



Fisheries New Zealand

Tini a Tangaroa

Operational management procedures for New Zealand rock lobster stocks (*Jasus edwardsii*) in 2018

New Zealand Fisheries Assessment Report 2018/23

D.N. Webber
P.J. Starr

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EXECUTIVE SUMMARY

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This document describes the management procedures used for the 2018–19 fishing year to manage New Zealand stocks of red rock lobsters (*Jasus edwardsii*). Management procedures are simulation-tested decision rules. Given an input (e.g. offset year 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.

In 2017 a new stock assessment and management procedure evaluation was done for CRA 2. For the 2018–19 fishing year the use of a management procedure was abandoned for CRA 2. There are currently six rock lobster stocks with management procedures (CRA 6 and CRA 9 are also managed without them).

For CRA 1, CRA 3, and CRA 5 the management procedures indicated no change. The management procedures for CRA 4 and CRA 8 resulted in an increase in TACC and TAC. The management procedure for CRA 7 resulted in a decrease in TACC and TAC.

This document contains the equations and specifications for the current management procedures and their recent histories. The original material is scattered among FARs, consultation documents, and other sources, so this document is updated every year to provide a central reference.

1. INTRODUCTION

The red rock lobster (*Jasus edwardsii*) supports the most valuable inshore commercial fishery in New Zealand, with exports worth NZ\$268 million in 2015 (Seafood New Zealand 2016), and is also valuable to customary Maori and recreational fishers. The commercial pot fisheries have been managed since 1 April 1990 with individual transferable quotas in nine arbitrary stocks (Breen et al. 2016a) (Figure 1).

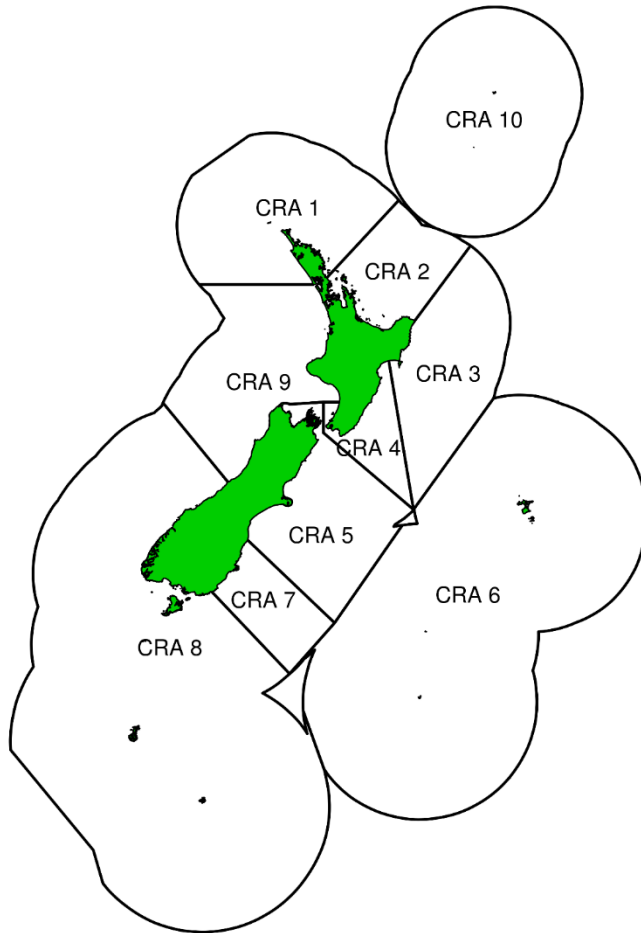


Figure 1: Rock lobster Quota Management Areas (QMAs).

This document describes the current (as of 1 April 2018) operational management procedures (MPs) used to manage New Zealand stocks of red rock lobsters (Breen et al. 2016b). Management procedures are simulated-tested decision rules (Butterworth & Punt 1999). MPs are now a major part of New Zealand rock lobster management (Bentley et al. 2003b; Breen et al. 2009a, 2016a, 2016b; Bentley & Stokes 2009) and are becoming an important 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).

MPs consist of a harvest control rule (i.e. a function) that specifies what data will be used as input(s) and they return an output value. New Zealand rock lobster MPs use standardised CPUE as the input and a catch limit as the output¹. 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. Before 2007, the input CPUE was from the preceding fishing year². This approach created a one-year lag between observed CPUE and the resulting catch limit (i.e. the fishing year ended on the 31 March and any new catch limit

¹Currently 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 in tonnes.

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

from the MP was applied in April of the next year). To shorten the lag to six months, "offset-year" CPUE was developed³. 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 manage the volatile CRA 7 stock (Starr et al. 1997; Bentley et al. 2003a; Breen et al. 2008; Haist et al. 2013). In the CRA 4 fishery, industry adopted an MP, before any formal adoption by the Ministry for Primary Industries (MPI), to reduce their catches voluntarily (quota "shelving", Breen et al. 2009b). A voluntary MP for CRA 5 was developed to maintain high abundance (Breen 2009).

There are now six rock lobster stocks with MPs. CRA 2, CRA 6, and CRA 9 are managed without MPs. The CRA 2 stock assessment in 2017 suggested that the stock was below the soft limit and therefore required implementing a rebuilding plan (Webber et al. 2018). This resulting rebuilding plan consisted of a simple fixed catch rather than an MP. CRA 6 has not had a formal stock assessment in several years due to limited data. An MP for CRA 9 was developed and then abandoned in 2016, after two years of operation, because analysis indicated that the CRA 9 CPUE analysis was not sufficiently robust to support an MP.

Much of the evolution of MPs for rock lobsters has occurred as each stock has been assessed and management procedure evaluations (MPEs) have been done, but some generalised work has also been done (e.g. Breen et al. 2003). Advances were made by Nokome Bentley in the way that MPE results are interpreted (Bentley et al. 2003b). The industry-inspired "plateau" rules described below impart great stability if they are designed appropriately. However, because designing stability into rules reduces their responsiveness to changes in abundance, there are tradeoffs between stability and safety. Recent experience (CRA 2, CRA 4) suggests a need for caution with respect to locating the lower edge of the plateau.

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. Fishing effort has declined in most of the stocks with longstanding MPs (CRA 3, CRA 4, CRA 7 and CRA 8 but not in CRA 5) (Breen et al. 2016a) while at the same time CPUE has increased (the increase in CPUE is at least three fold in both CRA 7 and CRA 8). The total arithmetic CPUE for all of New Zealand has doubled since the late 1990s (Breen et al 2016b).

One measure of success of these MPs is the rebuilding of depleted stocks and maintaining healthy stocks, but MPs also involve stakeholders in setting management goals and participating in the rebuilding process. This has resulted in 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, the NRLMG has rejected MP results:

- for CRA 5 for 2015–16, where the MP would have delivered a TACC reduction less than 5%
- for CRA 9 for 2015–16, where the industry requested a delay pending the results of an audit and other analyses
- for CRA 4 for 2016–17, where industry requested a larger decrease than was specified by the MP

And for both 2016–17 and 2017–18, the CRA 2 industry voted to shelve 49 tonnes (25%) of their quota voluntarily, despite the MP result of no TACC change.

This document is intended as a central reference containing all the specifications for the current MPs. The original material 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 annual Report from the Mid-Year Plenary is not a suitable repository because changes made for April of the new fishing year are not captured there). The most definitive documents for each rule are the relevant FARs describing the stock assessment and MPEs, the NRLMG Final Advice Paper

³An offset-year runs from 1 October through 30 September of the following year and is named by the first year (i.e. 2017–18 is termed "2018").
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or consultation document containing the basis on which the Minister for Primary Industries signed off the MP, and the Minister’s decision letter.

This document does not attempt to describe the historical MPs before the current MP for each stock but these can be found in previous versions of this document (e.g. Breen et al. 2009a; Breen 2015, 2017).

2. GENERALISED PLATEAU RULES

2.1 Step and slope harvest control rules

The six current MPs have either a "plateau step" harvest control rule or a "plateau slope" rule, illustrated in Figure 2 and Figure 3. CRA 3 has a modified plateau slope rule that is described below. With respect to output TACC vs. input CPUE these 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 in 2010, at MPI’s request, for CRA 5 (Haist et al. 2011). This had a TACC component plus components for non-commercial catch sectors; it was rejected by the Minister and a TACC-determining rule was developed and approved the following year. There is some 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 catch share as stocks increase. This idea was 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.

