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Tini a Tangaroa

Operational management procedures of New Zealand rock lobster (*Jasus edwardsii*) stocks for 2020–21

New Zealand Fisheries Assessment Report 2020/46

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This document describes the operation of management procedures (MPs) in November 2019 used to manage New Zealand red rock lobster (*Jasus edwardsii*) Quota Management Areas (QMAs) for the 2020–21 fishing year.

MPs are simulation-tested decision rules. Given an input (e.g., standardised offset-year catch per unit effort, CPUE), they return an output (e.g., Total Allowable Commercial Catch, TACC). They consist of a harvest control rule, which defines the relationship between CPUE and TACC, and other controls such as minimum change thresholds that modify the output. They are simulation-tested using an operating model, which is based on the most recent stock assessment model for each rock lobster QMA.

In 2019, there were four rock lobster QMAs with management procedures (CRA 4, CRA 5, CRA 7, and CRA 8). CRA 2, CRA 6, and CRA 9 are managed without management procedures. CRA 1 and CRA 3 had new stock assessments in 2019, which rendered the previous MPs no longer operable and new MPs were not developed due to the change in the collection methodology for the catch/and effort data which form the basis of existing MPs. For CRA 5 the management procedure indicated no change. The management procedures for CRA 4 and CRA 8 resulted in an increase in TACC and Total Allowable Catch. Operating the MP for CRA 7 resulted in a mixed response: there was no increase if the electronic (ERS) data were omitted but an increase resulted when all data were included. The RLFAWG recommended that that the new electronic data be omitted from the operation of the remaining MPs because it was not known how much the new electronic format would affect data reporting.

This document contains the equations and specifications for the current MPs and their recent histories. The original material is scattered among Fisheries Assessment Reports, consultation documents, and other sources, so this document is updated every year to provide a central reference. However, this will most likely be the final report for these MPs because changes resulting from a switch from paper to electronic reporting of catch and effort data are expected to break the comparability of the CPUE series between reporting types, causing all current MPs to become inoperable beyond 2019.

1. INTRODUCTION

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

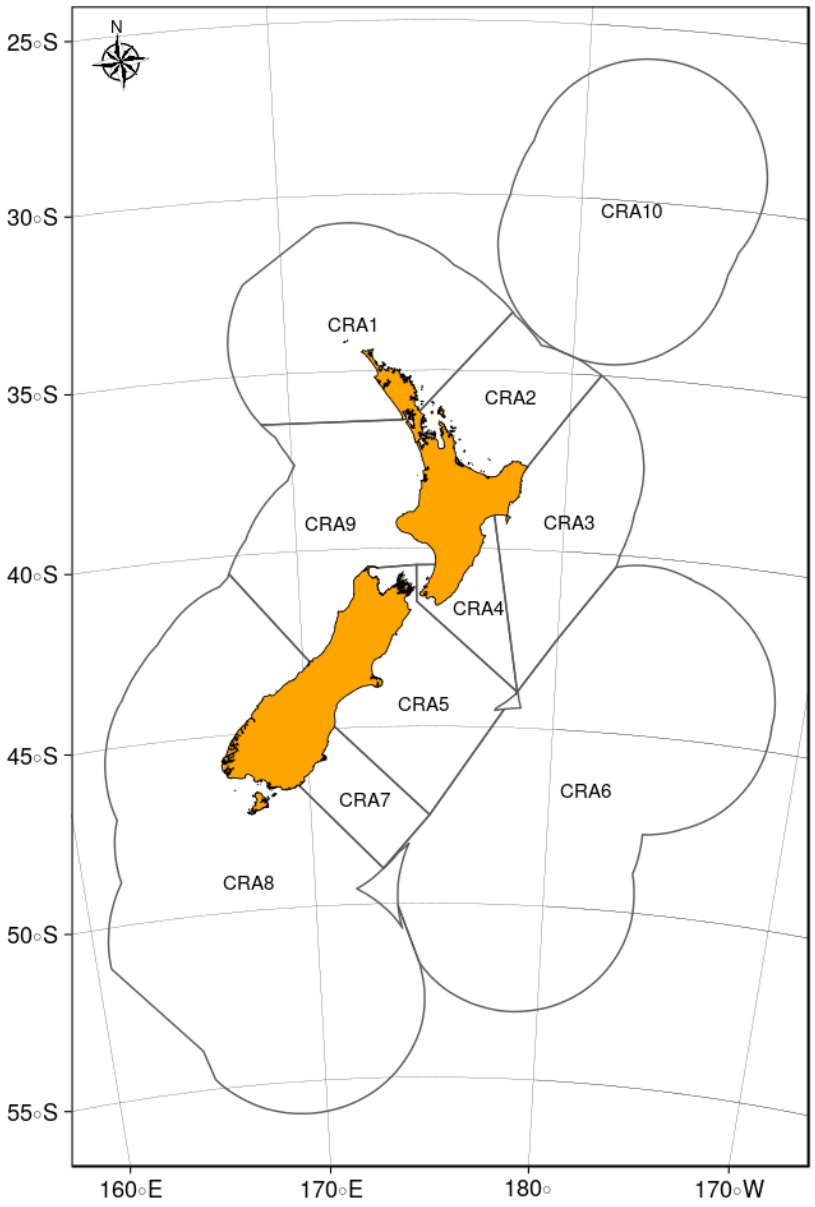

Figure 1: New Zealand red rock lobster (*Jasus edwardsii*) Quota Management Areas (QMAs).

This document describes the current (as of November 2019) operational management procedures (MPs) used to manage New Zealand stocks of red rock lobsters (Breen et al. 2016b). 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, Australia (Punt et al. 2013). MPs have been a major part of New Zealand rock lobster management (Bentley et al. 2003b; Breen et al. 2009a, 2016a, 2016b; Bentley &

Stokes 2009), but this will change, starting in 2020, because Fisheries New Zealand has changed the reporting of catch and effort data from paper forms to electronic data collection. Past experience, as well as some early analysis of the data from electronic forms, indicate that the comparability of the electronic data with the previous data collected on paper forms has most likely been lost, leading to the end of the existing MPs.

MPs are simulation-tested decision rules (Butterworth &Punt 1999), or functions, often referred to as harvest control rules (HCRs), that specify one or more inputs and return an output value. New Zealand rock lobster MPs use standardised catch per unit effort (CPUE) as the input and a catch limit as the output[1]. Other controls, such as minimum or maximum change thresholds, may also be used to modify the output.

Some work has investigated the use of MPs with additional inputs (e.g., settlement indices, Bentley et al. 2005) but so far other inputs have not been used formally for management in New Zealand. Before 2007, the input CPUE was from the preceding fishing year[2]. This approach resulted in a one-year lag between observed CPUE and the resulting catch limit (i.e., the fishing year ends on the 31 March and any new catch limit from the MP is applied to the year beginning in April the following year). To shorten the lag to six months, "offset-year" CPUE was developed[3]. Much exploratory work has been done on CPUE and its standardisation (e.g., Starr 2012).

The first New Zealand MP and its successors were used to rebuild the depleted CRA 8 stock in New Zealand and to concurrently manage the volatile CRA 7 stock (Starr et al. 1997, Bentley et al. 2003a, Breen et al. 2008, Haist et al. 2013). With the MPs for CRA 1 and CRA 3 coming to an end in 2019, there are now only four rock lobster QMAs with MPs (CRA 4, CRA 5, CRA 7, and CRA 8), leaving CRA 1, CRA 2, CRA 3, CRA 6, and CRA 9 to be managed without MPs.

In the CRA 4 fishery, industry adopted a MP to reduce their catches voluntarily (quota "shelving", Breen 2009) prior to formal requirement by Fisheries New Zealand for catch reductions. A voluntary MP for CRA 5 was designed to maintain high abundance (Breen et al. 2009b).

The CRA 2 stock assessment in 2017 suggested that the stock was below the soft limit and therefore required a rebuilding plan (Webber et al. 2018). The chosen rebuilding plan used a fixed catch rather than a MP. A stock assessment for CRA 6 was done in 2018 (Rudd et al. 2019) but a MP was not developed for managing this QMA because planned changes to the collection of catch and effort data made it unlikely that comparable offset-year CPUE would be available after November 2019. This was also true of the CRA 1 and CRA 3 stock assessments done in 2019 (Rudd et al. 2020, Webber et al. 2020). A MP for CRA 9 was abandoned in 2016, after two years of operation, because analysis indicated that the CRA 9 CPUE was not sufficiently robust to support its use in a stock assessment or a MP. New stock assessments done in 2019 for CRA 1 and CRA 3, coupled with substantive changes in the manner in which catch and effort data are collected, resulted in a decision by Fisheries New Zealand to manage these QMAs using fixed catch levels expected to be held over the next five years.

Rock lobster MPs have evolved over time as each stock was assessed and subsequent management procedure evaluations (MPEs) were conducted. Some generalised work has also been done (Bentley et al. 2003b, Breen et al. 2003). The industry-inspired "plateau" rules, described below, can impart great stability. However, because stable rules are less responsive to abundance changes, there are trade-offs between stability and safety. Recent experience (e.g., in CRA 2 and CRA 4) suggests a need for caution in locating the lower plateau edge.

[1] Currently all New Zealand rock lobster MPs produce Total Allowable Commercial Catch (TACC) and allowances for other sectors are added to provide a Total Allowable Catch (TAC). Catch limits and allowances are always specified in metric tonnes.

[2] A fishing year runs from 1 April to 31 March of the following year and is named by the first year (i.e., 2016–17 is termed '2016').

[3] An offset year runs from 1 October to 30 September of the following year and is named by the second year (i.e., 2017–18 is termed '2018').

The impetus for adoption of MPs for rock lobsters in New Zealand originally came from the need to rebuild depleted stocks. This has been largely successful, particularly in Otago (CRA 7) and Stewart Island/Fiordland (CRA 8). Both these stocks are now rebuilt, with standardised CPUE several times greater than the minimum observed in the late 1990s (Starr 2019). The total arithmetic CPUE for all New Zealand has nearly doubled since the late 1990s, and total catches have increased (Breen et al. 2016b). Fishing effort has declined in all QMAs with longstanding MPs (CRA 3, CRA 4, CRA 5, CRA 7, and CRA 8).

