increment at 50 mm TW
Gbeta	annual growth increment at 80 mm TW
Gdiff	the ratio of *Gbeta* to *Galpha*
Gshape	parameter for shape of growth curve: 1 implies von Bertalanffy straight line; >1 implies a concave upwards curve
GCV	coefficient of variation of process error for tag recaptures
Gobs	standard deviation of observation error for tag recaptures
selL	shape of the left-hand limb of the selectivity curve (as if it were a standard deviation)
selM	TW at maximum selectivity
vuln	relative vulnerability by sex and season
qdrift	additive change in catchability coefficient each year
U_0	initial exploitation rate (first year is in equilibrium using this estimate)

Table 2: Definitions of derived quantities including reference points and performance indicators. The 'YEAR' subscript is replaced with the relevant fishing year in the text and tables (e.g., B_{2022} is the beginning of season AW adjusted vulnerable biomass[7] for the 2022–23 fishing year).

Variable	Description
Reference points	
B_0	beginning of season AW adjusted vulnerable biomass (tonnes) before fishing
B_{0now}	equilibrium vulnerable reference biomass using mean 2009–2018 recruitment
B_{YEAR}	beginning of season AW adjusted vulnerable biomass (tonnes) for the specified fishing year
B_R	reference level in terms of AW adjusted vulnerable biomass (Rudd et al. 2021)
SSB_0	mature female spawning stock biomass (tonnes) in the AW season before fishing
SSB_{0now}	equilibrium female spawning biomass using mean 2009–2018 recruitment
SSB_{YEAR}	mature female spawning stock biomass (tonnes) in the AW season at beginning of the specified fishing year
T_0	equilibrium total biomass
T_{0now}	equilibrium total biomass using mean 2009–2018 recruitment
T_{YEAR}	beginning of season AW total biomass for the specified fishing year
H_{YEAR}	handling mortality (tonnes)
U_{YEAR}	exploitation rate weighted by seasonal vulnerable biomass for the specified fishing year
Performance indicators	
B_{YEAR} / B_0	ratio of B_{YEAR} to B_0
B_{YEAR} / B_{0now}	ratio of B_{YEAR} to B_{0now}
B_{YEAR} / B_R	ratio of B_{YEAR} to B_R
SSB_{YEAR} / SSB_0	ratio of SSB_{YEAR} to SSB_0
SSB_{YEAR} / SSB_{0now}	ratio of SSB_{YEAR} to SSB_{0now}
T_{YEAR} / T_0	ratio of T_{YEAR} to T_0
T_{YEAR} / T_{0now}	ratio of T_{YEAR} to T_{0now}
F_{YEAR} / F_{MSY}	ratio of F_{YEAR} to F_{MSY}

As in 2023, the Plenary agreed to repeat the CRA 2 base case model projections, extending them to 2028, reasoning that this rapid update assessment was informed by a fully updated CPUE series. Recruitment was also extended to 2020, three years before the model end year. Projected catches were 80 tonnes for the commercial catch (equal to the TACC) and for the non-size-limited catch updated to match the 2022 to 2024 catches. However, for the recreational catch, the RLWG agreed to use the average of the last 5 years (2019 to 2023) of the recreational harvest rates to project the catch from this sector (Table 3).

3. RESULTS

The 2024 rapid update for CRA 2 added two years of data to the stock assessment done in 2022, including: catch to 2023–24 (Table 3), logbook CPUE data to 2023–24, and additional tag recapture data up to 2023–24. There was a minor change made to the inputs used by the 2022 assessment for the illegal and recreational catch. The 2022 assessment scaled the illegal and recreational catch using logbook CPUE expressed as kg/pot instead of numbers/pot which is how this series was estimated and included in the assessment model. This error was fixed for the 2023 and 2024 rapid updates and accounted for the minor differences observed in Table 3 between the 2022 assessment and the 2024 rapid update. The CRA 2 logbook CPUE series was updated to include the 2022–23 and 2023–24 AW and SS indices. The 2024 CRA 2 rapid update assessment included updated LF data for 2022–23 and 2023–24.

[7] Adjusted vulnerable biomass is calculated by applying the MLS and selectivity from the final model year to all previous years, including those years where earlier regulations were active.

Table 3: Comparison of recent CRA 2 catch (tonnes) for the 2022 stock assessment and the following rapid update. The table shows the last five fishing years and the five projection years in the 2022 base case model (starting in 2017–18), compared with catch for 2017–18 onwards for the 2023 rapid update including also the five projection years. All projection years are highlighted in grey.