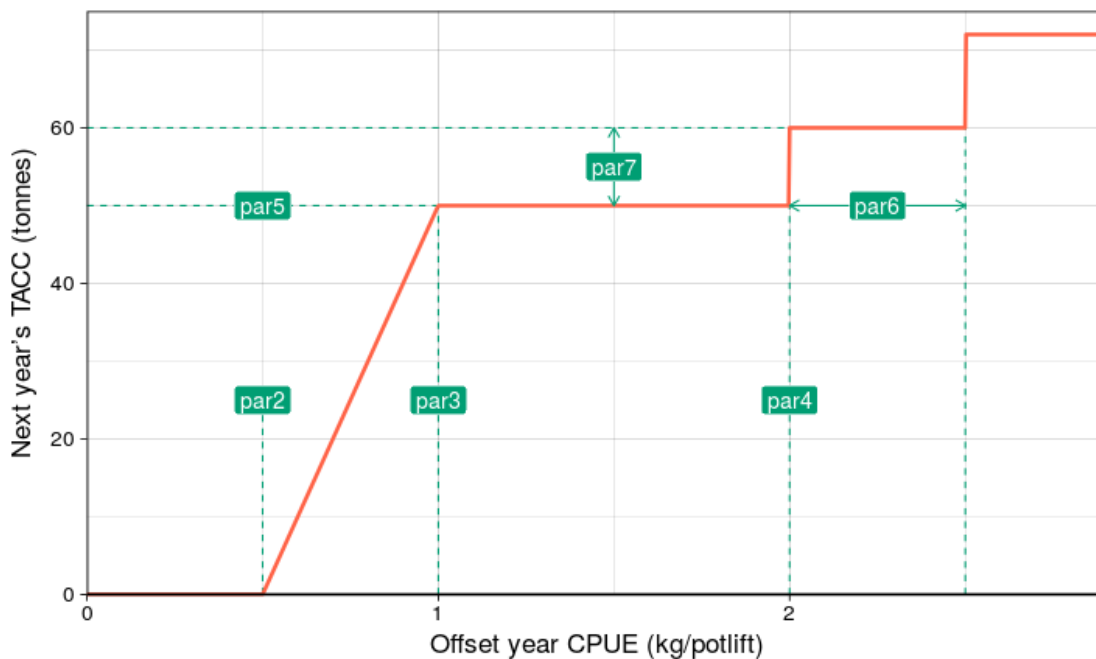


Figure 2: A generalised plateau step rule. See Table 1 for parameter definitions.

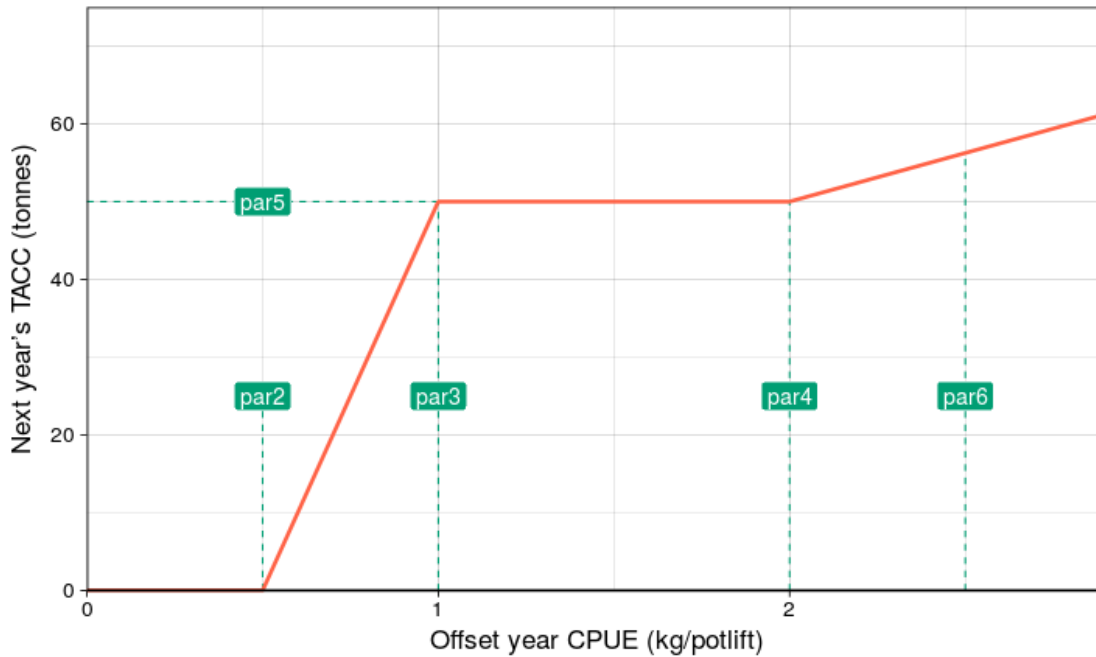


Figure 3: A generalised plateau slope rule. See Table 1 for parameter definitions.

2.2 Rule parameters

The generalised rule parameters are defined in Table 1.

Table 1: Parameters for the generalised plateau rules.

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

Rule type (*par1*) is set to 3 for plateau slope rules, 4 for plateau step rules, and 6 for the modified CRA 3 rule. The CRA 3 rule is described in the CRA 3 section below; 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*). *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:

$$par2 < par3 \leq par4$$

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

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 proportion of 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) is given by:

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

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:

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

and for plateau slope rules by:

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

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.

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; "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 (2016).

3. CRA 1 MANAGEMENT PROCEDURE

3.1 Summary

A summary of MPs in CRA 1 is provided in Table 2. The CRA 1 rule is based on work done in 2014 by Webber & Starr (2015), using an operating model based on the CRA 1 stock assessment model. Rules evaluated were generalised plateau step rules. From the options recommended (National Rock Lobster Management Group 2015), the Minister adopted the rule specified in Table 3. A TAC was set for the first time for CRA 1 in 2015, before that there had been only a TACC and in 2015 the Minister had to set allowances for non-commercial catches.

Table 2: Summary of CRA 1 MPs.

	CRA 1
First year with MP	2015
First year of current MP	2015
Review scheduled	2019
Input	F2-LFX offset year CPUE
Output	TACC
Type of rule	generalised plateau step rule
Minimum change	-
Maximum change	5%
Latent year	-
2018/19 customary allowance	20
2018/19 recreational allowance	50
2018/19 other mortality allowance	72
2018/19 total non-commercial allowance	142
2018/19 TACC	131.062
2018/19 TAC	273.062

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

Parameter	Function	Value
par1	rule type	4
par2	CPUE at TACC = 0	0.1
par3	CPUE at plateau left	1.1
par4	CPUE at plateau right	1.7
par5	plateau height	131.062
par6	step width	0.25
par7	step height	0.05
par8	minimum change	0.05
par9	maximum change	0
par10	latent year switch	0

The Final Advice Paper (National Rock Lobster Management Group 2015) for the 2015/16 fishing year described the rule as follows:

Some important elements of the CRA 1 management procedures 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 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. highgraded 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 minimum change threshold for the TACC is 5%. There is no maximum change threshold for the TACC;
- For Rule 9d: between CPUEs of 0 to 0.1 kg/potlift the TACC is zero, the TACC then increases linearly with CPUE to 1.1 kg/potlift, and between CPUEs of 1.1 to 1.7 kg/potlift the TACC is 131.062 tonnes. As CPUE increases above 1.7 kg/potlift, the TACC increases in steps with a width of 0.25 kg/potlift and a height of 5% of the preceding TACC.

3.2 History

This is the first MP for this stock.

- In November 2014, standardised F2-LFX CPUE was 1.5803 kg/potlift (Table 4 and Figure 4), which gave a suggested TACC of 131.062 tonnes (Table 4 and Figure 5). The Minister accepted this rule and assigned the current allowances of customary 20 tonnes, recreational 50 tonnes, and other mortality 72 tonnes (Table 2).
- In November 2015, standardised F2-LFX CPUE was 1.3154 kg/potlift, which remained on the plateau so there was no change to the TACC. The Minister accepted this.
- In November 2016, standardised F2-LFX CPUE was 1.4289 kg/potlift, which remained on the plateau so there was no change to the TACC. The Minister accepted this.
- In November 2017, standardised F2-LFX CPUE was 1.2792 kg/potlift, which remained on the plateau so there was no change to the TACC. The Minister accepted this.

Table 4: History of the CRA 1 management procedure. "Rule result" is the result of the management procedure after operation of all its components including thresholds.