One measure of the success of these MPs is where they have rebuilt depleted stocks and then maintained healthy stocks. MPs also involve stakeholders in setting management goals and participating in the rebuilding process. This has allowed an emphasis on strategic planning for research and management of these fisheries, stepping beyond the usual tactical responses used to manage fisheries (Bentley & Stokes 2009). This shift is evidenced by the willingness of the New Zealand government to accept, in most instances, the recommendations made by the National Rock Lobster Management Group (NRLMG) which are usually based on MP results. In some instances, either the NRLMG or the Minister has declined MP results:

- for CRA 5 in 2015–16, where the MP would have delivered a TACC reduction less than 5%
- for CRA 9 in 2015–16, where the industry requested a delay pending the results of an audit and other analyses
- for CRA 4 in 2016–17, where industry requested a larger decrease than was specified by the MP and this was implemented
- for CRA 2 in 2016–17 and 2017–18, where industry voted to shelve 49 tonnes (25%) of their annual catching rights voluntarily, despite the MP outcome resulting in no TACC change
- for CRA 4 in 2018–19, when the Fisheries Minister declined to implement an increase that was specified by the MP.

This document is intended as a central reference containing all the specifications for the current MPs, and their operation. The original documentation is scattered among New Zealand Fisheries Assessment Reports (FARs), consultation documents, ministerial decision letters, and other sources, so this document is updated every year. The most definitive documents for each rule are the relevant FARs describing the stock assessment and MPEs, the NRLMG Final Advice Paper or consultation document containing the basis on which the Minister of Fisheries signed off the MP, and the Minister's decision letter. We note that the Fisheries Stock Assessment Plenary report also contained material relevant to the rock lobster MPs (Fisheries New Zealand 2019). Unfortunately, the information in the 2019 Plenary was based an early version of this MP document that combined the analysis of paper (CELR) data and Electronic Reporting System (ERS) data, which were not the analyses that were eventually used to evaluate the four MPs. Instead, the NRLMG agreed to use the paper (CELR) data for CRA 4, 5, and 8 MP evaluations, omitting the new ERS data. For CRA 7, the NRLMG considered both analyses (with and without ERS data). It is unfortunate that the incorrect information is presented in the 2019 Plenary report. This document provides both analyses for completeness.

This document does not describe the historical MPs before the current MP for each QMA was adopted, but these can be found in previous versions of this document (e.g., Breen et al. 2009a; Breen 2015, 2016, 2017; Webber & Starr 2018, 2020).

Fisheries New Zealand progressively implemented electronic reporting of catch and effort for rock lobster, beginning in April 2019. It is not known how this change in the data collection procedure will ultimately affect the CPUE used to drive current MPs, but past experience (i.e., the 1987–1989 changeover from the Fishery Statistics Unit [FSU] to the CELR) and preliminary analyses have led us to conclude that the new data will most likely not be comparable to the previous paper-based Catch Effort Landing Return (CELR) data. However, the phased implementation of the new system over the 2019 April-September period meant that much of the 2019 data were reported on CELR forms rather

than electronically using the new ERS data format. The RLFAWG agreed, after an October 2019 review of the available CPUE data, that the remaining MPs could be evaluated in November 2019 if there were sufficient CELR data to operate the MPs in a manner consistent with previous years (see Appendix I for the results of this evaluation).

This document reports the operation of MPs based on CPUE indices for the 2018–19 offset (October–September) fishing year with and without ERS data, with a narrative associated with each MP indicating how the management advice was formulated as well as the Minister's response to the advice. It is the opinion of the RLFAWG that the changes to the collection of catch and effort data will require the development of new evaluation procedures beyond 2019.

2. GENERALISED PLATEAU RULES

2.1 Step and slope harvest control rules

The current MPs have either a "plateau step" harvest control rule or a "plateau slope" rule, illustrated in Figure 2 and Figure 3. With respect to output TACC vs. input CPUE, step and slope rules have:

- a straight-line segment from zero TACC at some value of CPUE (not necessarily zero CPUE) up to a plateau
- a plateau over which TACC stays the same as CPUE changes (the plateau could be of zero width, but all current rules have an actual plateau)
- and either:
    - a series of steps to the right of the plateau (step rules) or
    - an ascending function at CPUE values to the right of the plateau (slope rules).

Descriptions in this section assume that the MP determines the TACC, as do all current MPs for rock lobster in New Zealand. A TAC-determining MP was developed for CRA 5 in 2010, at the request of the Ministry of Fisheries (the name of the managing government agency in 2010, Haist et al. 2011). This had a TACC component plus components for non-commercial catch sectors. This approach was rejected by the Minister and a TACC-determining rule was developed and approved in the following year. There is concern that rules controlling only the commercial catch will divert catch away from the commercial sector into the non-commercial sectors, which can increase their relative catch share as stocks increase. This outcome has been confirmed by simulation modelling (Breen et al. 2003) and remains a concern for commercial stakeholders, who are increasingly unwilling to be the only sector affected by TAC changes.

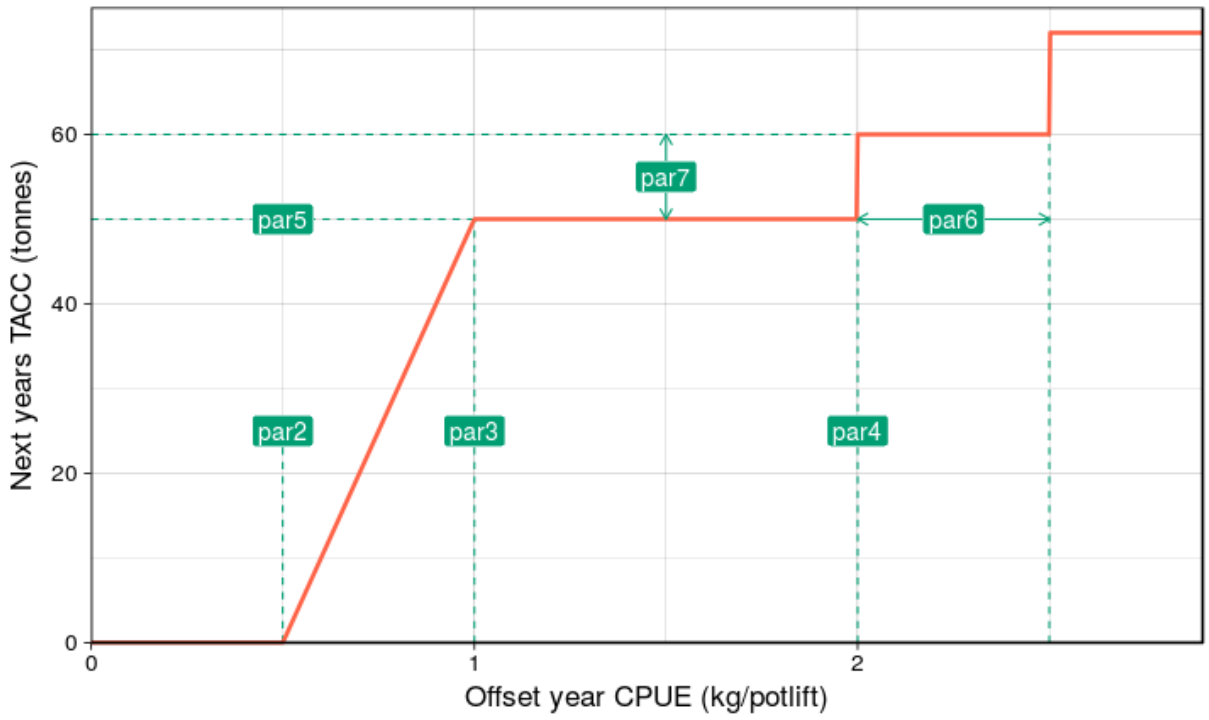

Figure 2: A generalised plateau step rule. See Table 1 for parameter definitions.

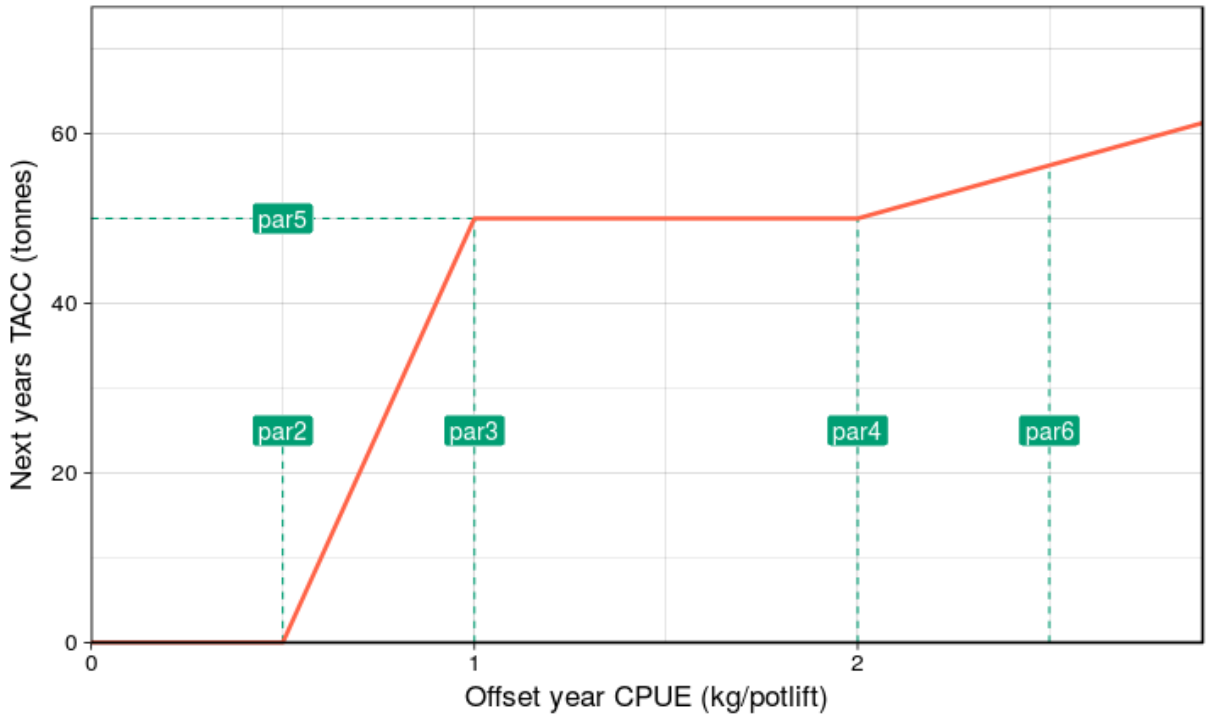

Figure 3: A generalised plateau slope rule. See Table 1 for parameter definitions.

