



Operational management procedures for New Zealand rock lobster stocks (*Jasus edwardsii*) in 2016

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TABLE OF CONTENTS

TABLE OF CONTENTS..... 1

EXECUTIVE SUMMARY..... 1

1. INTRODUCTION 2

2. GENERALISED PLATEAU RULES 4

3. CRA 1 MANAGEMENT PROCEDURE 8

4. CRA 2 MANAGEMENT PROCEDURE10

5. CRA 3 MANAGEMENT PROCEDURE12

6. CRA 4 MANAGEMENT PROCEDURE15

7. CRA 5 MANAGEMENT PROCEDURE17

8. CRA 7 MANAGEMENT PROCEDURE20

9. CRA 8 MANAGEMENT PROCEDURE23

10. CRA 9 MANAGEMENT PROCEDURE25

11. ACKNOWLEDGEMENTS26

12. REFERENCES26

EXECUTIVE SUMMARY

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This document describes operational management procedures used for the 2016–17 fishing year to manage New Zealand stocks of red rock lobsters (*Jasus edwardsii*). Management procedures are extensively simulated-tested decision rules; they specify what data will be used as input (CPUE for all stocks managed in 2016) and for every valid value of the input they return an output value (Total Allowable Commercial Catch, TACC). They consist of a harvest control rule, which defines the relation between CPUE and TACC, and other rules such as minimum change thresholds that modify the output.

In 2015, new stock assessments (described elsewhere) were done for CRA 5, CRA 7 and CRA 8. For the 2016–17 fishing year, new management procedures were adopted for CRA 5 and CRA 8, and the previous management procedure was continued for CRA 7. The CRA 9 management procedure was abandoned after analysis indicated that CPUE was not sufficiently robust to drive a management procedure. There are now seven rock lobster stocks with management procedures, with only CRA 6 and CRA 9 managed without them.

For CRA 2 the management procedure indicated no change to the TACC. CRA 2 industry considered that a decrease was necessary and have voluntarily shelved 25% of their quota.

For CRA 4 the management procedure indicated a small reduction in TACC, less than 5%. Industry considered that a larger decrease was required and the Minister accepted their request for a 15% TACC reduction.

This document is intended as a central reference resource that contains all 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 should be updated every year.

1. INTRODUCTION

The red rock lobster (*Jasus edwardsii*) supports the most valuable inshore commercial fishery in New Zealand, with exports worth NZ\$268 million (Seafood New Zealand 2016), and is also valuable to customary Maori and recreational fishers. The commercial trap or pot fisheries have been managed since 1991 with individual transferable quotas in nine arbitrary stocks (Breen et al. 2016a) (Figure 1).

This document describes the current – as of 1 April 2016 – operational management procedures (MPs) used to manage New Zealand stocks of red rock lobsters (Breen et al. 2016b). Management procedures (Butterworth & Punt 1999) are extensively simulated-tested decision rules: see Johnston & Butterworth (2005) and Johnston et al. (2014) for discussion of MPs used to manage rock lobsters in South Africa. The potential shift in management thinking that MPs can support is discussed by Bentley & Stokes (2009). MPs are now a major part of New Zealand rock lobster management (Bentley et al. 2003a; Breen et al. 2009a; Breen et al. 2016a; 2016b) and are becoming an important management tool globally (Edwards & Dankel 2016).

MPs specify what data will be used as input and for every valid value of the input they return an output value. For New Zealand rock lobster MPs, the input is standardised CPUE and the output is a catch limit: either a Total Allowable Commercial Catch or a Total Allowable Catch (TACC or TAC). Currently all MPs produce TACC.

Some work has investigated the use of MPs with additional inputs (e.g. settlement indices, Bentley et al. 2005 and Bentley unpublished) but so far other inputs have not been used. Before 2007, the input CPUE was from the preceding fishing year, which runs from April through March and is named by the first year, thus “2011–12” is called “2011”. This approach created a one-year lag between observed CPUE and resulting catch limit: the fishing year ended on the 31st of March and any new catch limit from the MP was applied in April of the next year. To shorten the lag to six months, “offset-year” CPUE is calculated using the October through September year. Much exploratory work has been done on CPUE and its standardisation (e.g. Starr 2012).