Offset year	Offset year CPUE (kg/potlift)	Applied to fishing year	Rule result TACC (tonnes)	Applied TACC (tonnes)	Applied TAC (tonnes)
2014	1.5803	2015/16	131.062	131.062	273.062
2015	1.3154	2016/17	131.062	131.062	273.062
2016	1.4289	2017/18	131.062	131.062	273.062
2017	1.2792	2018/19	131.062	131.062	273.062

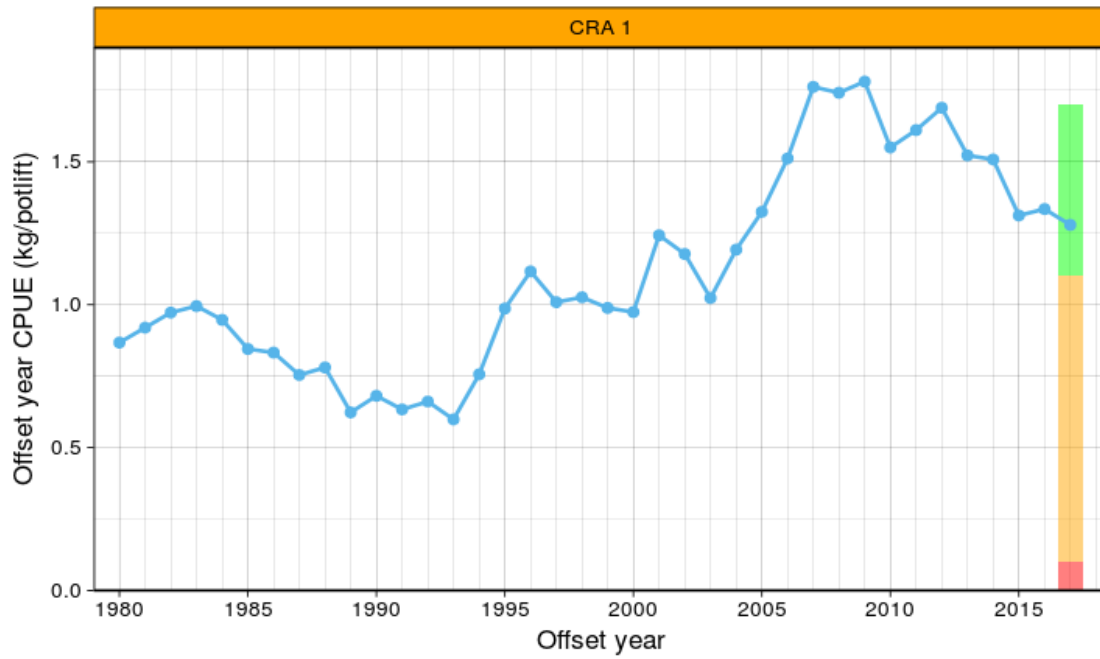


Figure 4: Offset-year CPUE (F2-LFX) (kg/potlift) for CRA 1. The coloured bar represents the plateau (green), the slope (orange), and the CPUE at which the TACC = 0 (red).

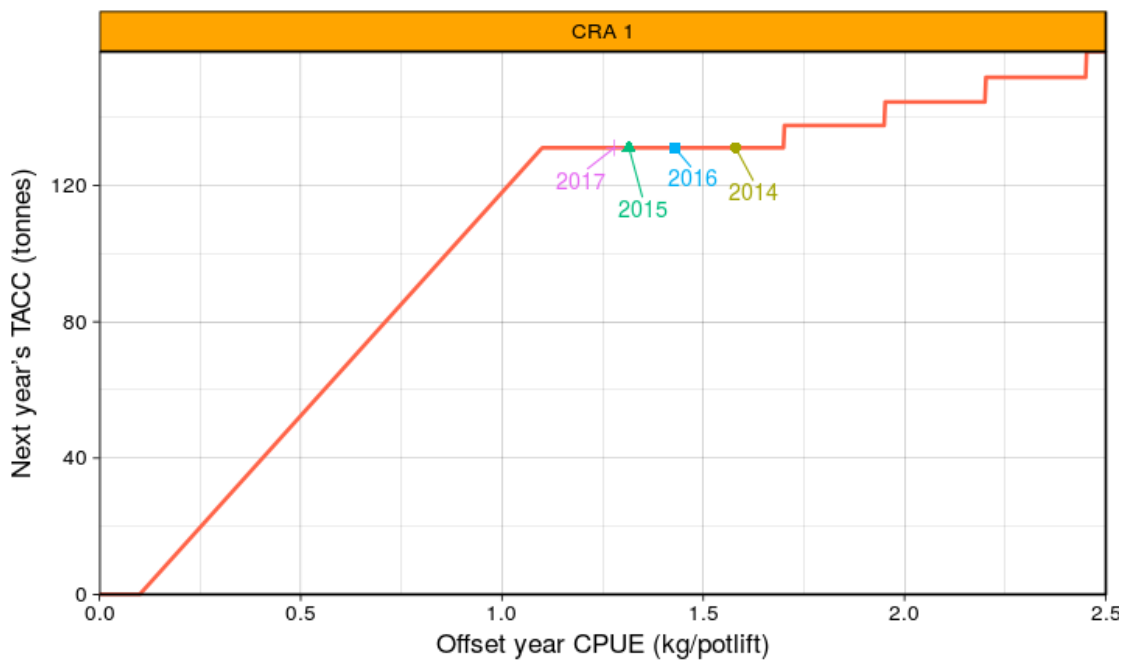


Figure 5: History of the current CRA 1 management procedure. The coloured symbols show the 2014 to 2017 offset-year CPUE and the resulting TACCs.

4. CRA 2 MANAGEMENT PROCEDURE

4.1 Summary

A summary of MPs in CRA 2 is provided in Table 5. The CRA 2 stock assessment in 2017 suggested that the stock was below the soft limit and therefore required a rebuilding plan be implemented (Webber et al. 2018). Using an operating model based on the CRA 2 stock assessment model, generalised plateau step rules and constant catch rules were evaluated. Only constant catch rules were selected for recommendation (National Rock Lobster Management Group 2018) and the Minister adopted a fixed TACC of 80 tonnes (Table 5). The offset-year CPUE during the last three years is the lowest in the series (Figure 6).

Table 5: Summary of CRA 2 MPs.

	CRA 2
First year with MP	2014
First year of current MP	-
Review scheduled	2018
Input	-
Output	-
Type of rule	-
Minimum change	-
Maximum change	-
Latent year	-
2018/19 customary allowance	16.5
2018/19 recreational allowance	34
2018/19 other mortality allowance	42.5
2018/19 total non-commercial allowance	93
2018/19 TACC	80
2018/19 TAC	173

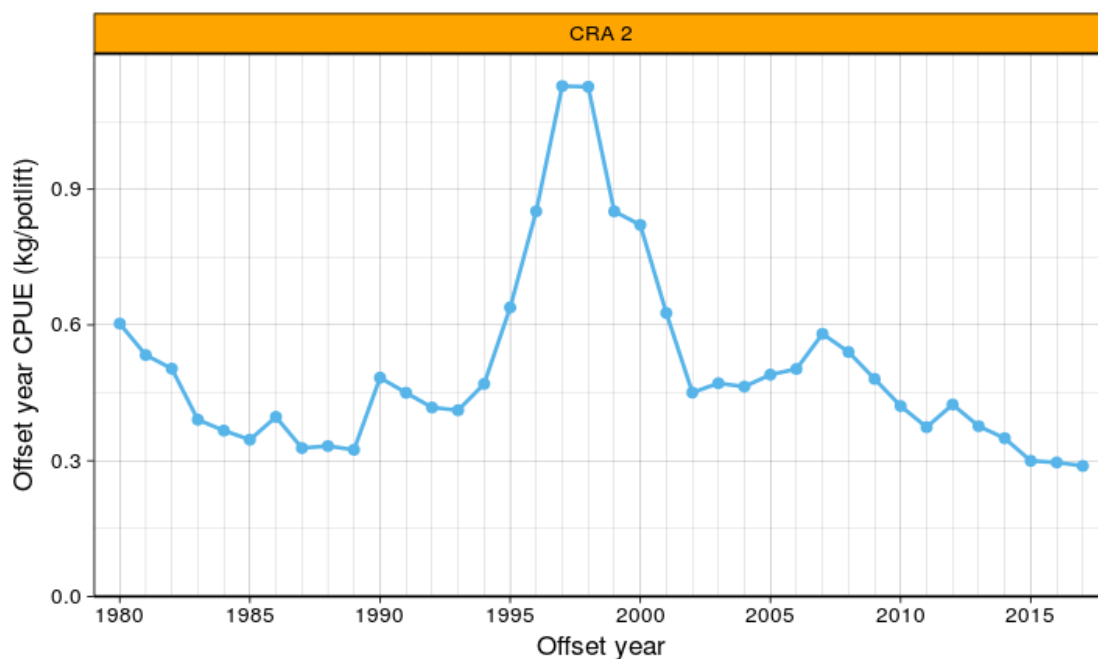


Figure 6: Offset-year CPUE (F2-LFX) (kg/potlift) for CRA 2.

5. CRA 3 MANAGEMENT PROCEDURE

5.1 Summary

A summary of MPs in CRA 3 is provided in Table 6. The CRA 3 rule is based on work done in 2014 by Haist et al. (2015), using an operating model based on the 2014 CRA 3 stock assessment model. The harvest control rule is a modified plateau slope rule. The modification involves: a) fixing the intercept to zero; b) having two straight-line segments (instead of one) between zero and the left of the plateau (Figure 8); and c) having a different slope equation from the generalised rule. Rule parameters (Table 7) are defined differently from those in the other rules. The Minister adopted rule 4, for which the specific parameter values are shown in Table 7.