	Commercial			Recreational			Customary			Illegal		
Fishing year	AW	SS	Total	AW	SS	Total	AW	SS	Total	AW	SS	Total
2022/base												
2017–18	41.99	100.77	142.75	3.07	27.59	30.65	0.50	4.50	5.00	3.28	7.88	11.17
2018–19	32.52	47.46	79.97	5.14	46.28	51.42	0.50	4.50	5.00	8.38	12.23	20.61
2019–20	45.55	30.46	76.01	3.41	30.73	34.15	0.50	4.50	5.00	15.13	10.12	25.24
2020–21	37.61	46.29	83.90	3.53	31.74	35.27	0.50	4.50	5.00	12.26	15.09	27.35
2021–22	47.49	32.50	79.99	3.31	29.80	33.11	0.50	4.50	5.00	15.77	10.79	26.57
2022–23	47.50	32.50	80.00	3.31	29.80	33.11	0.50	4.50	5.00	15.77	10.79	26.57
2023–24	47.50	32.50	80.00	3.31	29.80	33.11	0.50	4.50	5.00	15.77	10.79	26.57
2024–25	47.50	32.50	80.00	3.31	29.80	33.11	0.50	4.50	5.00	15.77	10.79	26.57
2025–26	47.50	32.50	80.00	3.31	29.80	33.11	0.50	4.50	5.00	15.77	10.79	26.57
2026–27	47.50	32.50	80.00	3.31	29.80	33.11	0.50	4.50	5.00	15.77	10.79	26.57
2023/base												
2017–18	41.99	100.77	142.75	2.92	26.29	29.21	0.50	4.50	5.00	3.39	8.13	11.52
2018–19	32.52	47.46	79.97	4.70	42.30	46.99	0.50	4.50	5.00	8.37	12.21	20.58
2019–20	45.55	30.46	76.01	3.41	30.73	34.15	0.50	4.50	5.00	13.98	9.35	23.33
2020–21	37.61	46.29	83.90	3.53	31.74	35.27	0.50	4.50	5.00	11.64	14.33	25.98
2021–22	47.49	32.50	79.99	3.31	29.80	33.11	0.50	4.50	5.00	13.93	9.53	23.46
2022–23	46.93	33.06	79.99	3.42	30.76	34.17	0.50	4.50	5.00	13.20	9.30	22.50
2023–24	46.93	33.07	80.00	3.42	30.76	34.17	0.50	4.50	5.00	13.20	9.30	22.50
2024–25	46.93	33.07	80.00	3.42	30.76	34.17	0.50	4.50	5.00	13.20	9.30	22.50
2025–26	46.93	33.07	80.00	3.42	30.76	34.17	0.50	4.50	5.00	13.20	9.30	22.50
2026–27	46.93	33.07	80.00	3.42	30.76	34.17	0.50	4.50	5.00	13.20	9.30	22.50
2027–28	46.93	33.07	80.00	3.42	30.76	34.17	0.50	4.50	5.00	13.20	9.30	22.50
2024/base												
2017–18	41.99	100.77	142.75	1.91	17.18	19.09	0.50	4.50	5.00	3.45	8.27	11.72
2018–19	32.52	47.46	79.97	4.58	41.20	45.78	0.50	4.50	5.00	7.54	11.01	18.56
2019–20	45.55	30.46	76.01	3.16	28.43	31.59	0.50	4.50	5.00	13.13	8.78	21.91
2020–21	37.61	46.29	83.90	3.20	28.80	32.00	0.50	4.50	5.00	11.59	14.27	25.86
2021–22	47.49	32.50	79.99	3.16	28.46	31.62	0.50	4.50	5.00	13.53	9.26	22.78
2022–23	46.93	33.06	79.99	1.29	11.60	12.88	0.50	4.50	5.00	12.86	9.06	21.92
2023–24	36.30	43.70	80.00	1.16	10.45	11.61	0.50	4.50	5.00	9.37	11.28	20.65
2024–25	36.30	43.70	80.00	3.03	26.51	29.54	0.50	4.50	5.00	9.37	11.28	20.65
2025–26	36.30	43.70	80.00	3.19	28.52	31.71	0.50	4.50	5.00	9.37	11.28	20.65
2026–27	36.30	43.70	80.00	3.39	29.75	33.14	0.50	4.50	5.00	9.37	11.28	20.65
2027–28	36.30	43.70	80.00	3.57	30.98	34.54	0.50	4.50	5.00	9.37	11.28	20.65
2028–29	36.30	43.70	80.00	3.73	32.07	35.80	0.50	4.50	5.00	9.37	11.28	20.65

MCMC trace plots for the 2023 rapid update suggested that mixing was adequate with no signs of non-convergence (Figure 3).