MPs consist of a harvest control rule, which defines the relation between input CPUE and output TACC, and other rules such as minimum change thresholds that modify the output.

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. 2003b; Breen et al. 2008; Haist et al. 2013). In the CRA 4 fishery described below, industry adopted an MP, before any formal adoption by MPI, to reduce their catches voluntarily (quota “shelving”; Breen et al. 2009b) and a voluntary MP for CRA 5 was designed to maintain high abundance (Breen 2009a).

There are now seven rock lobster stocks with MPs, all described below. Only CRA 6 and CRA 9 are managed without MPs, although management procedure evaluations (MPEs) have been conducted for CRA 6 (Breen 2009b). An MP for CRA 9 was abandoned for 2016, after two years of operation, because analysis indicated that CPUE was not robust enough to support an MP.

Much of the evolution of MPs for rock lobsters has occurred as each stock has been assessed and MPEs have been made, 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. 2003a). The industry-inspired “plateau” rules described below impart great stability if they are designed appropriately.

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: Breen et al. (2016a) show that fishing effort (potlifts) has been steady in stocks where MPs are only recent, but has declined strongly since 2000 in stocks with established MPs. Catch and CPUE, also steady in stocks without MPs, have increased since 2008 in stocks with established MPs: in CRA 7 and CRA 8 the CPUE increase has been two- or three-fold.

Success of these MPs is partly in rebuilding depleted stocks and maintaining healthy stocks, but also in making stakeholders think about management goals. There has been a shift in thinking towards the strategic (Bentley & Stokes 2009). A series of Ministers, in whose hands the catch limit decisions always lie, have chosen to accept all recommendations from the National Rock Lobster Management Group (NRLMG) based on MP results throughout their short New Zealand history. 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 the MP specified.
- And for 2016–17, CRA 2 industry rejected the MP result (no TACC change) and voluntarily shelved 25% of their quota.

This document is intended as a central reference containing all the specifications for the current MPs. The original material is scattered among FARs, consultation documents and other sources, so this document should be updated every year (the Plenary Report 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 FAR describing the stock assessment and MPEs, the NRLMG Final Advice Paper or consultation document containing the basis on which the Minister of Fisheries or Minister for Primary Industries (MPI) signed off the MP, and the Minister’s decision letter.

The document does not attempt to describe the historical MPs before the current MP for each stock (see Breen et al. 2009a and previous incarnations of this document, e.g. Breen 2015).

Catch limits and allowances are all in tonnes; CPUE is in kg/potlift. The fishing year runs from April through March, and is named by the first year; *viz.* 2016–17 is termed “2016”.