The CRA 3 rule is described by:

$$TACC_{y+1} = \begin{cases} par7 \left(\frac{I_y}{par2} \right) & \text{if } I_y \leq par2 \\ par7 + (par5 - par7) \left(\frac{I_y - par2}{par3 - par2} \right) & \text{if } par2 < I_y \leq par3 \\ par5 & \text{if } par3 < I_y \leq par4 \\ par5 + par6 \left(\frac{I_y - par4}{0.5} \right) & \text{if } I_y > par4 \end{cases}$$

where $TACC_{y+1}$ is the provisional TACC (before thresholds operate) and I_y is the offset-year CPUE in the preceding year.

Table 6: Summary of CRA 3 MPs.

	CRA 3
First year with MP	2010
First year of current MP	2015
Review scheduled	2019
Input	F2-LFX offset year CPUE
Output	TACC
Type of rule	modified plateau slope rule
Minimum change	-
Maximum change	5%
Latent year	-
2018/19 customary allowance	20
2018/19 recreational allowance	20
2018/19 other mortality allowance	89
2018/19 total non-commercial allowance	129
2018/19 TACC	237.86
2018/19 TAC	366.86

Table 7: Parameters for the CRA 3 plateau slope rule evaluated in 2014 and their values for the rule agreed by the Minister in 2015.

Parameter	Function	Value
par1	rule type	6
par2	CPUE at first inflection	1
par3	CPUE at plateau left	2
par4	CPUE at plateau right	3
par5	plateau height	260
par6	step width	50
par7	step height	180
par8	minimum change	0.05
par9	maximum change	0
par10	latent year switch	0

The Final Advice Paper (National Rock Lobster Management Group 2015) for the 2015/16 fishing year described the rule as follows:

Some important elements of the proposed CRA 3 management procedures 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 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. highgraded 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 minimum change threshold for the TACC is 5*
- *The proposed new Rule 4 CRA 3 management procedure is a non-standard rule, illustrated in [Figure 6]. For Rule 4: the TACC is zero at a CPUE of zero, the TACC increases linearly with CPUE, reaching 180 tonnes at a CPUE of 1.0 kg/potlift. The TACC then increases linearly to reach 260 tonnes at a CPUE of 2.0 kg/potlift. The TACC remains at 260 tonnes until CPUE reaches 3.0 kg/potlift, after which the TACC increases linearly again with a slope of 100 tonnes per 1 kg/potlift.*

5.2 History

The current rule is the second MP for this stock. Of the rules recommended (National Rock Lobster Management Group 2015), the Minister chose rule 4 for the 2015/16 fishing year. The history of the CRA 3 MP is shown in Table 8.

- In November 2014, standardised F2-LFX offset-year CPUE was 2.2139 (Figure 7), which specified a TACC of 260.0 tonnes, on the plateau (Figure 8Figure 12). This result was accepted by the Minister.
- In November 2015, standardised F2-LFX offset-year CPUE was 1.8842 (Figure 7Figure 15), which specified a TACC of 260.0 tonnes (Figure 8Figure 16Figure 12). This result was accepted by the Minister.
- In November 2016, standardised F2-LFX offset-year CPUE was 1.7232 (Figure 7Figure 11), which specified a TACC of 237.9 tonnes (Figure 8Figure 16Figure 12). This result was accepted by the Minister.
- In November 2017, standardised F2-LFX offset-year CPUE was 1.7873 (Figure 7), which specified a TACC of 237.9 tonnes (Figure 8Figure 16Figure 12). This result was accepted by the Minister.

Table 8: History of the CRA 3 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

Offset year	Offset year CPUE (kg/potlift)	Applied to fishing year	Rule result TACC (tonnes)	Applied TACC (tonnes)	Applied TAC (tonnes)
2014	2.2139	2015/16	260.000	260.95	389.95
2015	1.8842	2016/17	260.000	260.95	389.95
2016	1.7232	2017/18	237.857	237.86	366.86
2017	1.7873	2018/19	237.857	237.86	366.86

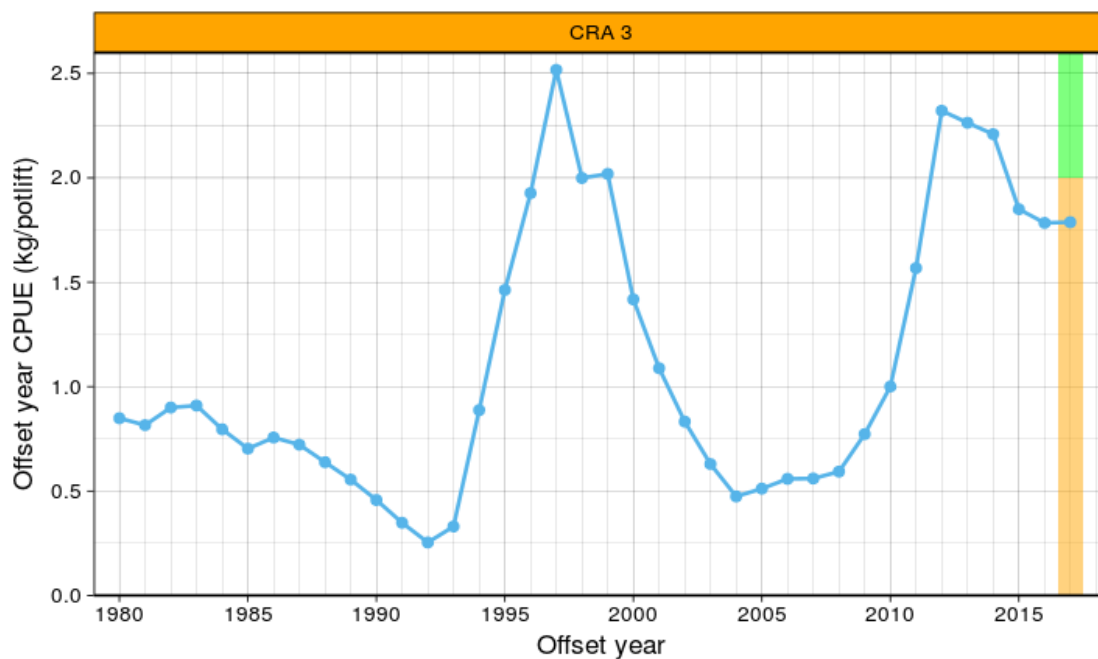


Figure 7: Offset-year CPUE (F2-LFX) (kg/potlift) for CRA 3. The coloured bar represents the plateau (green), the slope (orange), and the CPUE at which the TACC = 0 (red).

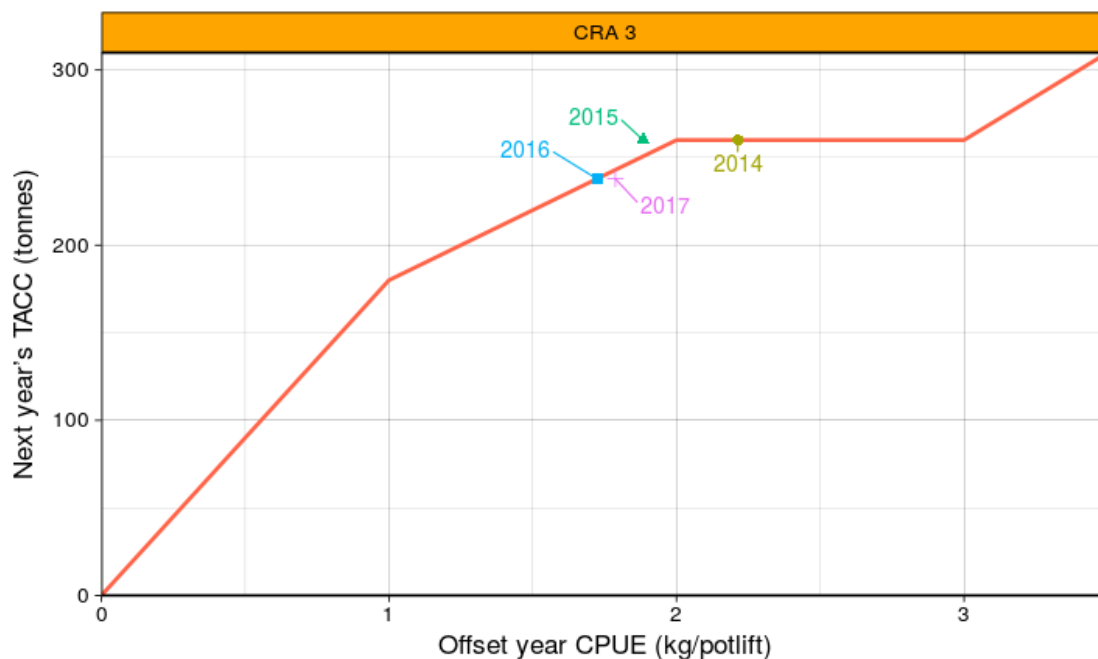


Figure 8: History of the current CRA 3 management procedure. The coloured symbols show the 2014 to 2017 offset-year CPUE and the resulting TACCs.