2.2 Rule parameters

The generalised rule parameters are defined in Table 1.

Table 1: Parameters for the generalised plateau rules and the CRA 3 rule.

Parameter	Applies to	Function
$par1$	all	rule type
$par2$	all except CRA 3	CPUE at TACC = 0
$par2$	CRA 3 rule	CPUE at first inflection
$par3$	all	CPUE at plateau left
$par4$	all	CPUE at plateau right
$par5$	all	plateau height
$par6$	step rules	step width
$par6$	slope rules	slope
$par6$	CRA 3 rule	slope (defined differently)
$par7$	step rules	step height
$par8$	all	minimum change
$par9$	all	maximum change
$par10$	all	latent year switch

The rule type parameter ($par1$) is set to 1 for fixed catch rules, 2 for slope rules (i.e., constant CPUE multiplier), 3 for plateau slope rules, and 4 for plateau step rules. The description here is for rule types 3 and 4 only. The point at which TACC becomes zero ($par2$) can be zero or non-zero but must be less than the left edge of the plateau ($par3$). The value of $par3$ must be less than or equal to the right edge ($par4$). In plateau slope rules ($par6$) must be greater than $par4$. Thus, for an acceptable rule:

$$par2 < par3 \leq par4$$

$$par4 < par6 \quad \text{if} \quad par1 = 3$$

Step height for step rules ($par7$) is defined as a proportion of the TACC on the previous step, thus 0.1 would indicate that TACC on the first step is 10% higher than TACC on the plateau and that each step increases by 10% of the previous step. The slope parameter for slope rules ($par6$) is defined as the CPUE at which TACC is 1.5 times the plateau height ($par5$).

The minimum change parameter ($par8$) defines the minimum proportional change in TACC. When CPUE changes only slightly and the rule specifies a new TACC differing from the existing TACC by an amount less than $par8$, there is no change to the TACC. If the minimum change parameter and the step height are the same, then technically the TACC cannot be reduced from the second step to the first because the step downwards would be less than the minimum change threshold. Either it must be agreed that minimum change does not apply in the area of the steps, or the minimum change parameter must be set at less than $par7/(1 + par7)$.

The maximum change parameter ($par9$) specifies the maximum allowable proportional TACC change. When CPUE changes so much that the rule specifies a TACC change greater than $par9$, the TACC is changed only by the $par9$ proportion. A value of zero for $par9$ indicates that there is no maximum change threshold and that any TACC change is allowed.

A latent year component to the rule means that TACC cannot be changed if it was changed in the previous year ($par10 = 1$). An "asymmetric latent year" means that TACC can be decreased but not increased when it was changed in the previous year ($par10 = 2$). If $par10 = 0$ then no latent year is used.

2.3 Rule operation

For both rule forms, and for CPUE less than or equal to the right edge of the plateau ($par4$), the provisional TACC (before operation of thresholds $par8$, $par9$, and $par10$) is given by:

$$TACC_{y+1} = \begin{cases} 0 & \text{if} \quad I_y \le par2 \\ par5\left(\dfrac{I_y - par2}{par3 - par2}\right) & \text{if} \quad par2 < I_y \le par3 \\ par5 & \text{if} \quad par3 < I_y \le par4 \end{cases}$$

where $TACC_{y+1}$ is the provisional TACC and I_y is the standardised offset-year CPUE in the preceding year. When CPUE is above the right edge of the plateau, the TACC for plateau step rules is given by:

$$TACC_{y+1} = par5\left((1 + par7)^{\lfloor (I_y - par4)/par6 \rfloor + 1}\right) \quad \text{if} \quad I_y > par4$$

and for plateau slope rules by:

$$TACC_{y+1} = par5\left(1 + \frac{0.5\left(I_y - par4\right)}{par6 - par4}\right) \quad \text{if} \quad I_y > par4.$$

The provisional TACC that results from these equations may be modified by the operation of the minimum and maximum change thresholds, or by a latent year, to give the rule's recommended TACC. The change in TACC is defined as:

$$\Delta = \frac{TACC_{y+1} - TACC_y}{TACC_y}$$

The minimum change threshold is applied as:

$$TACC'_{y+1} = \begin{cases} TACC_y & \text{if} \quad par8 > 0, |\Delta| < par8 \\ TACC_{y+1} & \text{if} \quad par8 > 0, |\Delta| \ge par8 \end{cases}$$

and the maximum change threshold is applied as:

$$TACC'_{y+1} = \begin{cases} (1 - par9)TACC_{y+1} & \text{if} \quad par9 > 0, |\Delta| > par9, \Delta < 0 \\ (1 + par9)TACC_{y+1} & \text{if} \quad par9 > 0, |\Delta| > par9, \Delta > 0 \end{cases}$$

In the rule information given below for each stock, some definitions are:

- "review scheduled" is usually the year five years after development of the current rule; whether the review occurs is a matter for the NRLMG and reviews are sometimes brought forward
- input CPUE is standardised offset-year for all stocks where the standardisation includes year, month, and statistical area coefficients; "F2-LFX" (now used for all stocks except CRA 8) defines the data extraction algorithm, which must be the same as that used in MPEs when the rule was developed
- managers vary in the precision they use in recommending catch limits; the tables report at least the precision used by managers.

For more information on CPUE see Starr (2019).

3. CRA 4 MANAGEMENT PROCEDURE

3.1 Summary

A summary of MPs in CRA 4 (Figure 4) is provided in Table 2. The CRA 4 MP is based on work done in 2016 (Breen et al. 2017), using an operating model based on the CRA 4 stock assessment model. Rules evaluated were generalised plateau step rules. From the options recommended (National Rock Lobster Management Group 2017), the Minister adopted the rule specified in Table 3.

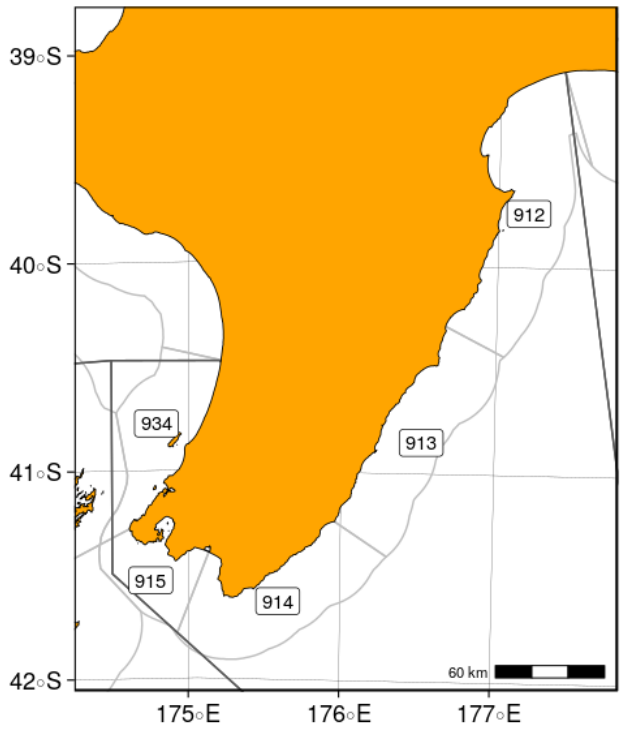

Figure 4: Statistical areas within CRA 4.

Table 2: Summary of CRA 4 MPs.

First year with MP	2007
First year of current MP	2017
Review scheduled	2021
Input	F2-LFX offset-year CPUE
Output	TACC
Type of rule	generalised plateau step rule
Minimum change	5%
Maximum change	none
Latent year	none
2019–20 customary allowance	35
2019–20 recreational allowance	85
2019–20 other mortality allowance	75
2019–20 total non-commercial allowance	195
2019–20 TACC	318.8
2019–20 TAC	513.8

Table 3: Parameters for the CRA 4 generalised plateau step rule.

Parameter	Function	Value
$par1$	rule type	4
$par2$	CPUE at TACC = 0	0
$par3$	CPUE at plateau left	0.9
$par4$	CPUE at plateau right	1.3
$par5$	plateau height	380
$par6$	step width	0.1
$par7$	step height	0.053
$par8$	minimum change	0.05
$par9$	maximum change	0
$par10$	latent year switch	0

The Final Advice Paper (National Rock Lobster Management Group 2017) for the 2017–18 fishing year described the rule as follows:

- *The output variable is TACC (tonnes);*
- *Offset-year standardised CPUE is used as an input to the rule to determine the TACC for the fishing year that begins in the following April;*
- *CPUE is calculated using the 2012 F2_LFX procedure…*
- *The management procedure is to be evaluated every year (no "latent year"), based on offset-year CPUE; and*
- *The minimum change threshold for the TACC is 5%. There is no maximum change threshold for the TACC.*

The proposed new CRA 4 management procedures are both generalised plateau step rules… For Rule 6: at a CPUE value of zero the TACC is zero; the TACC then increases linearly to 0.9 kg/potlift; between CPUEs of 0.9 and 1.3 kg/potlift the TACC is 380 tonnes; as CPUE increases above 1.3 kg/potlift, the TACC increases in steps with a width of 0.1 kg/potlift and a height of 5.3% of the preceding TACC.

3.2 History

The first MP for CRA 4 was voluntary (Breen et al. 2009b), based on the work of Breen & Kim (2006), and was used to guide ACE (Annual Catch Entitlement, related to quota) shelving for 2007 and 2008. The Minister adopted the current MP in March 2017 for the 2017–18 fishing year.

- In November 2016, standardised offset-year CPUE was 0.6851 kg/potlift (Table 4, Figure 5), giving a TACC of 289.264 tonnes (Table 4, Figure 6). This result was accepted by the Minister.
- In November 2017, standardised offset-year CPUE increased to 0.7550 kg/potlift, giving a TACC of 318.778 tonnes. This result was accepted by the Minister after rounding to 1 decimal place.
- In November 2018, standardised offset-year CPUE increased to 0.9012 kg/potlift, giving a TACC on the plateau of 380.0 tonnes. This TACC change was +19.2%, well above the minimum change threshold of 5%, so the MP result was an increase in the TACC. However, this result was not accepted by the Minister who decided to retain the previous year's TACC of 318.8 tonnes.

- In November 2019, standardised offset-year CPUE decreased to 0.8867 kg/potlift, giving a TACC just below the plateau of 374.4 tonnes. This TACC change was +17.4%, well above the minimum change threshold of 5%, so the MP result was an increase in the TACC.