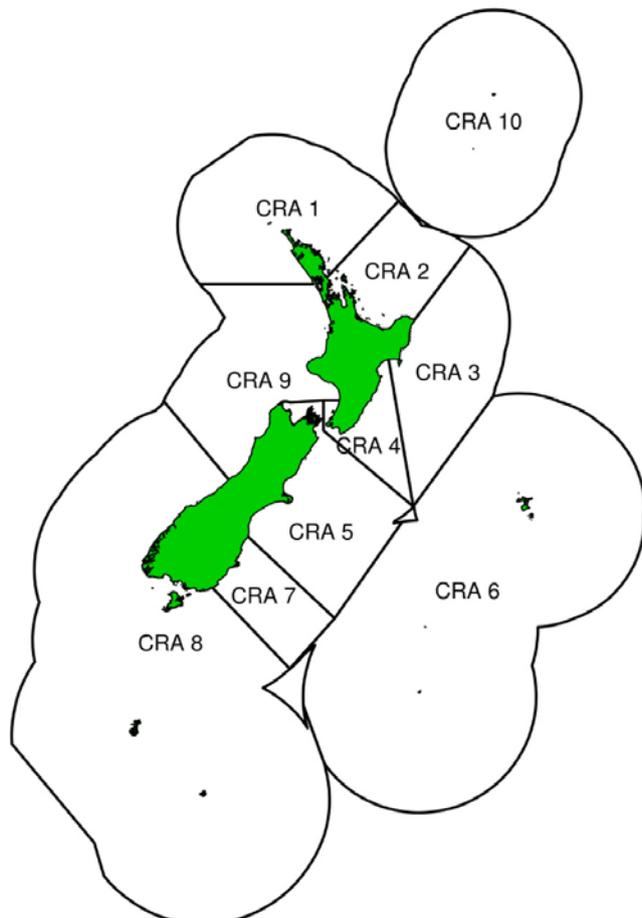


Figure 1: Rock lobster Quota Management Areas.

2. GENERALISED PLATEAU RULES

2.1 Step and slope harvest control rules

The seven 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 (described in the CRA 3 section below). 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).

In the past, model coding of the rule parameters has been inconsistent. For a given stock, the parameters defined here may differ from those defined in the relevant MPE document, or in previous descriptions, but MPs have not changed except after review as noted here; the descriptions here and the model code are now consistent.

The description in this section assumes that the MP determines the TACC, as all current MPs do. A TACC-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 pump catch away from the commercial sector and 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).

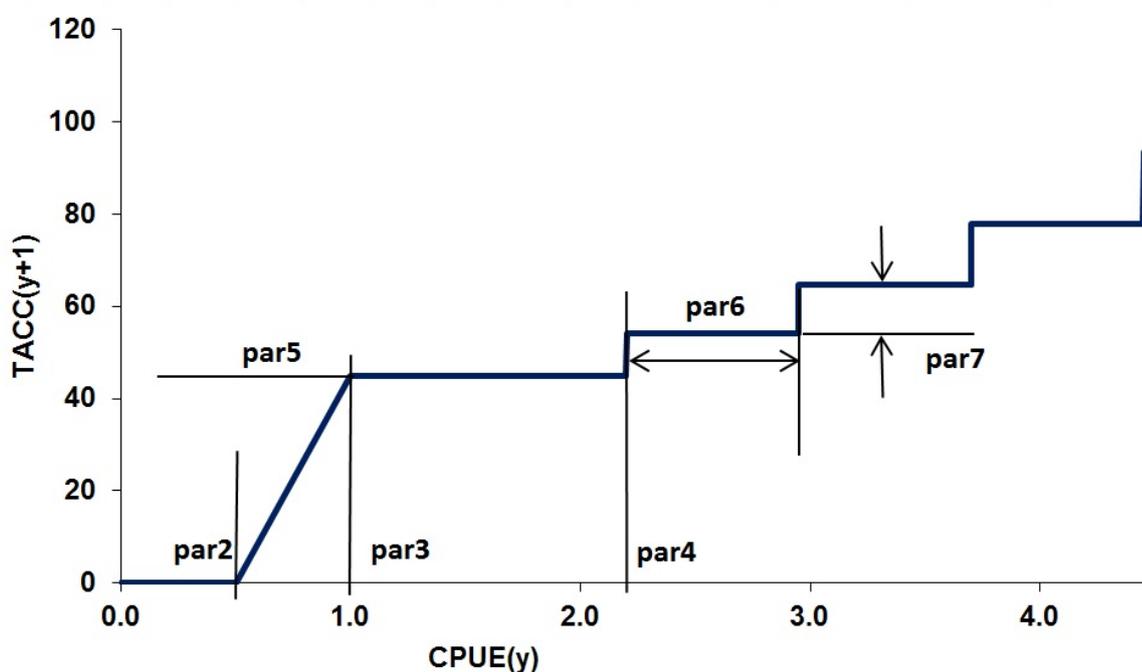


Figure 2: A generalised plateau step rule; see Table 1 for parameter definitions.