6. CRA 4 MANAGEMENT PROCEDURE

6.1 Summary

A summary of MPs in CRA 4 is provided in Table 9. The CRA 4 MP is based on work conducted in 2016 (Breen et al. 2017), using an operating model based on the CRA 4 stock assessment done in that year. Rules evaluated were generalised plateau step rules. From the options recommended (National Rock Lobster Management Group 2017), the Minister adopted rule 6, for which the specific parameter values are shown in Table 10.

Table 9: Summary of CRA 4 MPs.

	CRA 4
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	none
Maximum change	5%
Latent year	none
2018/19 customary allowance	35
2018/19 recreational allowance	85
2018/19 other mortality allowance	75
2018/19 total non-commercial allowance	195
2018/19 TACC	318.8
2018/19 TAC	513.8

Table 10: 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:

- a) The output variable is TACC (tonnes);
- b) 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;
- c) CPUE is calculated using the 2012 F2_LFX procedure...
- d) The management procedure is to be evaluated every year (no “latent year”), based on offset-year CPUE; and
- e) 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.

6.2 History

The first MP for CRA 4 was voluntary (Breen 2009), 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. The history of the CRA 4 MP is shown in Table 11.

- In November 2016, standardised F2-LFX offset-year CPUE was 0.6851 (Figure 9Figure 7Figure 11), which specified a TACC of 298.3 tonnes (Figure 10Figure 8Figure 16Figure 12). This result was accepted by the Minister.
- In November 2017, standardised F2-LFX offset-year CPUE was 0.7550 (Figure 9Figure 7), which specified a TACC of 318.8 tonnes (Figure 10Figure 8Figure 16Figure 12). This result was accepted by the Minister.

Table 11: History of the CRA 4 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

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

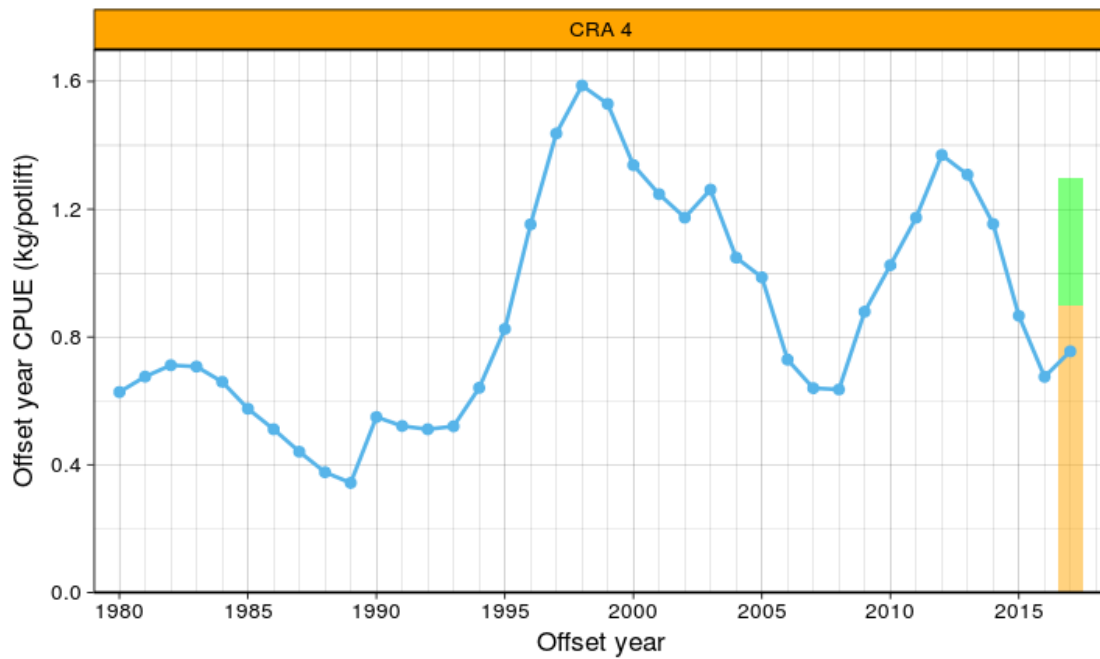


Figure 9: Offset-year CPUE (F2-LFX) (kg/potlift) for CRA 4. The coloured bar represents the plateau (green), the slope (orange), and the CPUE at which the TACC = 0 (red).

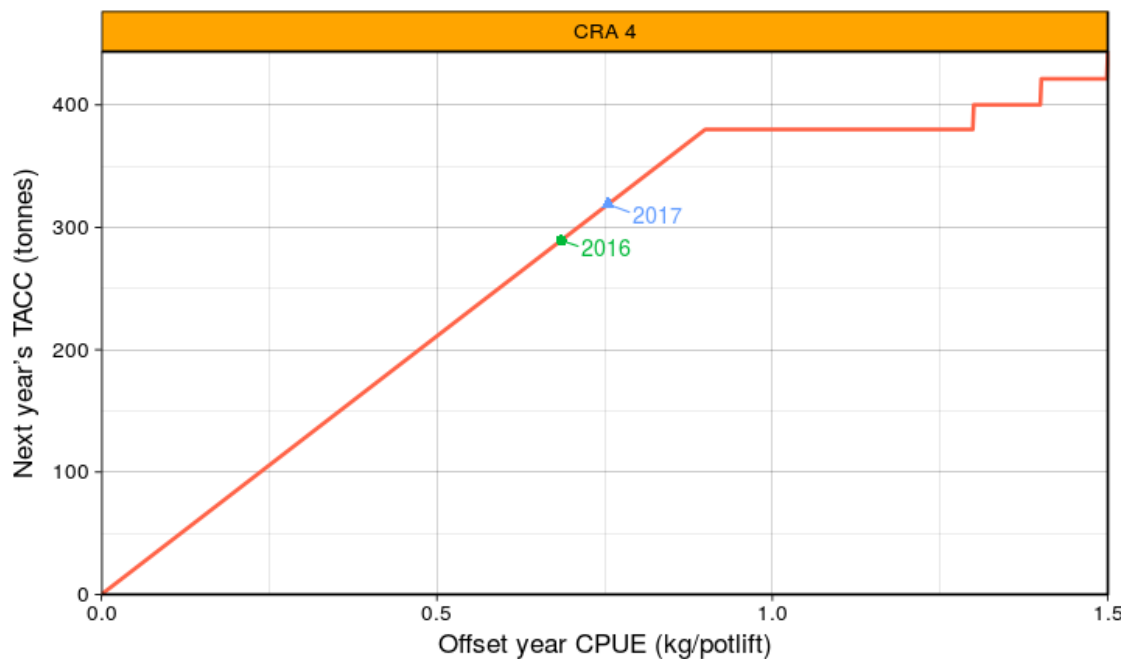


Figure 10: History of the current CRA 4 management procedure. The coloured symbols show the 2016 to 2017 offset-year CPUE and the 2017 TACC.

7. CRA 5 MANAGEMENT PROCEDURE

7.1 Summary

A summary of MPs in CRA 5 is provided in Table 12. The CRA 5 MP is based on MPEs done in 2015 (Starr & Webber 2016), using an operating model based on a stock assessment in that year. Rules evaluated were generalised plateau step rules. From the options recommended to them, the National Rock Lobster Management Group (NRLMG 2016) chose, and the Minister accepted, rule 45, for which the specific parameter values are shown in Table 13. The Minister increased the recreational allowance from 40 to 87 tonnes to conform with best available information.

Table 12: Summary of CRA 5 MPs.

	CRA 5
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	none
Maximum change	5%
Latent year	none
2018/19 customary allowance	40
2018/19 recreational allowance	87
2018/19 other mortality allowance	37
2018/19 total non-commercial allowance	164
2018/19 TACC	350
2018/19 TAC	514

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

- a) *The output variable is TACC (tonnes);*
- b) *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;*
- c) *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. highgraded 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;*
- d) *The management procedure is to be operated every year (no “latent year”), based on offset-year CPUE;*
- e) *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.*

Table 13: 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

7.2 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 12).

- In November 2015, standardised F2-LFX offset-year CPUE was 1.7890 (Figure 11), which specified a TACC of 350 tonnes, on the plateau (Figure 12). This result was accepted by the Minister (Table 14).
- In November 2016, standardised F2-LFX offset-year CPUE was 1.5902 (Figure 11), which specified a TACC of 350 tonnes, on the plateau (Figure 12). This result was accepted by the Minister (Table 14).
- In November 2017, standardised F2-LFX offset-year CPUE was 2.0482 (Figure 11), which specified a TACC of 350 tonnes, on the plateau (Figure 12). This result was accepted by the Minister (Table 14).