The NRLMG, using the 2019 offset-year CPUE index which excluded the ERS data (0.8867), recommended a TACC increase of 55.6 tonnes to 374.4 tonnes from the existing 318.8 tonne TACC (National Rock Lobster Management Group 2020). The Minister rejected this advice and left the TACC at 313.8 tonnes and the TAC at 513.8 tonnes (Nash 2020).

Table 4: History of the current CRA 4 management procedure and its operation in 2019. "Rule result TACC" is the result of the management procedure. "Applied TACC" and "Applied TAC" are the catch limits decided by the Minister.

Offset year	Offset-year CPUE (kg/potlift)	Applied to fishing year	Rule result TACC (tonnes)	Applied TACC (tonnes)	Applied TAC (tonnes)
2016	0.6851	2017–18	289.264	289.0	484.0
2017	0.7550	2018–19	318.778	318.8	513.8
2018	0.9012	2019–20	380.000	318.8	513.8
2019[1]	0.8867	2020–21	374.384	–	–
2019[2]	0.8961	2020–21	378.353	–	–

[1]excludes ERS data, [2]includes ERS data

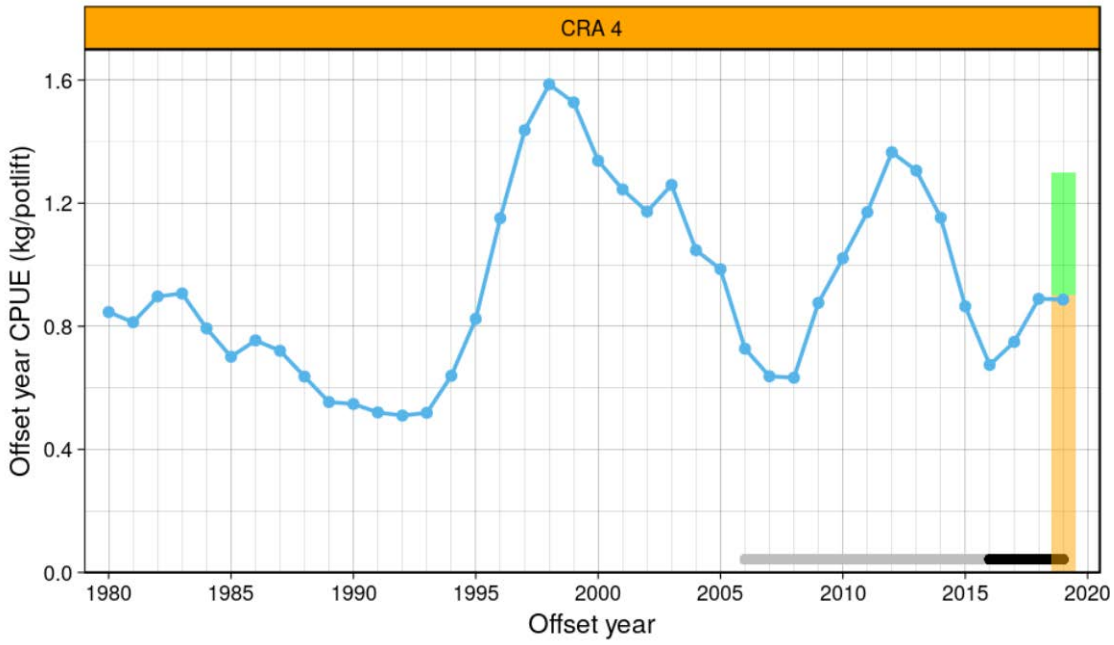

Figure 5: Offset-year CPUE (F2-LFX) (kg/potlift) for CRA 4. The coloured bar represents the plateau (green) and the slope (orange). The horizontal black line indicates the years that the current MP has operated, the grey indicates the years that other MPs operated.

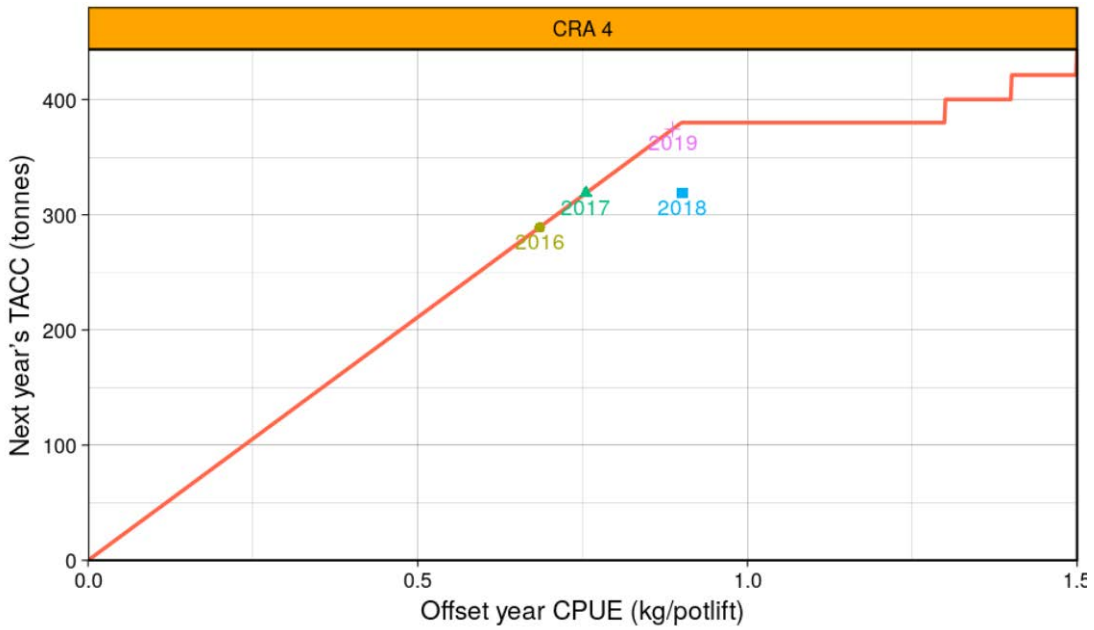

Figure 6: History of the current CRA 4 management procedure. The coloured symbols show the 2016 to 2019 offset-year CPUE and the resulting TACCs.

4. CRA 5 MANAGEMENT PROCEDURE

4.1 Summary

A summary of MPs in CRA 5 (Figure 7) is provided in Table 5. The CRA 5 MP is based on MPEs done in 2015 (Starr & Webber 2016), using an operating model based on the CRA 5 stock assessment model. Rules evaluated were generalised plateau step rules. From the options recommended, the NRLMG chose, and the Minister accepted, the rule specified in Table 6 (National Rock Lobster Management Group 2016). The Minister increased the recreational allowance from 40 to 87 tonnes.

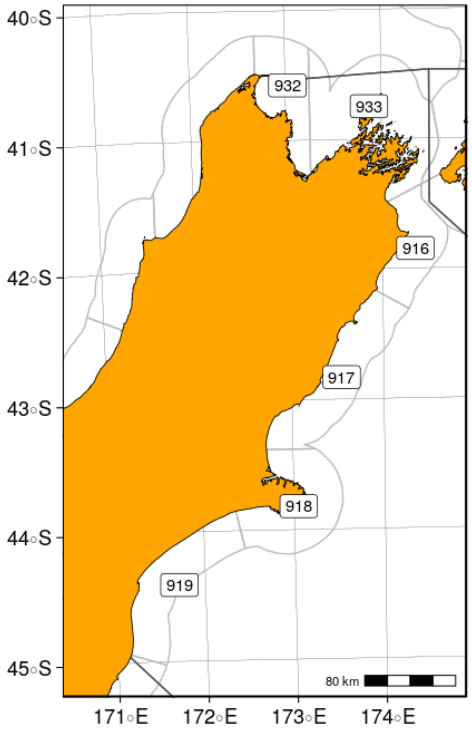

Figure 7: Statistical areas within CRA 5.

Table 5: Summary of CRA 5 MPs.

First year with MP	2009
First year of current MP	2016
Review scheduled	2020
Input	F2-LFX offset year CPUE
Output	TACC
Type of rule	generalised plateau step rule
Minimum change	5%
Maximum change	none
Latent year	none
2019–20 customary allowance	40
2019–20 recreational allowance	87
2019–20 other mortality allowance	37
2019–20 total non-commercial allowance	164
2019–20 TACC	350
2019–20 TAC	514

Table 6: Parameters for the CRA 5 generalised plateau step rule.

Parameter	Function	Value
$par1$	rule type	4
$par2$	CPUE at TACC = 0	0.3
$par3$	CPUE at plateau left	1.2
$par4$	CPUE at plateau right	2.2
$par5$	plateau height	350
$par6$	step width	0.2
$par7$	step height	0.055
$par8$	minimum change	0.05
$par9$	maximum change	0
$par10$	latent year switch	0

The Final Advice Paper (National Rock Lobster Management Group 2016) for the 2016/17 fishing year described the new harvest control rule as follows:

- *The output variable is TACC (tonnes);*
- *Offset-year standardised CPUE is used as an input to the rule to determine the TACC for the fishing year that begins in the following April;*
- *CPUE is calculated using the 2012 F2_LFX procedure which uses:*
    - *landings to a licensed fisher receiver, along with recreational landings from a commercial vessel and the amount of rock lobsters returned to the water in accordance with Schedule 6 of the Act (i.e. high-graded rock lobsters),*
    - *estimates, by vessel, of the ratio of annual landed catch divided by annual estimated catch to correct every landing record in a quota management area for the vessel;*
- *The management procedure is to be operated every year (no "latent year"), based on offset-year CPUE;*
- *The minimum change threshold for the TACC is 5%. There is no maximum change threshold for the TACC.*

The proposed new CRA 5 management procedure is based on a generalised plateau step rule … Between CPUEs of zero and 0.3 kg/potlift the TACC is zero, the TACC then increases linearly with CPUE to 350 tonnes at a CPUE of 1.2 kg/potlift. The TACC remains at 350 tonnes until CPUE reaches 2.2 kg/potlift and then increases by 5.5% in CPUE steps of 0.2 kg/potlift.

4.2 History

The current rule was adopted by the Minister for the 2016–17 fishing year. The Minister retained the customary allowance of 40 tonnes and the illegal allowance of 37 tonnes, but increased the recreational allowance from 40 to 87 tonnes (Table 5).