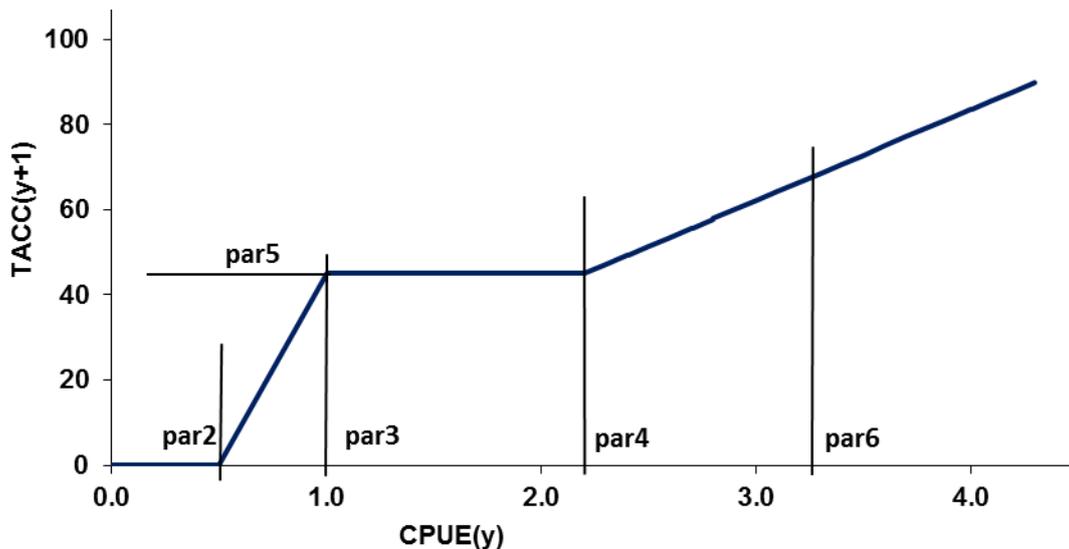


Figure 3: A generalised plateau slope rule; see Table 1 for parameter definitions.

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
<i>par1</i>	all	rule type
<i>par2</i>	all except CRA 3	CPUE at TACC = 0
<i>par2</i>	CRA 3 rule	CPUE at first inflection
<i>par3</i>	all	CPUE at plateau left
<i>par4</i>	all	CPUE at plateau right
<i>par5</i>	all	plateau height
<i>par6</i>	step rules	step width
<i>par6</i>	slope rules	slope
<i>par6</i>	CRA 3 rule	slope
<i>par7</i>	step rules	step height
<i>par8</i>	all	minimum change
<i>par9</i>	all	maximum change
<i>par10</i>	all	latent year switch

Rule type, *par1*, is 3 for plateau slope rules, 4 for plateau step rules and 6 for the modified CRA 3 rule form. The CRA 3 rule form will be 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:

$$par2 < par3 \leq par4 < par6$$

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.

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. For some stocks, this parameter is modified by other rules: for instance, in CRA 4 the maximum applies only when the TACC is below the plateau. A value of zero for *par9* indicates no maximum change threshold, and any TACC change is allowed.

A latent year component to the rule (not used in any current rule) means that TACC cannot be changed if it was changed in the previous year. An “asymmetric latent year” means that TACC can be decreased but not increased when it was changed in the previous year. The switch *par10* operates as follows:

Par10	Effect
0	no latent year
1	latent year
2	asymmetric latent year

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:

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

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

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

and for the plateau slope rules by:

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

The provisional TACC that results from these equations may be modified by the operation of the minimum and maximum change thresholds, or by the latent year, to give the rule’s recommended TACC.