Table 14: History of the CRA 5 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

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

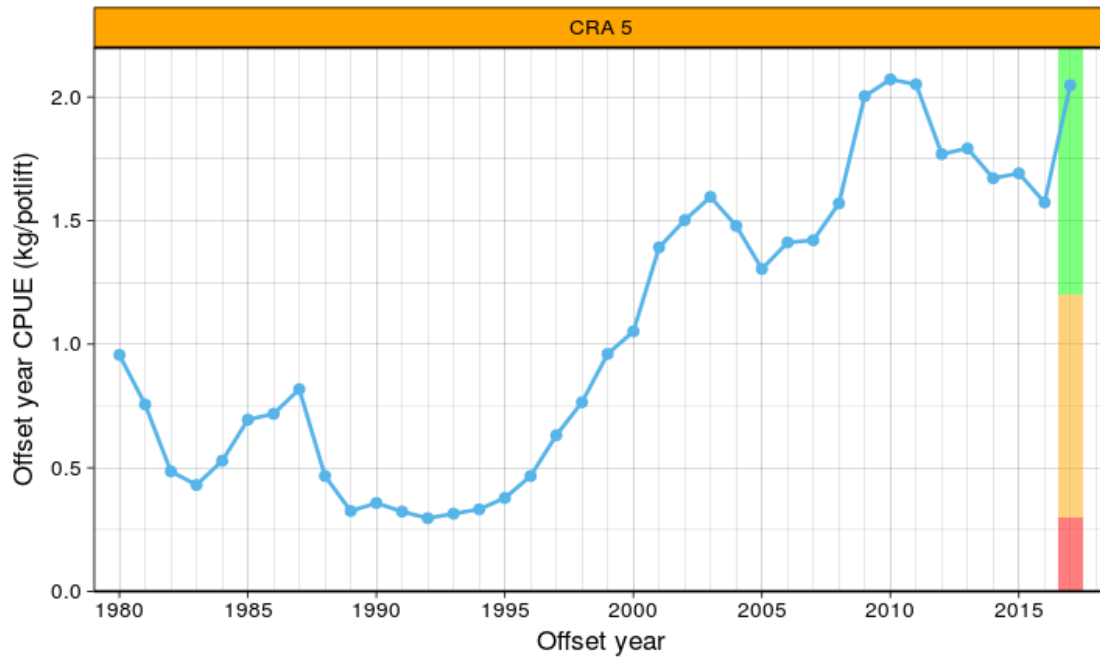


Figure 11: Offset-year CPUE (F2-LFX) (kg/potlift) for CRA 5. The coloured bar represents the plateau (green), the slope (orange), and the CPUE at which the TACC = 0 (red).

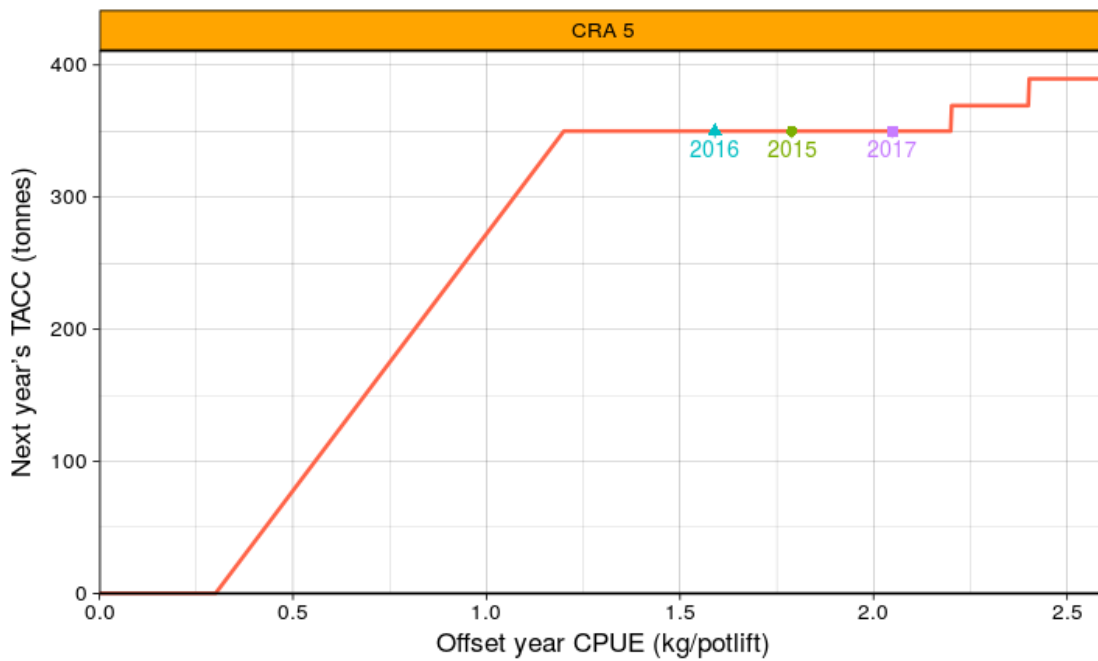


Figure 12: History of the current CRA 5 management procedure. The coloured symbols show the 2015 to 2017 offset-year CPUE and resulting TACCs.

8. CRA 6 MANAGEMENT PROCEDURE

8.1 Summary

There is no management procedure for CRA 6 and there has been no recent stock assessment (Table 15).

Table 15: Summary of CRA 6.

	CRA 6
First year with MP	-
First year of current MP	-
Review scheduled	-
Input	-
Output	-
Type of rule	-
Minimum change	-
Maximum change	-
Latent year	-
2018/19 customary allowance	4
2018/19 recreational allowance	6
2018/19 other mortality allowance	0
2018/19 total non-commercial allowance	10
2018/19 TACC	360
2018/19 TAC	370

9. CRA 7 MANAGEMENT PROCEDURE

9.1 Summary

A summary of MPs in CRA 7 is provided in Table 16. 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 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 rule 39, for which specific parameter values are shown in Table 17. 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).

Table 16: Summary of CRA 7 MPs.

	CRA 7
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	none
Maximum change	10%
Latent year	50%
2018/19 customary allowance	10
2018/19 recreational allowance	5
2018/19 other mortality allowance	5
2018/19 total non-commercial allowance	20
2018/19 TACC	97
2018/19 TAC	117

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. highgraded 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%.*

Table 17: 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

9.2 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 (Figure 13), giving a TACC of 44.96 tonnes. The Minister accepted this result and used the same allowances as for previous years (customary 10 tonnes, recreational 5 tonnes, other mortality 5 tonnes) to set a TAC of 64 tonnes (Table 18, Figure 14).
- 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 t. 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 the 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 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. The Minister accepted this result and set the TACC at 97 tonnes.

Table 18: History of the CRA 7 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

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

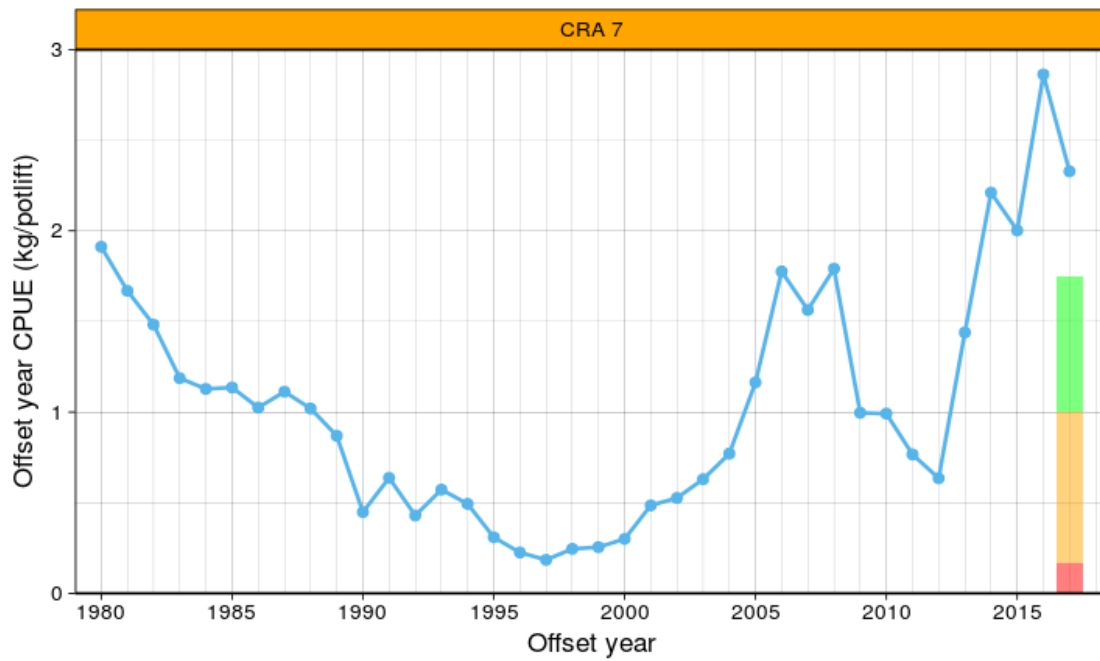


Figure 13: Offset-year CPUE (F2-LFX) (kg/potlift) for CRA 7. The coloured bar represents the plateau (green), the slope (orange), and the CPUE at which the TACC = 0 (red).