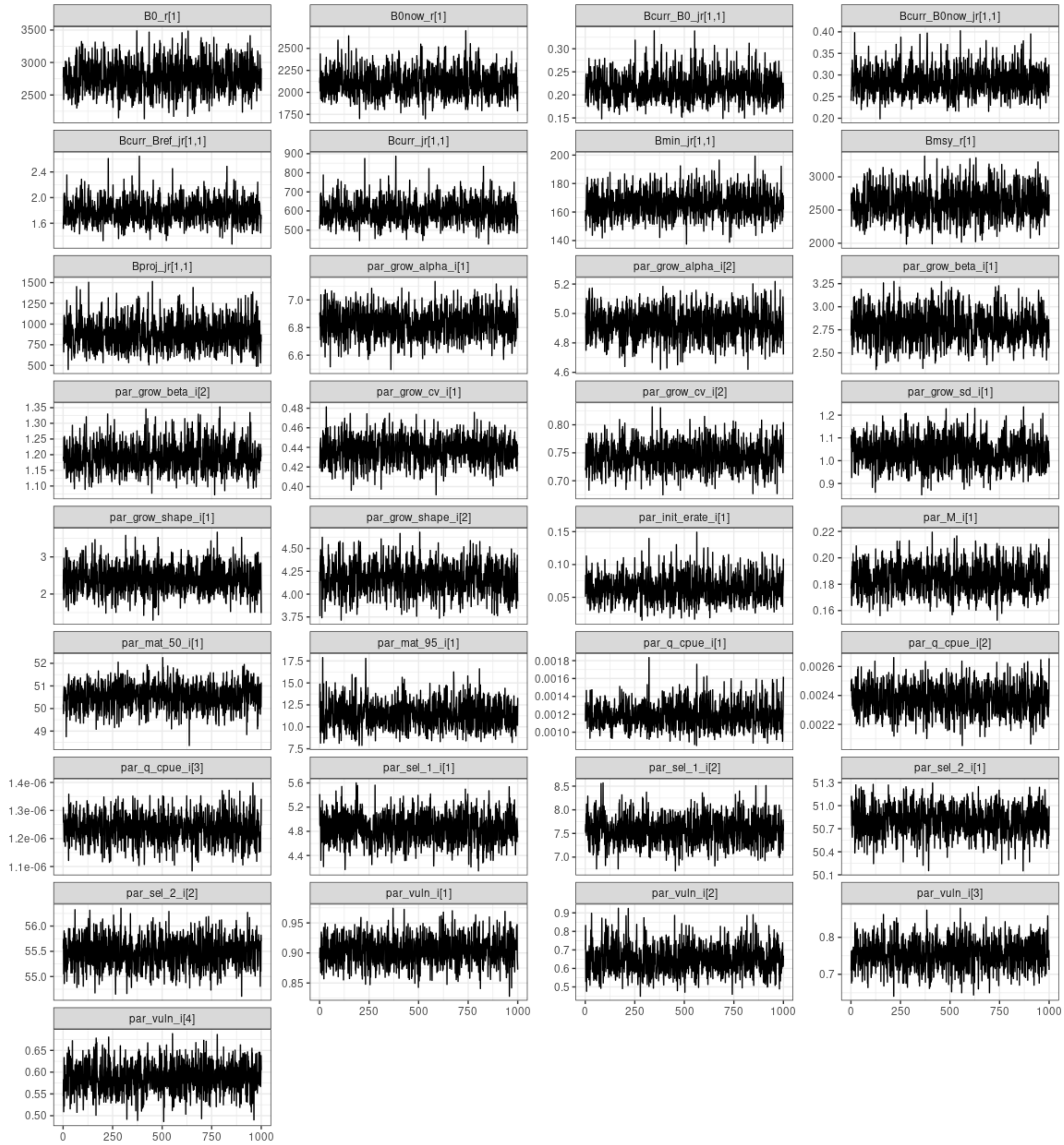

Figure 3 MCMC trace plots for estimated model parameters in the CRA 2 rapid update (MCMC iteration on the x-axis and parameter value on y-axis).

The rapid update fit to the CPUE series was almost indistinguishable from the fit obtained by the 2022 assessment up until 2019, when the CPUE trajectory dropped relative to the 2022 trajectory (Figure 4). The fits to the CPUE for the last three data points were improved compared to the 2023 rapid update which did not include LFs for 2022 and 2023 (Figure 4). The 2022 assessment estimated a small recruitment pulse in 2018–19 which shifted to 2019–20 in the 2023 rapid update. The 2024 model did not show either of these pulses and estimated a low recruitment in 2020 (the last estimated year) (Figure 5) so that it could fit to the new 2023–24 CPUE index value, which dropped from 2022–23 (Figure 4). The average projected recruitment in the 2024 rapid update was slightly lower than in the 2022 full assessment (Figure 5). The fits to the LF data were almost indistinguishable from the 2022 assessment in the overlapping years with minor differences in 2020 where the LF data were corrected (Figure 6). Since recruitment was predicted to be lower in the last few years, the adjusted vulnerable biomass and SSB were predicted to increase but less steeply at the beginning of 2024–25 than estimated by the 2022 stock assessment projections (Figure 7, Figure 8).

The CRA 2 rapid update predicted that the posterior median stock size at the beginning of 2024–25 was 20% B_0, 38% SSB_0, and 154% of B_R (Table 4). At the beginning of 2028–29, the posterior median stock size was projected to be 196% of B_R, 26% B_0, and 41% SSB_0. Exploitation rates (U) at the beginning of 2024–25 and 2028–29 were about 1/3 of U_R. The probabilities of being greater than B_R at the beginning of 2024–25 and 2028–29 were 1.0. The probabilities of being greater than 20% SSB_0 at the beginning of the same two years were 1.0.

All parameter estimates were similar to those made by the 2022 stock assessment and by the 2023 rapid update (Table 5).