- In November 2015, standardised F2-LFX offset-year CPUE was 1.7890 (Table 7, Figure 8), which specified a TACC of 350 tonnes, on the plateau (Table 7, Figure 9). This result was accepted by the Minister.
- In November 2016, standardised F2-LFX offset-year CPUE was 1.5902, which specified a TACC of 350 tonnes, which remained on the plateau. This result was accepted by the Minister.
- In November 2017, standardised F2-LFX offset-year CPUE was 2.0482, which specified a TACC of 350 tonnes, which remained on the plateau. This result was accepted by the Minister.
- In November 2018, standardised F2-LFX offset-year CPUE was 1.7977, which specified a TACC of 350 tonnes, which remained on the plateau. This result was accepted by the Minister.
- In November 2019, standardised F2-LFX offset-year CPUE was 1.7470, which specified a TACC of 350 tonnes, which remained on the plateau.

The NRLMG did not recommend any change to the existing TACC for CRA 5, given the nearly identical results for the 2019 offset year CPUE, whether or not the ERS data were included or excluded, and the location of both indices on the plateau.

Table 7: History of the current CRA 5 management procedure and its operation in 2019. "Rule result TACC" is the result of the management procedure. "Applied TACC" and "Applied TAC" are the catch limits decided by the Minister.

Offset year	Offset-year CPUE (kg/potlift)	Applied to fishing year	Rule result TACC (tonnes)	Applied TACC (tonnes)	Applied TAC (tonnes)
2015	1.7890	2016–17	350	350	514
2016	1.5902	2017–18	350	350	514
2017	2.0482	2018–19	350	350	514
2018	1.7977	2019–20	350	350	514
2019[1]	1.7470	2020–21	350	–	–
2019[2]	1.7500	2020–21	350	–	–

[1]excludes ERS data, [2]includes ERS data

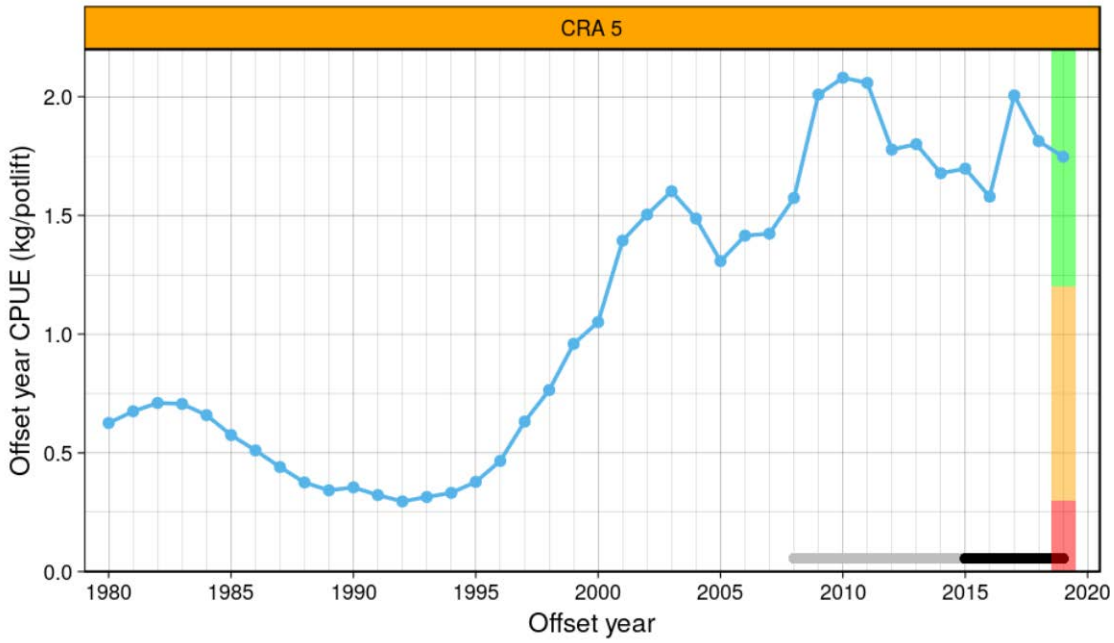

Figure 8: Offset-year CPUE (F2-LFX) (kg/potlift) for CRA 5. The coloured bar represents the plateau (green), the slope (orange), and the CPUE at which the TACC = 0 (red). The horizontal black line indicates the years that the current MP has operated, the grey indicates the years that other MPs operated.

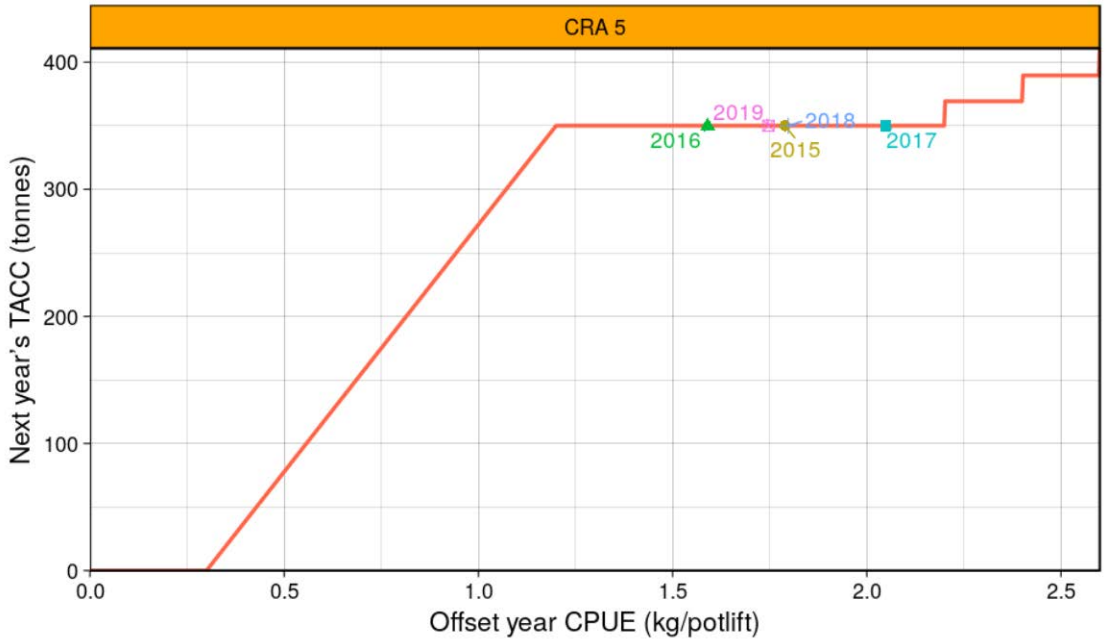

Figure 9: History of the current CRA 5 management procedure. The coloured symbols show the 2015 to 2019 offset-year CPUE and the resulting TACCs.

5. CRA 7 MANAGEMENT PROCEDURE

5.1 Summary

A summary of MPs in CRA 7 (Figure 10) is provided in Table 8. The CRA 7 MP is based on MPEs done in 2012, which used an operating model based on the 2012 joint stock assessment for CRA 7 and CRA 8 (Haist et al. 2013). This MP was re-evaluated in 2015 after a new stock assessment (Haist et al. 2016) and was retained. Rules evaluated in 2012 and again in 2015 were generalised slope rules. From the options originally recommended (National Rock Lobster Management Group 2013), the Minister adopted the rule specified in Table 9. This rule replaced an earlier rule and is the latest in a series (Starr et al. 1997, Bentley et al. 2003a, Breen et al. 2008).

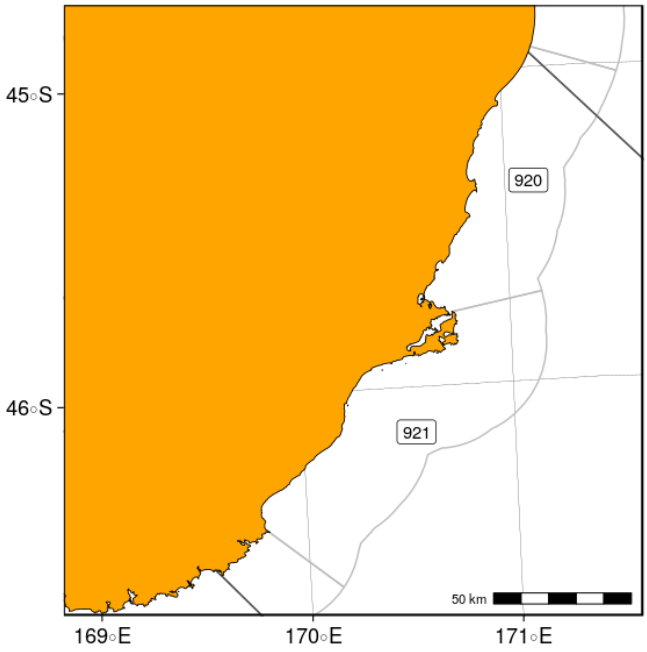

Figure 10: Statistical areas within CRA 7.

Table 8: Summary of CRA 7 MPs.

First year with MP	1996
First year of current MP	2013
Review scheduled	2020
Input	F2-LFX offset year CPUE
Output	TACC
Type of rule	generalised plateau slope rule
Minimum change	10%
Maximum change	50%
Latent year	none
2019–20 customary allowance	10
2019–20 recreational allowance	5
2019–20 other mortality allowance	5
2019–20 total non-commercial allowance	20
2019–20 TACC	97
2019–20 TAC	117

Table 9: Parameters for the CRA 7 generalised plateau slope rule.

Parameter	Function	Value
$par1$	rule type	3
$par2$	CPUE at TACC = 0	0.17
$par3$	CPUE at plateau left	1
$par4$	CPUE at plateau right	1.75
$par5$	plateau height	80
$par6$	slope	3
$par7$	n.a.	0
$par8$	minimum change	0.1
$par9$	maximum change	0.5
$par10$	latent year switch	0

The Final Advice Paper (National Rock Lobster Management Group 2013) for the 2013–14 fishing year described the rule as follows:

Some important elements of the new Rule 39 CRA 7 Management Procedure are:

- *the output variable is TACC (tonnes) (non-commercial catch assumptions are made from the operating model).*
- *offset-year standardised CPUE is used as an input to the rule to determine the TACC for the fishing year that begins in the following April.*
- *CPUE is calculated using the new "F2-LFX" procedure which uses:*
    - *Ministry for Primary Industries landings to a licensed fisher receiver, along with recreational landings from a commercial vessel and the amount of rock lobsters returned to the water in accordance with Schedule 6 of the Act (i.e. high-graded rock lobsters),*
    - *estimates, by vessel, of the ratio of annual landed catch divided by annual estimated catch to correct every landing record in a quota management area for the vessel.*
- *the management procedure is to be evaluated every year (no "latent year"), based on offset-year CPUE.*
- *the new CRA 7 Management Procedure is based on a generalised plateau rule. Below a CPUE of 0.17 kg/potlift, the TACC is zero; between a CPUE of [0.17] and 1.0 kg/potlift, the TACC increases linearly with CPUE to a plateau of 80 tonnes, which extends to a CPUE of 1.75 kg/potlift. As CPUE increases above 1.75 kg/potlift, TACC increases linearly. The minimum change threshold for the TACC is 10% and the maximum change threshold is 50%.*

5.2 History

The Minister adopted this rule in 2013 for the 2013–14 fishing year.