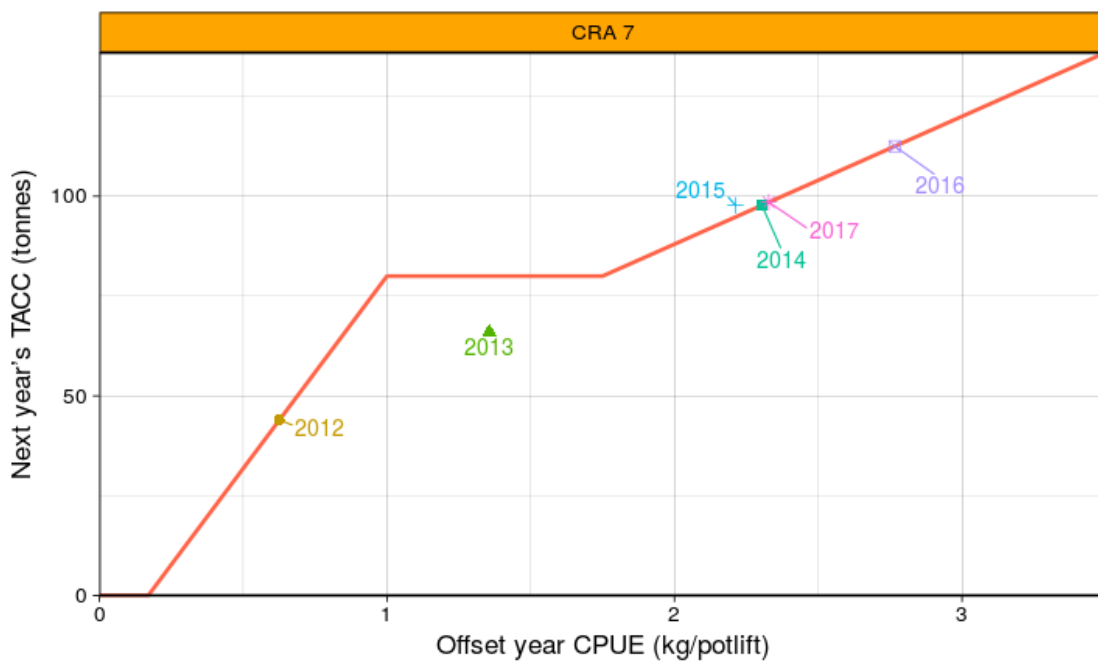


Figure 14: History of the current CRA 7 management procedure. The coloured symbols show the 2012 to 2017 offset-year CPUE and the resulting TACCs.

10. CRA 8 MANAGEMENT PROCEDURE

10.1 Summary

A summary of MPs in CRA 8 is provided in Table 19. 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 2016). The more usual F2-LFX procedure also considers destination X (i.e. legal lobsters returned to the sea). From the options recommended, the National Rock Lobster Management Group (2016) chose and the Minister adopted rule 43, for which the parameters are shown in Table 20. This rule replaced a similar rule and is the fourth in a series that began in 1996 (Starr et al. 1997; Bentley et al. 2003a; Breen et al. 2008). 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).

Table 19: Summary of CRA 8 MPs.

	CRA 8
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	none
Maximum change	5%
Latent year	none
2018/19 customary allowance	30
2018/19 recreational allowance	33
2018/19 other mortality allowance	28
2018/19 total non-commercial allowance	91
2018/19 TACC	1070.7
2018/19 TAC	1161.7

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:

a) The output variable is TACC (tonnes);

b) 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. highgraded 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;*

d) The management procedure is to be evaluated every year (no “latent year”), based on offset-year CPUE;

e) 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.

Table 20: 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

10.2 History

The history of the CRA 8 MP is shown in Table 21.

- In November 2015, standardised F2-LFX offset-year CPUE was 3.0620 (Figure 15), which specified a TACC of 962.0 tonnes, on the plateau (Figure 16Figure 12). This result was accepted by the Minister.
- In November 2016, standardised F2-LFX offset-year CPUE was 3.0254 (Figure 15Figure 11), which specified a TACC of 962.0 tonnes, on the plateau (Figure 16Figure 12). This result was accepted by the Minister.
- In November 2017, standardised F2-LFX offset-year CPUE was 3.7113 (Figure 15), which specified a TACC of 1070.7 tonnes (Figure 16Figure 12). This result was accepted by the Minister.

Table 21: History of the CRA 8 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

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

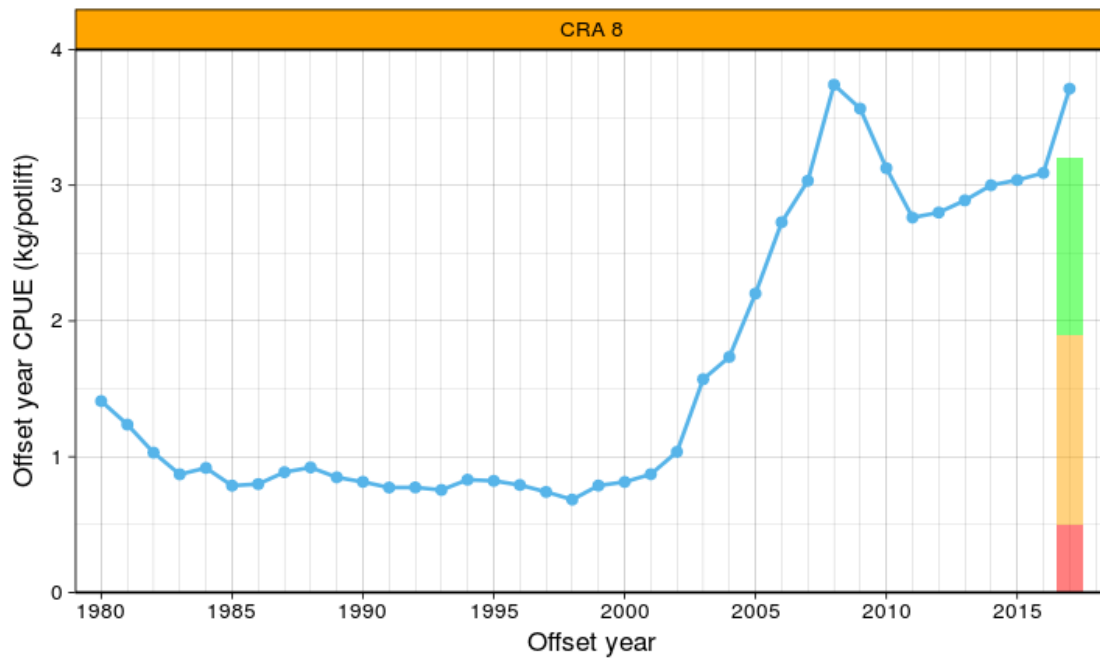


Figure 15: Offset-year CPUE (F2-LF) (kg/potlift) for CRA 8. The coloured bar represents the plateau (green), the slope (orange), and the CPUE at which the TACC = 0 (red).

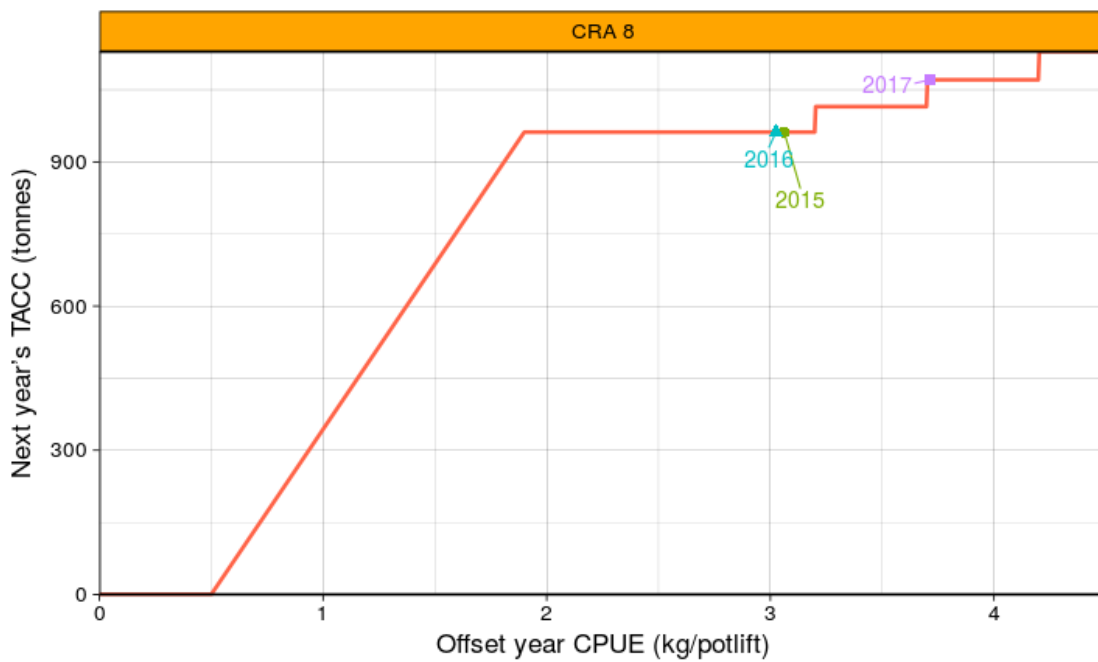


Figure 16: History of the current CRA 8 management procedure. The coloured symbols show the 2015 to 2017 offset-year CPUE and the resulting TACCs.