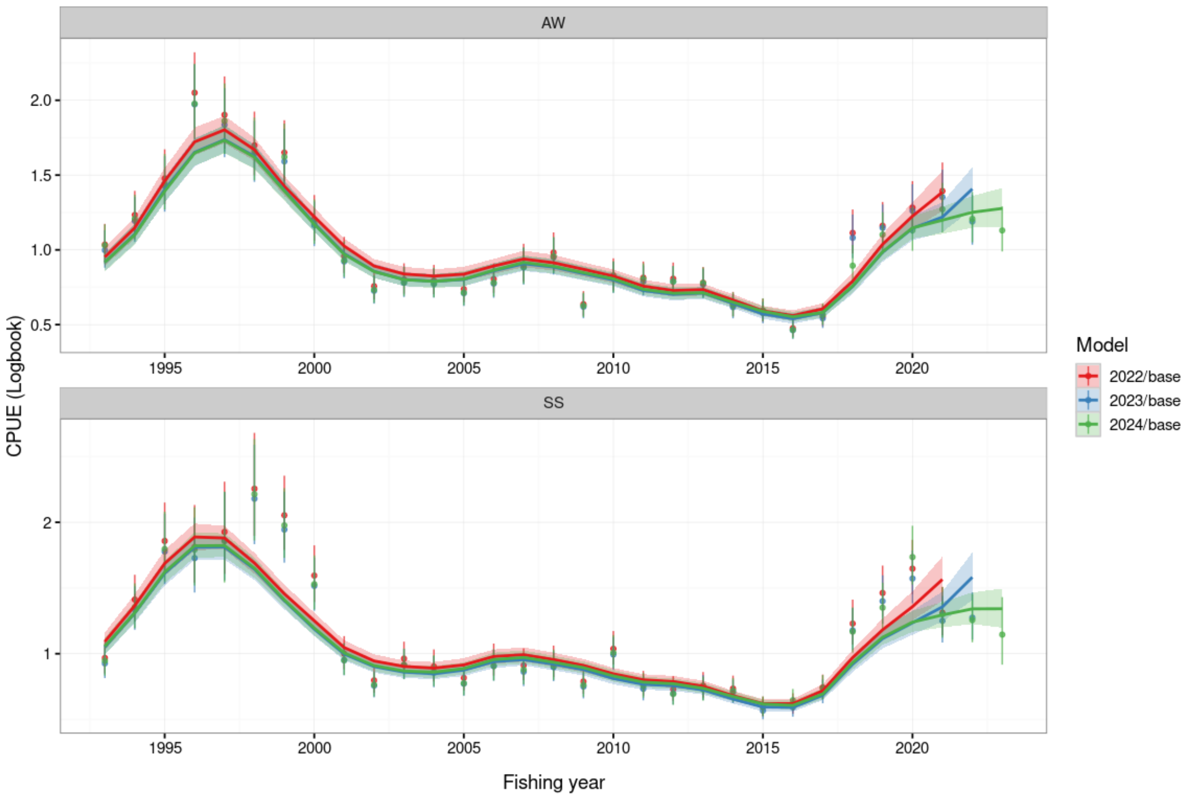

Figure 4: CRA 2 Logbook CPUE observations (points) and posterior distribution showing the median (line) and 90% credible interval (shaded region) by season (AW = autumn/winter, SS = spring/summer) and fishing year (labelled using the first year in the pair) for the 2022 stock assessment and the 2023 and 2024 rapid updates.

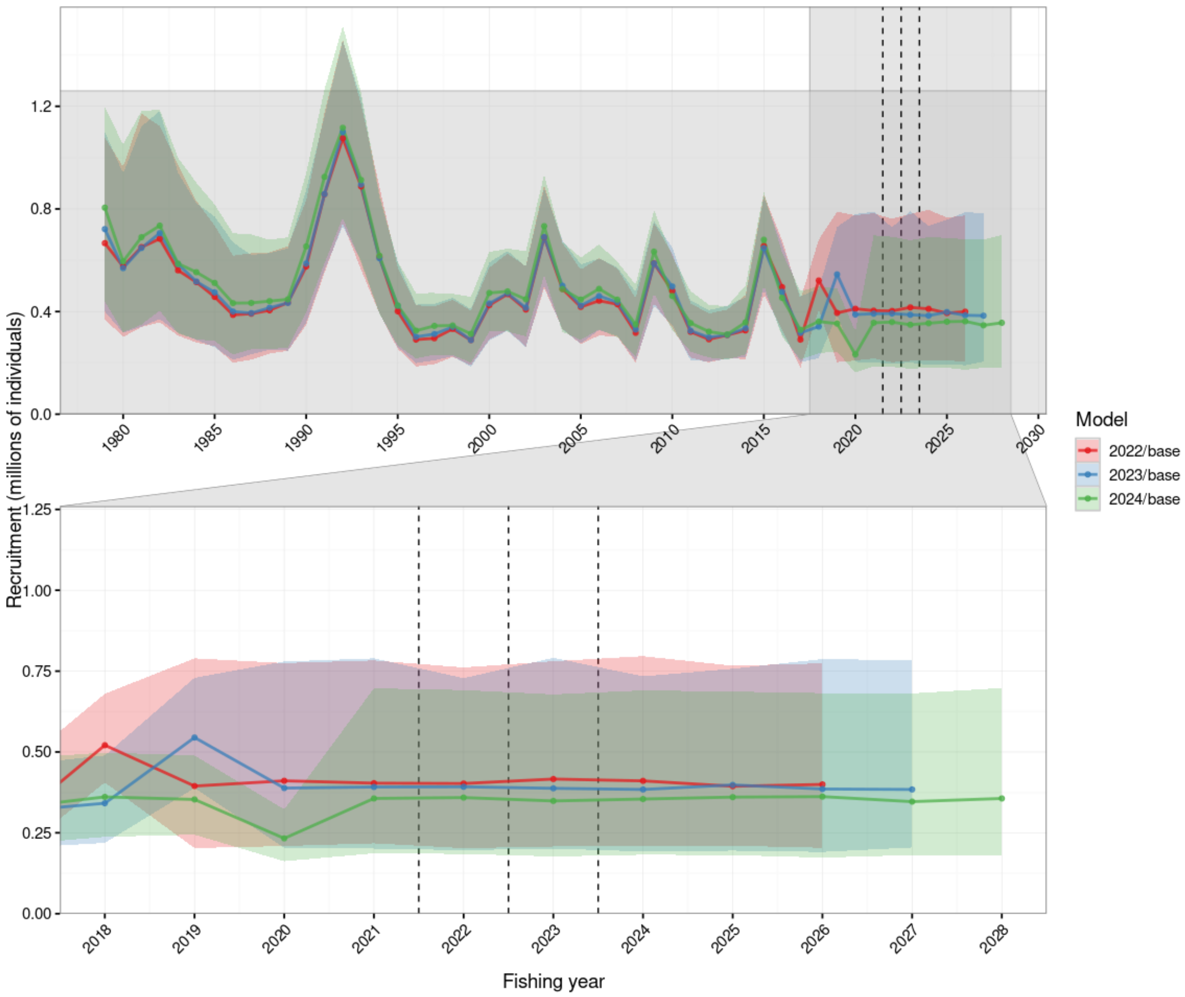

Figure 5: CRA 2 posterior distribution of recruitment showing the median (line and points) and 90% credible interval (shaded region) for the 2022 stock assessment and the 2023 and 2024 rapid updates (showing the five projected years). The vertical dashed lines indicate the transition between the final model year and the five projected years for the 2022 stock assessment and the 2023 and 2024 rapid updates. The top panel shows the recruitment for all model years, and the lower panel shows recruitment for the last ten years, including the five year projection period.