- In November 2012 the standardised offset-year CPUE was 0.625 kg/potlift (Table 10, Figure 11), giving a TACC of 44.96 tonnes (Table 10, Figure 12). The Minister accepted this result and retained the previous non-commercial allowances of customary 10 tonnes, recreational 5 tonnes, and other mortality 5 tonnes, to set a TAC of 64 tonnes (Table 8).
- In November 2013 the offset-year CPUE had more than doubled to 1.356 kg/potlift, which suggested a TACC of 80 tonnes. The increase was greater than the maximum allowed increase of 50%, so the TACC was increased by 50% to 66 tonnes. The Minister accepted this result and used the same allowances to set a TAC of 86 tonnes.

- In November 2014 the offset-year CPUE had increased to 2.304 kg/potlift, giving a TACC of 97.72 tonnes. The Minister accepted this result and retained the same allowances as before, giving a TAC of 117.72 tonnes.
- In November 2015, standardised F2-LFX offset-year CPUE had decreased slightly to 2.212 kg/potlift and the preliminary rule result was a TACC of 94.797 tonnes. Because this would be a change of only 2.9%, less than minimum change threshold of 10%, the MP result was no change to the TACC.
- In November 2016, standardised F2-LFX offset-year CPUE had increased to 2.766 kg/potlift and the preliminary rule result was a TACC of 112.512 tonnes. The increase of 25% was greater than the 10% minimum change threshold, so the MP result was an increase in the 2017–18 TACC to 112.512 tonnes. The Minister accepted this result.
- In November 2017, standardised F2-LFX offset-year CPUE decreased to 2.328 kg/potlift and the preliminary rule result was a TACC of 98.499 tonnes, a 12.5% decrease from the TACC of 112.52 tonnes. Because this is greater than the minimum change threshold of 10%, the result was a 12.5% decrease in the 2018–19 TACC to 98.499 tonnes. The Minister accepted this result and set the TACC at 97 tonnes.
- In November 2018, standardised F2-LFX offset-year CPUE decreased to 2.292 kg/potlift and the preliminary rule result was a TACC of 97.343 tonnes. This change in TACC is less than 1% and less than the minimum change threshold of 10%, resulting in no change to the TACC. The Minister accepted this result.
- In November 2019, standardised F2-LFX offset-year CPUE was 2.567 kg/potlift when the ERS data were excluded (Table 10), which resulted in a TACC increase of 9.51% when applying the rule specified in Table 9. This increase is less than the minimum change threshold of 10%, resulting in no change to the TACC. The 2019 CPUE index value which included the ERS data was 3.217 kg/potlift (Table 10), which resulted in a TACC of 126.947 tonnes representing an increase of 30.9%. This is greater than the minimum change threshold of 10%.

The NRLMG, using the 2019 offset year CPUE index which included the ERS data (3.217), recommended a TACC increase of 29.9 tonnes to 126.9 tonnes from the existing 97 tonne TACC (National Rock Lobster Management Group 2020). The Minister increased the TACC to 106.2 tonnes (Nash 2020). This increase of 9.2 tonnes (+9.5%) was the result of applying the CPUE index which omitted the ERS data (2.567) to the CRA 7 MP rule, but which ignored the 10% threshold specified by that rule. No change was made to the existing non-commercial allowances, so the TAC was raised by 29.9 tonnes to 126.2 tonnes.

Table 10: History of the current CRA 7 management procedure and its operation in 2019. "Rule result TACC" is the result of the management procedure. "Applied TACC" and "Applied TAC" are the catch limits decided by the Minister.

Offset year	Offset-year CPUE (kg/potlift)	Applied to fishing year	Rule result TACC (tonnes)	Applied TACC (tonnes)	Applied TAC (tonnes)
2012	0.625	2013–14	43.960	44.00	64.00
2013	1.356	2014–15	66.000	66.00	86.00
2014	2.304	2015–16	97.720	97.72	117.72
2015	2.212	2016–17	97.720	97.72	117.72
2016	2.766	2017–18	112.512	112.52	132.52
2017	2.328	2018–19	98.499	97.00	117.00
2018	2.292	2019–20	97.343	97.00	117.00
2019[1]	2.567	2020–21	97.00	-	-
2019[2]	3.217	2020–21	126.947	-	-

[1]excludes ERS data, [2]includes ERS data

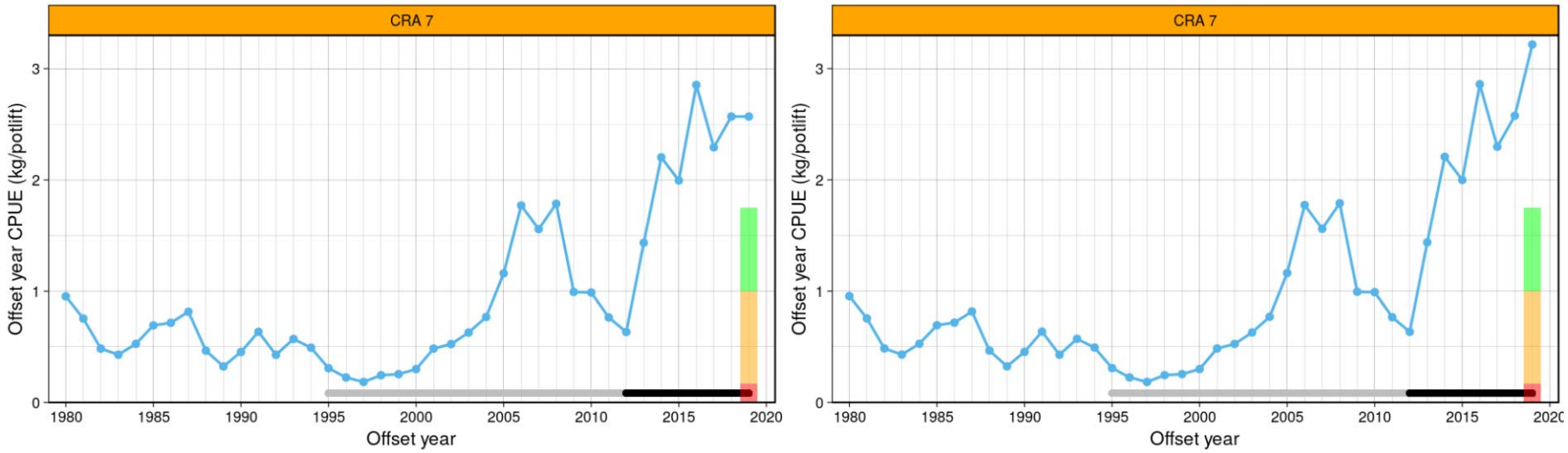

Figure 11: Offset-year CPUE (F2-LFX) (kg/potlift) for CRA 7. The coloured bar represents the plateau (green), the slope (orange), and the CPUE at which the TACC = 0 (red). The horizontal black line indicates the years that the current MP has operated, the grey indicates the years that other MPs operated; [left panel]: exclude ERS data; [right panel]: include ERS data.

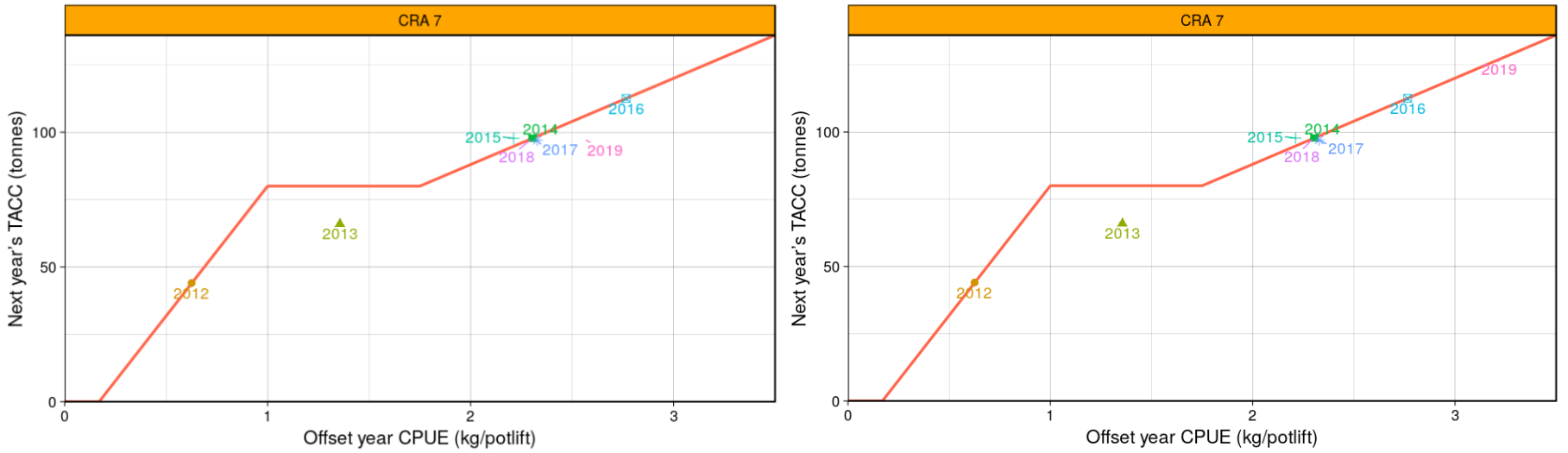

Figure 12: History of the current CRA 7 management procedure. The coloured symbols show the 2012 to 2019 offset-year CPUE and the resulting TACCs. [left panel]: exclude ERS data; [right panel]: include ERS data.