11. CRA 9 MANAGEMENT PROCEDURE

11.1 Summary

A summary of MPs in CRA 9 is provided in Table 22.

Table 22: Summary of CRA 9.

	CRA 9
First year with MP	2014
First year of current MP	-
Review scheduled	-
Input	-
Output	-
Type of rule	-
Minimum change	-
Maximum change	-
Latent year	-
2018/19 customary allowance	20
2018/19 recreational allowance	30
2018/19 other mortality allowance	5
2018/19 total non-commercial allowance	55
2018/19 TACC	60.8
2018/19 TAC	115.8

A CRA 9 MP was based on MPEs made in 2013 (Breen 2014), using an operating model based on a simple surplus-production model. From the options recommended (National Rock Lobster Management Group 2014) the Minister adopted rule 4041. When used for 2014/15, it was the first MP for this stock, and for the first time in 2014 the Minister set TAC and non-commercial allowances.

When CPUE declined in November 2014, industry complained that this did not reflect a decline in the stock and instead was a mistake or an artefact of the small number of fishing vessels. The NRLMG advised the Minister not to change the TACC or TAC in 2015 and planned a CPUE review for this stock in 2015. The Minister made no changes.

In 2015, an audit of the CRA 9 catch and effort reporting identified some problems, concluded that the decline in CPUE was real, and questioned whether CRA 9 CPUE is a suitable index of abundance for the whole stock (Webber, unpublished). This analysis and those performed by Starr (unpublished) suggested that, because of the very large area and very small fleet, the small volume of information available and the sensitivity of standardised CPUE to standardisation options, CPUE is not a reliable index for CRA 9 stock abundance. Based on these findings the NRLMG recommended that the MP not be followed for 2016/17, marking the end of the CRA 9 MP. The Minister accepted this suggestion (Nathan Guy, Minister for Primary Industries, unpublished document):

I am comfortable with not using the current CRA 9 management procedure as long as the NRLMG explores alternative management approaches for the fishery during 2016. I recommend that the NRLMG and the CRA 9 industry starts to discuss feasible options for the future management of the CRA 9 as soon as possible, and in conjunction with the Rock Lobster Fisheries Assessment Working Group.

Making no change to the CRA 9 catch limit in the short-term is unlikely to pose a sustainability risk; the size frequency distribution of commercial catches does not suggest a rock lobster stock under high fishing pressure.

No changes were made to the TAC, TACC, or allowances in 2017 or 2018.

12. SUMMARY

Offset year CPUE for all areas is summarised in Figure 17 and the MPs for all areas are summarised in Figure 18.

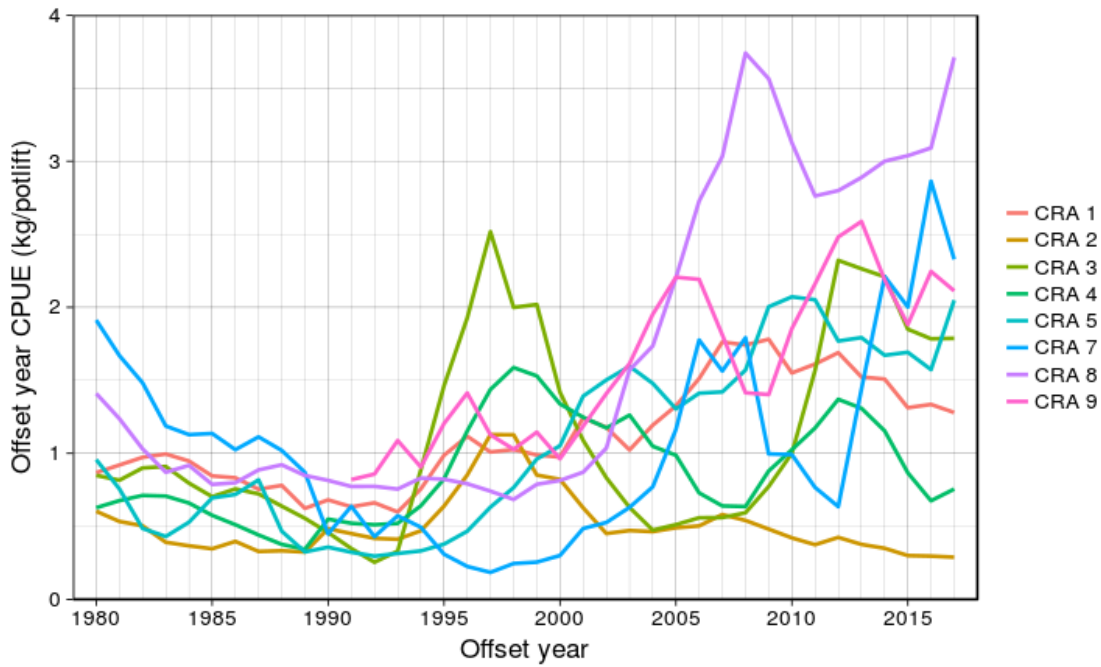


Figure 17: Offset-year CPUE (kg/potlift) for all stocks managed using a MP, plus CRA 2 and CRA 9 that do not have MPs in place.

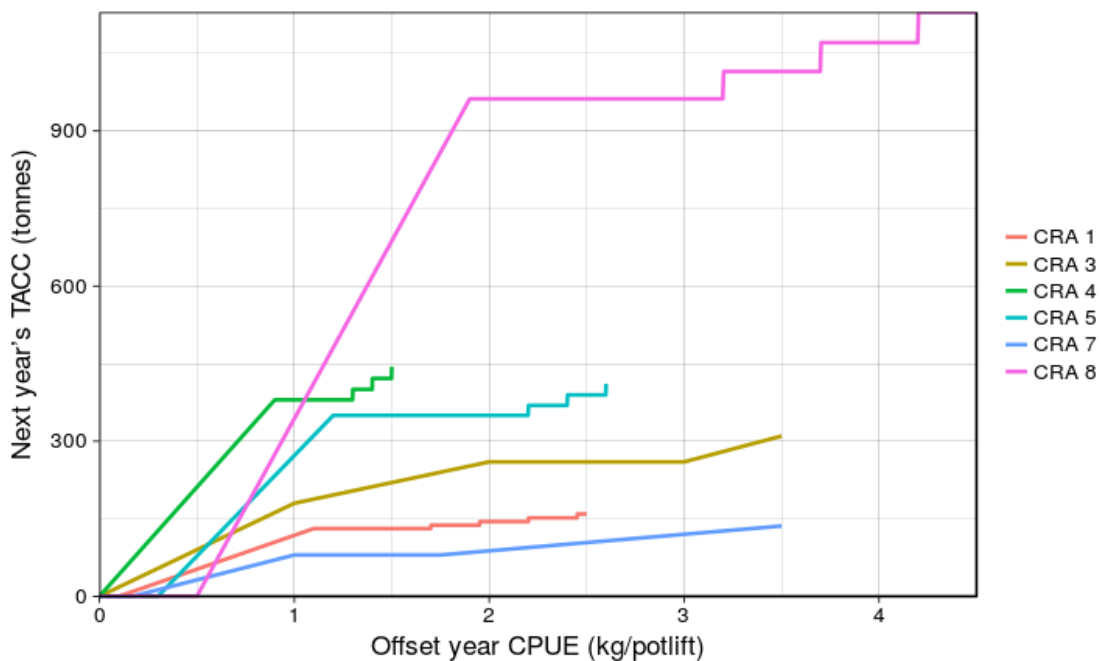


Figure 18: All current management procedures.

13. ACKNOWLEDGEMENTS

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Author contacts:

Quantifish, darcy@quantifish.co.nz

Starrfish, paul@starrfish.net

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