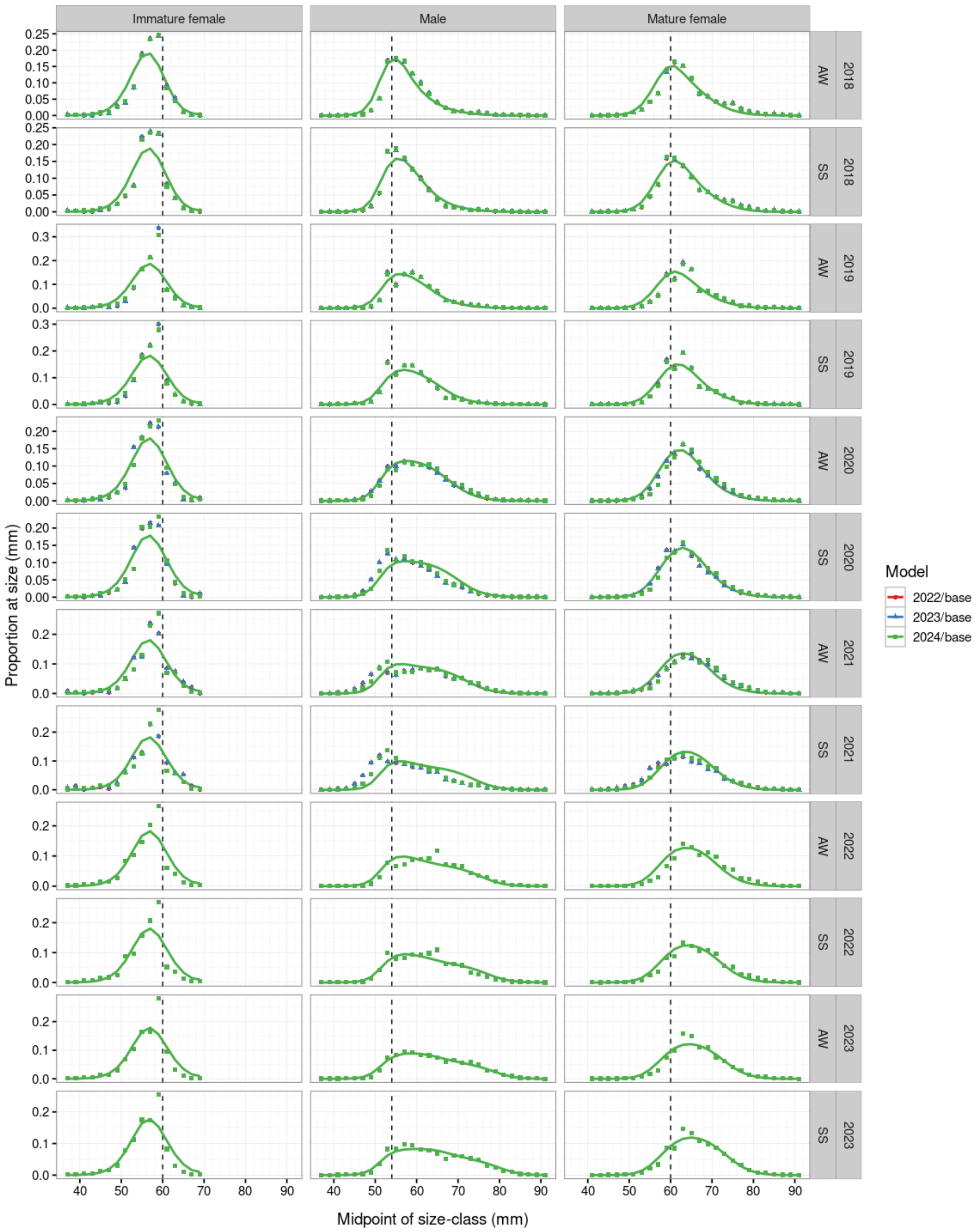

Figure 6: 2018–2023 CRA 2 length frequency observations (points) and median of the posterior distribution (line) by year, and season (AW = autumn/winter, SS = spring/summer) for the 2022 stock assessment and the 2023 and 2024 rapid updates. Dashed vertical lines represent the minimum legal size (MLS) for the respective sexes.