6. CRA 8 MANAGEMENT PROCEDURE

6.1 Summary

A summary of MPs in CRA 8 (Figure 13) is provided in Table 11. The CRA 8 MP is based on MPEs done in 2015, using an operating model based on the combined CRA 7 and CRA 8 stock assessment (Haist et al. 2016). The input CPUE is based only on the sizes of fish that are landed, not on all sizes including the larger ones that are not economic. This was called "$CPUE" or "money-fish CPUE" in the MPEs and is calculated using the F2-LF algorithm (see Starr 2019). The more usual F2-LFX procedure includes destination code X (i.e., legal lobsters returned to the sea). From the options recommended, the NRLMG chose, and the Minister adopted, the rule specified in Table 12 (National Rock Lobster Management Group 2016). This rule replaced a similar rule and is the fifth in a series that began in 1996 (Starr et al. 1997, Bentley et al. 2003a, Breen et al. 2008, Haist et al. 2013). Except for an extended plateau and the altered input, the adopted rule is very similar to the previous CRA 8 MP when the allowances are the same (the previous rule generated a TAC, this rule generates a TACC).

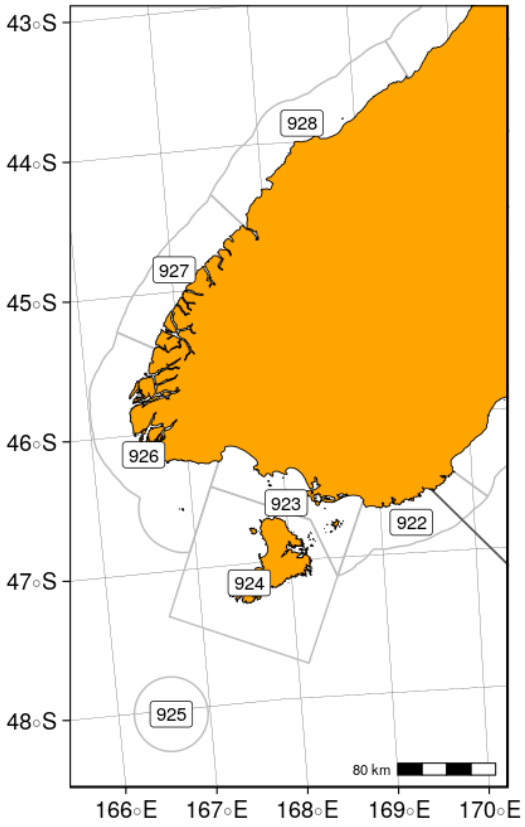

Figure 13: Statistical areas within CRA 8.

Table 11: Summary of CRA 8 MPs.

First year with MP	1996
First year of current MP	2016
Review scheduled	2020
Input	F2-LF offset-year CPUE
Output	TACC
Type of rule	generalised plateau step rule
Minimum change	5%
Maximum change	none
Latent year	none
2019–20 customary allowance	30
2019–20 recreational allowance	33
2019–20 other mortality allowance	28
2019–20 total non-commercial allowance	91
2019–20 TACC	1129.6
2019–20 TAC	1220.6

Table 12: Parameters for the CRA 8 generalised plateau step rule.

Parameter	Function	Value
$par1$	rule type	4
$par2$	CPUE at TACC = 0	0.5
$par3$	CPUE at plateau left	1.9
$par4$	CPUE at plateau right	3.2
$par5$	plateau height	962
$par6$	step width	0.5
$par7$	step height	0.055
$par8$	minimum change	0.05
$par9$	maximum change	0
$par10$	latent year switch	0

The Final Advice Paper (National Rock Lobster Management Group 2016) for the 2016–17 fishing year described the rule as follows:

Some important elements of the proposed new CRA 8 management procedure are:

- *The output variable is TACC (tonnes);*
- *Offset-year standardised CPUE is used as an input to the rule to determine the TACC for the fishing year that begins in the following April;*
- *CPUE is calculated using the new "F2_LF" procedure, which gives the "money-fish" CPUE, or $CPUE. This procedure uses:*
    - *landings to a licensed fisher receiver, along with recreational landings from a commercial vessel (it does not include the amount of rock lobsters returned to the water in accordance with Schedule 6 of the Act (i.e. high-graded rock lobsters) as does the F2_LFX procedure),*
    - *estimates, by vessel, of the ratio of annual landed catch divided by annual estimated catch to correct every landing record in a quota management area for the vessel;*
- *The management procedure is to be evaluated every year (no "latent year"), based on offset-year CPUE;*

- *The minimum change threshold for the TACC is 5%. There is no maximum change threshold for the TACC.*

The proposed new CRA 8 management procedure is based on a generalised plateau step rule … Between CPUEs of zero and 0.5 kg/potlift the TACC is zero, the TACC then increases linearly with CPUE to 962 tonnes at a CPUE of 1.9 kg/potlift. The TACC remains at 962 tonnes until CPUE reaches 3.2 kg/potlift and then increases by 5.5% in CPUE steps of 0.5 kg/potlift.

6.2 History

History of the CRA 8 MP is shown in Table 11.

- In November 2015, standardised offset-year F2-LF CPUE was 3.0620 kg/potlift (Table 13, Figure 14), which gave a TACC on the plateau of 962 tonnes (Table 13, Figure 15).
- In November 2016, standardised offset-year F2-LF CPUE was 3.0254 kg/potlift, which gave a suggested TACC on the plateau of 962.0 tonnes.
- In November 2017, standardised offset-year F2-LF CPUE was 3.7113 kg/potlift, which gave a suggested TACC above the plateau of 1070.7 tonnes. This TACC change was +11.3%, well above the minimum change threshold of 5%, so the MP result was an increase in the TACC. The Minister accepted this result and increased the TACC.
- In November 2018, standardised offset-year F2-LF CPUE was 4.2481 kg/potlift, which gave a suggested TACC above the plateau of 1129.6 tonnes. This TACC change was +5.5%, above the minimum change threshold of 5%, so the MP result was an increase in the TACC. The Minister accepted this result and increased the TACC.
- In November 2019, standardised offset-year F2-LF CPUE was 4.8302 kg/potlift, which gave a suggested TACC above the plateau of 1191.7 tonnes. This TACC change was +5.5%, above the minimum change threshold of 5%, so the MP result was an increase in the TACC.

The NRLMG, using the 2019 offset year CPUE index which excluded the ERS data (4.8302), recommended a TACC increase of 62.1 tonnes to 1191.7 tonnes from the existing 1129.6 tonne TACC (National Rock Lobster Management Group 2020). The Minister accepted this advice and raised the TACC to 1191.7 tonnes (Nash 2020). No change was made to the existing non-commercial allowances, so the TAC was raised by 62.1 tonnes to 1282.7 tonnes.

Table 13: History of the current CRA 8 management procedure and its operation in 2019. "Rule result TACC" is the result of the management procedure. "Applied TACC" and "Applied TAC" are the catch limits decided by the Minister.

Offset year	Offset-year CPUE (kg/potlift)	Applied to fishing year	Rule result TACC (tonnes)	Applied TACC (tonnes)	Applied TAC (tonnes)
2015	3.0620	2016–17	962.0	962.0	1053.0
2016	3.0254	2017–18	962.0	962.0	1053.0
2017	3.7113	2018–19	1070.7	1070.7	1161.7
2018	4.2481	2019–20	1129.6	1129.6	1220.6
2019[1]	4.8302	2020–21	1191.7	-	-
2019[2]	4.8743	2020–21	1191.7	-	-

[1]excludes ERS data, [2]includes ERS data

Figure 14: Offset-year CPUE (F2-LF) (kg/potlift) for CRA 8. The coloured bar represents the plateau (green), the slope (orange), and the CPUE at which the TACC = 0 (red). The horizontal black line indicates the years that the current MP has operated, the grey indicates the years that other MPs operated.

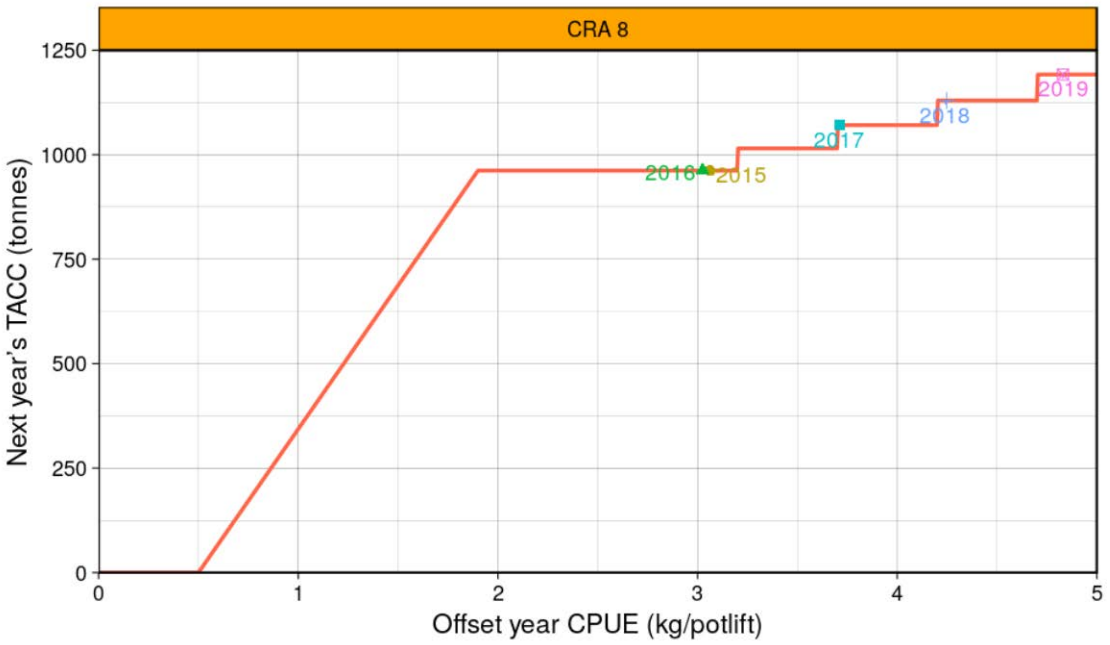

Figure 15: History of the current CRA 8 management procedure. The coloured symbols show the 2015 to 2019 offset-year CPUE and the resulting TACCs.

7. SUMMARY

Offset-year CPUE for the four QMAs managed using MPs are summarised in Figure 16 and the associated MPs are summarised in Figure 17.