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

- fishing years (April through the following March) are named by the April–December portion; *viz.* 2010–11 is labelled “2010”
- offset years (October through the following September) are named by the January–September portion; *viz.* 2010–11 is labelled “2011”
- “review scheduled” is simply the year five years after development of the current rule; whether the review occurs is a matter for the NRLMG

- input CPUE is standardised offset year for all stocks; “B4-L” and “F2-LFX” define the data extraction algorithm, which must be the same as was used when the rule was developed (see Starr 2016)
- managers vary in the precision they use in recommending catch limits; the tables report at least the precision used by managers

3. CRA 1 MANAGEMENT PROCEDURE

3.1 Summary

	CRA 1
First year with MP	2015
First year of current MP	2015
Review scheduled	2019
Input CPUE	offset year F2-LFX
Output	TACC
Type of rule	generalised plateau step rule
Latent year?	no
Minimum change	5%
Maximum change	none
2016–17 TAC	273.062
2016–17 customary allowance	20
2016–17 recreational allowance	50
2016–17 other mortality allowance	72
Total non-commercial allowance	142
2016–17 TACC	131.062

The rule is based on work conducted 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 as described above. From the options recommended (NRLMG 2015), the Minister adopted rule 9d, for which the specific parameter values are shown in Table 2.

Table 2: Parameters for the CRA 1 generalised plateau step rule.

Par	Function	CRA 1 rule 9d value
<i>par1</i>	rule type	4
<i>par2</i>	CPUE at TACC = 0	0.1
<i>par3</i>	CPUE at plateau left	1.1
<i>par4</i>	CPUE at plateau right	1.7
<i>par5</i>	plateau height	131.062
<i>par6</i>	step width	0.25
<i>par7</i>	step height	0.05
<i>par8</i>	minimum change	0.05
<i>par9</i>	maximum change	0
<i>par10</i>	latent year switch	0

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.

The Final Advice Paper (NRLMG 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 offset-year CPUE was 1.5803 kg/potlift, which gave a suggested TACC of 131.062 t. The Minister accepted this rule and assigned the current allowances (customary 20 t, recreational 50 t and other mortality 72 t).

In November 2015, standardised F2-LFX CPUE was 1.3154, which remained on the plateau so there was no change to the TACC. The Minister accepted this (Table 3 and Figure 4).

Table 3: History of the CRA 1 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

Year	Applied to fishing year	Offset CPUE (kg/potlift)	Rule result: TACC (t)	Applied TACC (t)	Applied TAC (t)
2014	2015–16	1.5803	131.062	131.062	273.062
2015	2016–17	1.3154	131.062	131.062	273.062

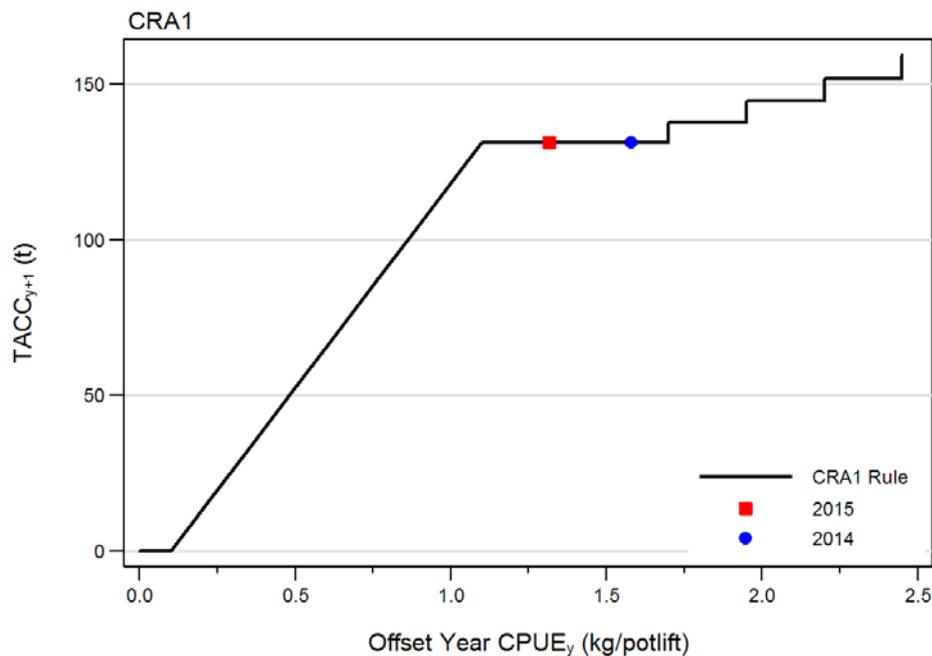


Figure 4: The current CRA 1 harvest control rule. The coloured symbols show the 2014 and 2015 offset-year CPUE and the resulting TACCs.