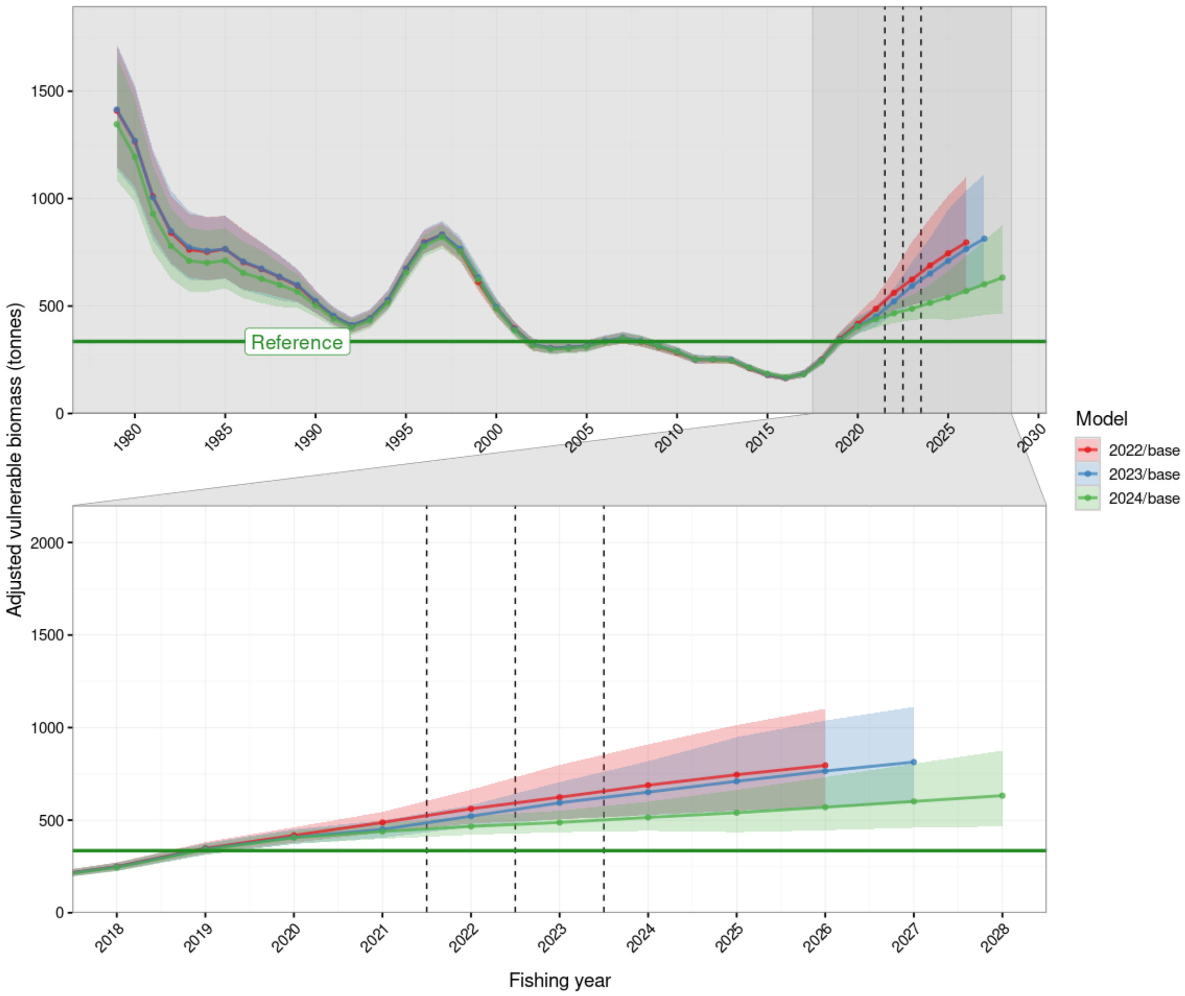

Figure 7: CRA 2 posterior distribution of adjusted vulnerable biomass (tonnes) showing the median (line and points) and 90% credible interval (shaded region) for the 2022 stock assessment and the 2023 and 2024 rapid updates (showing the five projected years). The vertical dashed lines indicate the transition between the final model year and the five projected years for the 2022 stock assessment and the 2023 and 2024 rapid updates. The top panel shows the adjusted vulnerable biomass for all model years, and the lower panel shows adjusted vulnerable biomass for the last ten years. The reference level (B_R) is shown in both panels (horizontal green line) and corresponds to the reference level estimated by the 2022 stock assessment.