Fisheries New Zealand began electronic reporting of catch for rock lobster in April 2019. It is not known how this change in the catch and effort data collection procedure will affect the CPUE used to drive current MPs, but past experience (during the changeover from the FSU to the CELR system) and preliminary analyses suggest that the new data will not be comparable to the previous paper-based data collection system. The changes to the collection of catch and effort data will require the development of new evaluation procedures beyond 2019.

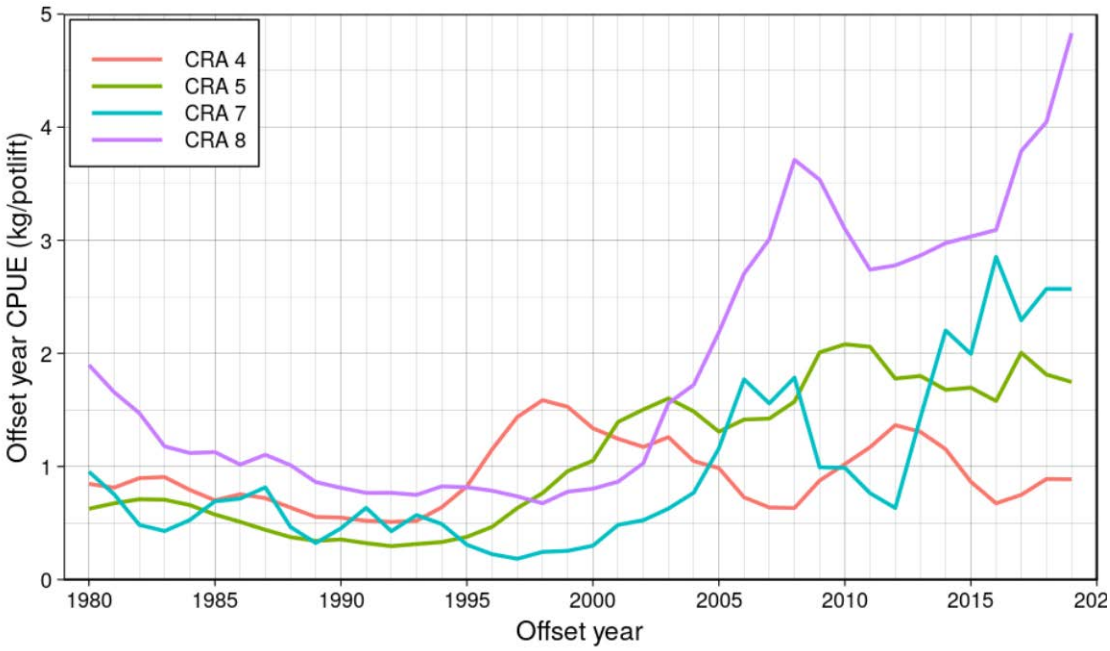

Figure 16: Offset-year CPUE (kg/potlift) for all QMAs managed using a management procedure. The plotted 2019 values exclude the ERS data.

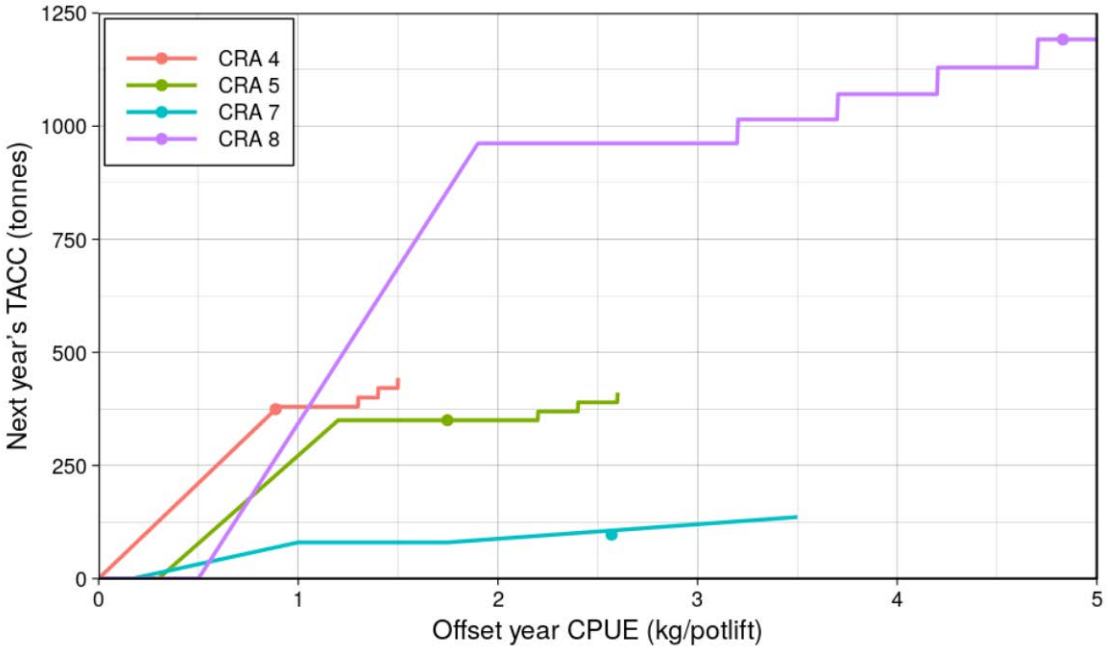

Figure 17: All current management procedures (lines) and the proposed TACC (points) based on the 2019 CPUE values which exclude the ERS data.

8. ACKNOWLEDGMENTS

Thanks to all who have worked on the 2019 rock lobster stock assessments including Kath Large, Merrill Rudd, Jim Roberts, and members of the Rock Lobster Fishery Assessment Working Group. Thanks to Paul Breen for previous incarnations of this document. Thanks to our colleagues at Fisheries New Zealand, especially Alicia McKinnon, Marine Pomarède, and Pamela Mace. And thanks also to Daryl Sykes and Mark Edwards of 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.

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APPENDIX I

Beginning on 1 April 2019, Fisheries New Zealand implemented a transition to electronic reporting of catch and effort in the rock lobster fleet. This implementation was staged, beginning with operators with the largest amount of ACE (Annual Catch Entitlements) across all QMS species (Mark Edwards, NZRLIC, pers. comm.). This resulted in a staggered uptake of electronic data reporting. The new electronic data have been given a "source" designation (in the EDW: electronic data warehouse) so they can be distinguished from the previous paper returns (CELR).

The RLFAWG reviewed, in October 2019, the implications of this substantial change in the collection of the rock lobster catch and effort data. It concluded that the ERS data were not likely to be fully comparable with the data collected by the previous paper forms and recommended that the operation of the rock lobster MPs be suspended pending further evaluation. However, the RLFAWG agreed that the remaining active MPs (CRA 4, CRA 5, CRA 7, and CRA 8) could be evaluated in November 2019 if there were sufficient CELR data to operate the MPs in a manner consistent with previous years.

The rock lobster stock assessment team suggested that the amount of available CELR data justified the operation the existing MPs in three of the four QMAs (Table 14). It was noted that the 2018–19 CPUE indices in these three QMAs, calculated with and without the ERS data, showed only small differences, ranging from 0.2% (CRA 5) to 1.1% (CRA 4) (Table 15). The fourth QMA (CRA 7) showed a much larger difference in the 2018–19 index, with the "include ERS" estimate differing by more than 25% from the "exclude ERS" estimate (Table 15). It is not known what has caused the substantial difference between the two CRA 7 estimates. However, examination of the data presented in Table 14 indicated a much larger proportion of ERS data in CRA 7 compared with the other QMAs, as well as a much earlier uptake of electronic reporting in that QMA. ERS data predominated in July and August in CRA 7 whereas there were proportionately more CELR data in these months in the other three QMAs (Table 14). ERS data predominated in CRA 7 and CRA 8 during September, but CELR data predominated in CRA 4 and CRA 5 in the final month.

The NRLMG reviewed this information on 13 November 2019 and agreed to use the "exclude ERS" CPUE index values to evaluate the 2019 MPs for CRA 4, CRA 5, and CRA 8. The NRLMG also agreed to put forward MP evaluations based on both of the CRA 7 indices (Table 10). It is unlikely that the new ERS data are fully comparable with the previous CELR data. Consequently, caution should be used when interpreting the ERS data until their comparability with the CELR data has been properly evaluated.

Table 14: Comparison of total catch (t) and effort (potlifts) by month between the paper (CELR) and electronic (ERS) reporting methods for the four rock lobster QMAs with active MPs. This comparison has been made using landing data prepared with the B4_L algorithm (see Starr 2019) from a Fisheries New Zealand data extract received 5 November 2019 (replog 12675).

	Catch (t)		Potlifts	
	CELR	ERS	CELR	ERS
April				
CRA4	5.32	–	4 430	–
CRA5	19.27	–	16 034	–
CRA7	1.70	–	931	–
CRA8	132.67	–	41 542	–
May				
CRA4	11.43	–	17 261	–
CRA5	81.22	0.04	54 073	89
CRA7	1.47	–	1 691	–
CRA8	127.12	–	34 414	–
June				
CRA4	19.94	–	27 667	–
CRA5	23.14	0.51	18 763	788
CRA7	1.14	1.18	1 728	1 962
CRA8	102.62	1.82	28 142	694
July				
CRA4	14.26	0.50	17 342	850
CRA5	9.86	–	9 280	–
CRA7	3.56	5.99	3 632	7 441
CRA8	15.54	0.56	6 374	313
August				
CRA4	8.94	1.95	12 819	1 477
CRA5	10.37	0.08	6 220	880
CRA7	4.83	15.30	2 729	12 384
CRA8	30.41	14.62	10 691	4 582
September				
CRA4	6.65	4.93	11 351	4 287
CRA5	8.69	7.78	5 520	7 432
CRA7	0.56	17.32	560	13 360
CRA8	34.51	153.15	10 134	31 578
Total				
CRA4	66.55	7.38	90 870	6 614
CRA5	152.56	8.41	109 890	9 189
CRA7	13.26	39.80	11 271	35 147
CRA8	442.88	170.15	131 297	37 167

Table 15: Comparison of 2019 offset-year CPUE indices for the four QMAs with active MPs based on only using the paper forms (without ERS) and using all the data (with ERS).

QMA	Exclude ERS	Include ERS	Difference
CRA4	0.8867	0.8961	1.1%
CRA5	1.7470	1.7500	0.2%
CRA7	2.5695	3.2171	25.2%
CRA8	4.8302	4.8743	0.9%