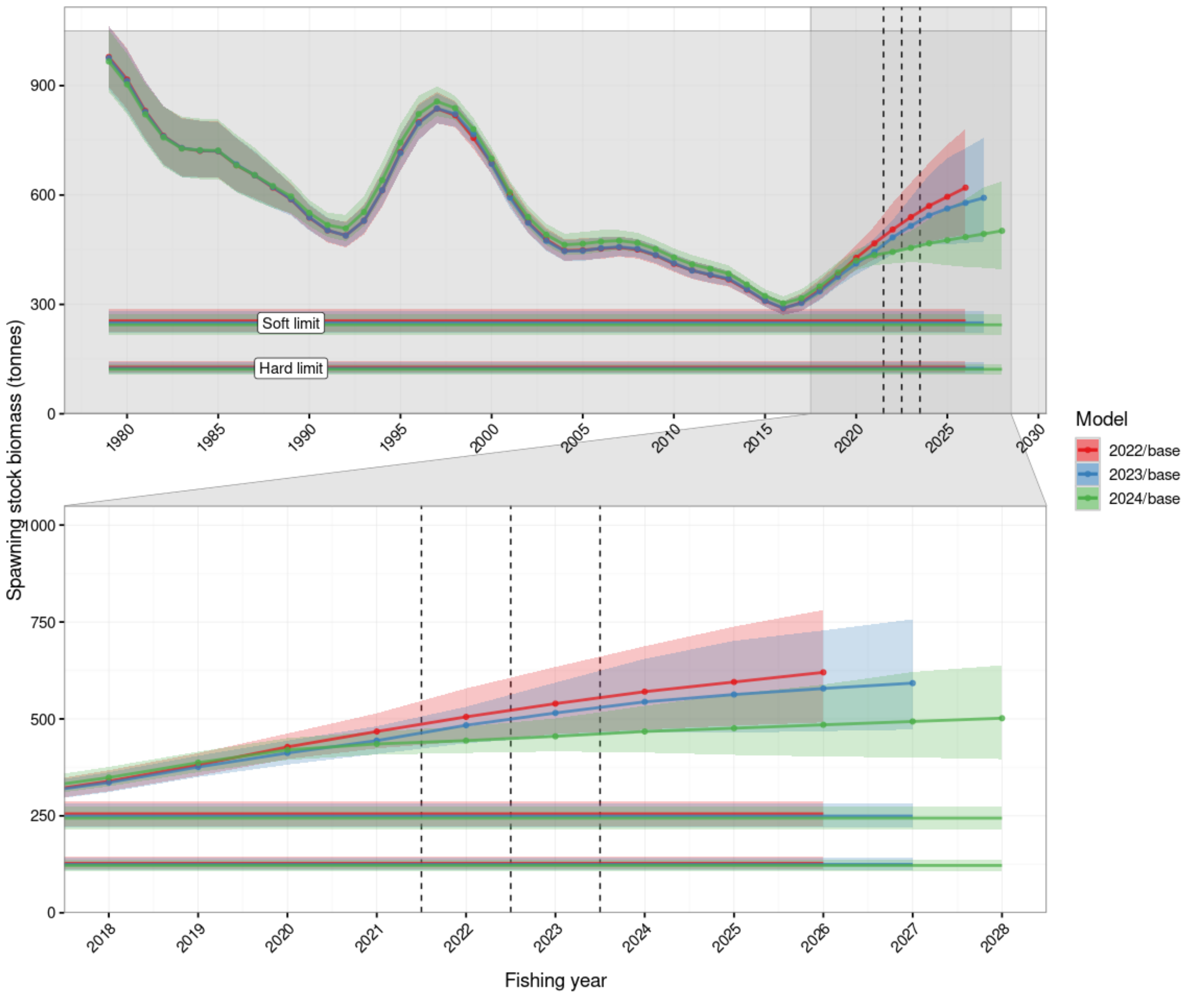

Figure 8: CRA 2 posterior distribution of spawning stock biomass (tonnes) showing the median (line and points) and 90% credible interval (shaded region) for the 2022 stock assessment and the 2023 and 2024 rapid updates (showing the five projected years). The vertical dashed line indicates the transition between the final model year and the five projected years for the 2022 stock assessment and the 2023 and 2024 rapid updates. The top panel shows the spawning stock biomass for all model years, and the lower panel shows spawning stock biomass for the last ten years. The horizontal lines and shaded regions represent the soft limit (top horizontal line and shaded region) and the hard limit (lower horizontal line and shaded region).

Table 4: CRA 2 rapid update indicators summarising the mean, median, and 90% credible intervals.

Indicator	Mean	5%	50%	95%
Vulnerable biomass				
B_0	2 593.000	2 235.000	2 588.000	2 958.000
B_{0now}	1 756.000	1 560.000	1 753.000	1 955.000
B_{MIN}	168.600	154.700	168.300	183.300
B_R	335.100	335.100	335.100	335.100
B_{2024}	518.200	443.200	515.200	602.700
B_{2028}	667.600	469.500	657.100	915.200
B_R / B_0	0.130	0.113	0.130	0.149
B_R / B_{0now}	0.192	0.171	0.191	0.214
B_{2024} / B_0	0.201	0.164	0.200	0.245
B_{2028} / B_0	0.259	0.181	0.255	0.356
B_{2024} / B_{0now}	0.296	0.253	0.294	0.343
B_{2028} / B_{0now}	0.381	0.273	0.375	0.516
B_{2028} / B_{2024}	1.289	0.972	1.264	1.678
B_{2024} / B_R	1.546	1.323	1.538	1.799
B_{2028} / B_R	1.992	1.401	1.961	2.731
Exploitation				
U_R	–	0.296	0.296	0.296
U_{2024}	0.095	0.079	0.094	0.110
U_{2028}	0.096	0.075	0.094	0.120
U_{2024} / U_R	0.319	0.269	0.319	0.373
U_{2028} / U_R	0.323	0.253	0.319	0.404
Spawning stock biomass				
SSB_0	1 224.000	1 078.000	1 221.000	1 373.000
SSB_{0now}	828.700	759.800	826.000	906.200
SSB_{2024}	470.400	414.100	468.500	538.200
SSB_{2028}	507.500	396.000	501.900	638.100
SSB_{2024} / SSB_0	0.386	0.327	0.383	0.454
SSB_{2028} / SSB_0	0.417	0.322	0.411	0.534
SSB_{2024} / SSB_{0now}	0.568	0.510	0.561	0.648
SSB_{2028} / SSB_{0now}	0.613	0.488	0.606	0.767
SSB_{2028} / SSB_{2024}	1.078	0.903	1.064	1.297
Handling mortality				
H_{2023}	1.489	1.334	1.476	1.693
H_{2028}	1.300	1.080	1.287	1.569
Probabilities				
P($B_{2024} > B_{MIN}$)	1.000	–	–	–
P($B_{2024} > B_R$)	1.000	–	–	–
P($B_{2028} > B_R$)	0.999	–	–	–
P($B_{2028} > B_{2023}$)	0.921	–	–	–
P($SSB_{2024} > 20\% \ SSB_0$)	1.000	–	–	–
P($SSB_{2024} > 10\% \ SSB_0$)	1.000	–	–	–
P($SSB_{2028} > 20\% \ SSB_0$)	1.000	–	–	–
P($SSB_{2028} > 10\% \ SSB_0$)	1.000	–	–	–
P($SSB_{2024} > 20\% \ SSB_{0now}$)	1.000	–	–	–
P($SSB_{2024} > 10\% \ SSB_{0now}$)	1.000	–	–	–
P($SSB_{2028} > 20\% \ SSB_{0now}$)	1.000	–	–	–
P($SSB_{2028} > 10\% \ SSB_{0now}$)	1.000	–	–	–
P($SSB_{2028} > SSB_{2024}$)	0.743	–	–	–

Table 5: CRA 2 MCMC outputs, reporting the 5%, 50% (median), and 95% quantiles of the posterior distribution of parameter estimates for the 2022 full assessment and the 2023 and 2024 rapid updates. Growth increment values in mm TW and R_0 in numbers. M = male, F = female, IF = immature female, and MF = mature female.

	2022 base			2023 rapid update			2024 rapid update		
	5%	50%	95%	5%	50%	95%	5%	50%	95%
R_0	460 917	535 990	624 415	467 500	541 700	626 900	559 600	481 100	555 900
M	0.162	0.181	0.200	0.166	0.184	0.203	0.189	0.172	0.189
qCR	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
qFSU	0.002	0.002	0.003	0.002	0.002	0.003	0.002	0.002	0.002
qCELR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
qLB	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
mat50	49.610	50.600	51.460	49.590	50.550	51.400	50.400	49.430	50.440
mat95	9.131	11.420	14.200	9.090	11.350	13.960	11.480	9.294	11.370
Galpha [M]	6.671	6.854	7.023	6.669	6.833	7.000	6.837	6.658	6.840
Galpha [F]	4.739	4.902	5.064	4.756	4.932	5.101	4.978	4.815	4.976
Gbeta [M]	2.472	2.723	2.985	2.502	2.777	3.075	2.439	2.219	2.425
Gbeta [F]	1.114	1.183	1.267	1.123	1.188	1.269	1.149	1.076	1.148
Gshape [M]	1.810	2.338	2.926	1.830	2.394	3.006	1.770	1.278	1.757
Gshape [F]	3.886	4.174	4.445	3.902	4.171	4.431	4.037	3.747	4.036
GCV [M]	0.417	0.439	0.463	0.415	0.437	0.458	0.437	0.415	0.436
GCV [F]	0.713	0.748	0.791	0.705	0.744	0.785	0.734	0.694	0.734
Gobs	0.899	0.999	1.099	0.934	1.034	1.144	0.930	1.045	1.160
vuln SS [M]	0.867	0.903	0.943	0.866	0.904	0.942	0.900	0.865	0.900
vuln AW [IF]	0.533	0.642	0.776	0.535	0.646	0.781	0.635	0.526	0.632
vuln SS [IF+MF]	0.693	0.755	0.817	0.689	0.753	0.818	0.728	0.669	0.727
vuln AW [MF]	0.530	0.582	0.637	0.531	0.588	0.644	0.553	0.504	0.552
selL [M]	4.490	4.861	5.239	4.464	4.849	5.234	4.714	4.357	4.707
selL [F]	7.117	7.602	8.072	7.106	7.556	8.043	7.578	7.117	7.569
selM [M]	50.490	50.820	51.100	50.490	50.800	51.100	50.920	50.630	50.920
selM [F]	55.020	55.510	55.980	55.010	55.480	55.950	55.550	55.080	55.570

4. DISCUSSION

Rapid updates provide an annual update of stock status for the rock lobster stocks which have already been formally assessed. This provides a framework for managing these stocks that will be responsive to annual changes, much as the previous MPs were. However, CPUE based on statutory commercial catch and effort data are presently not available for most stocks. An alternative CPUE series has been developed for CRA 2, based on catch and effort from logbook data, that has been accepted by the RLWG as an abundance series (Webber & Starr 2022). This information was included for CRA 2 in the 2023 and 2024 rapid updates.

A rapid update was only done for CRA 2 in 2024. The reason for this was that CRA 3 and CRA 4 were subject to a full stock assessment in 2024, MPs were developed and accepted for CRA 7 and CRA 8 in 2024 using updated standardised logbook CPUE data (Webber et al. 2025), and the lack of an accepted CPUE abundance series in CRA 1 and CRA 5 for the last four years made the estimates of stock status for these stocks unreliable. Even though there was a full assessment for CRA 6 last year, this QMA showed no significant new data to inform a rapid update this year.

The CRA 2 vulnerable biomass decreased to a low point in 1992, increased to a peak in the mid-1990s, and decreased rapidly until 2002. Median estimated vulnerable biomass at the beginning of 2017–18 was about 50% of the reference level and the SSB was close to the soft limit. This triggered management measures designed to reverse the decline and to rebuild the stock. As a result, there was a decrease in exploitation rate stemming from the 2018 management measures. The 2022 assessment indicated that the stock had rebuilt rapidly and had reached a median of 1.68 times the reference level by the beginning of 2022–23 (Rudd et al. 2023). The SSB responded equivalently, rising to a median of 40% SSB_0. This CRA 2 rapid update predicts the vulnerable biomass at the beginning of 2024–25 to be slightly lower than was projected by the 2022 assessment. The median 2024 adjusted vulnerable biomass is now estimated to be 1.54 times the reference level and the median SSB to be at 38% of SSB_0 in that year. Both biomass series were projected to increase under current catch levels by the 2024 CRA 2 rapid update.

5. POTENTIAL RESEARCH

Future research considerations for rapid assessment updates include:

- Construct performance criteria to identify changes in parameter estimates and model fits between the full assessment and the rapid update.
- Develop diagnostic procedures such as likelihood profiles to improve the understanding of contributions by model components.
- Explore how recent recruitment is informed in rapid updates (e.g., using likelihood profiles) and determine the range of years for which recruitment should be estimated in rock lobster stock assessment models.

6. FULFILLMENT OF BROADER OUTCOMES

As required under Government Procurement rules[8], Fisheries New Zealand considered broader outcomes (secondary benefits such as environmental, social, economic or cultural benefits) that would be generated by this project.

[8]https://www.procurement.govt.nz/procurement/principles-charter-and-rules/government-procurement-rules/planning-your-procurement/broader-outcomes/

Whakapapa links all people back to the land, sea, and sky, and our obligations to respect the physical world. This research aims to ensure the long-term sustainability of red rock lobster stocks, for the good of the wider community (including stakeholders and the public) and the marine ecosystems that lobsters inhabit. This project supports both Māori and regional businesses, and our research is inextricably linked to the moana from the work it carries out and the tangata whenua it supports.

To support the wider fisheries science community and enable more value to be extracted from the limited resources (time and money) available for fisheries research, we make as much code as possible open source (i.e., publicly available). Furthermore, this project has built capacity and capability in fisheries science and stock assessment by employing researchers with a range of experience so that those with a long history of working in fisheries science can pass on their knowledge. This approach has meant that rock lobster stock assessments have consisted of a team with some members that have been involved for many years and some newer team members. This approach further mitigates risk associated with team members not being able to participate any longer.

7. ACKNOWLEDGEMENTS

Thank you to all who have worked with us on rock lobster stock assessments including members of the RLWG. Thank you to Fisheries New Zealand and especially Bruce Hartill, the chair of the RLWG. Also, thank you to the New Zealand Rock Lobster Industry Council, members of the National Rock Lobster Management Group, and many individual fishers and quota owners in the commercial rock lobster fishery. This research project was awarded to Quantifish Limited by Fisheries New Zealand (project code CRA2022-01).

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