4. CRA 2 MANAGEMENT PROCEDURE

4.1 Summary:

	CRA 2
First year with MP	2014
First year of current MP	2014
Review scheduled	2018
Input CPUE	offset year F2-LFX
Output	TACC
Type of rule	generalised plateau step rule
Latent year?	no
Minimum change	5%
Maximum change	none
2016–17 TAC	416.5
2016–17 customary allowance	16.5
2016–17 recreational allowance	140
2016–17 other mortality allowance	60
Total non-commercial allowance	216.5
2016–17 TACC	200

The rule is based on work conducted in 2013 by Starr et al. (2014), using an operating model based on the CRA 2 stock assessment model.

Rules evaluated were generalised plateau step rules as described above. From the options recommended (NRLMG 2014), the Minister adopted rule 4, with the specific parameter values shown in Table 4.

Table 4: Parameters for the CRA 2 generalised plateau step rule.

CRA 2 rule 4		
Par	Function	value
<i>par1</i>	rule type	4
<i>par2</i>	CPUE at TACC = 0	0
<i>par3</i>	CPUE at plateau left	0.3
<i>par4</i>	CPUE at plateau right	0.5
<i>par5</i>	plateau height	200
<i>par6</i>	step width	0.1
<i>par7</i>	step height	0.1
<i>par8</i>	minimum change	0.05
<i>par9</i>	maximum change	0
<i>par10</i>	latent year switch	0

The 2014 decision was the first time that a TAC was set for CRA 2; before 2014 there had been only a TACC and in 2014 the Minister had to set allowances for non-commercial catches.

The Final Advice Paper (NRLMG 2014) for the 2014–15 fishing year described the rule as follows:

Some important elements of the CRA 2 management procedures 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;*
- 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) and 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%.*

The CRA 2 management procedures are based on a generalised ‘step’ rule. For Rule 4: between a CPUE of zero and 0.3 kg/potlift, the TACC increases linearly with CPUE to a plateau of 200 tonnes, which extends to a CPUE of 0.5 kg/potlift. As CPUE increases above 0.5 kg/potlift, the TACC increases in steps with a width of 0.1 kg/potlift and a height of 10% of the preceding TACC.

4.2 History

First used for the 2014–15 fishing year, this was the first MP for this stock. In November 2013, standardised offset-year CPUE was 0.367 kg/potlift, which gave a suggested TACC of 200 t. The Minister accepted this rule and assigned the current allowances (customary 16.5 t, recreational 140 t and other mortality 60 t) to give the results in Table 5 and Figure 5.

In November 2014, CPUE was 0.3361, which gave a TACC that remained on the plateau.

In November 2015, standardised F2-LFX offset-year CPUE again decreased and was just below the plateau: the preliminary rule result was a TACC of 199.397 t. Because this would be change of only 0.3%, below the minimum change threshold of 5%, the MP result was no change to the TACC. The Minister accepted this result and retained the current allowances to give the results in Table 5. However, more than 95% of the quota held by CRA 2 industry was voted in favour of a 25% quota shelving, so the functional TACC for 2016 was 150 t.

Table 5: History of the CRA 2 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

Year	Applied to fishing year	Offset CPUE (kg/potlift)	Rule result: TACC (t)	Applied TACC (t)	Applied TAC (t)
2013	2014–15	0.3668	200.0	200.0	416.5
2014	2015–16	0.3361	200.0	200.0	416.5
2015	2016–17	0.2991	200.0	200.0*	416.5

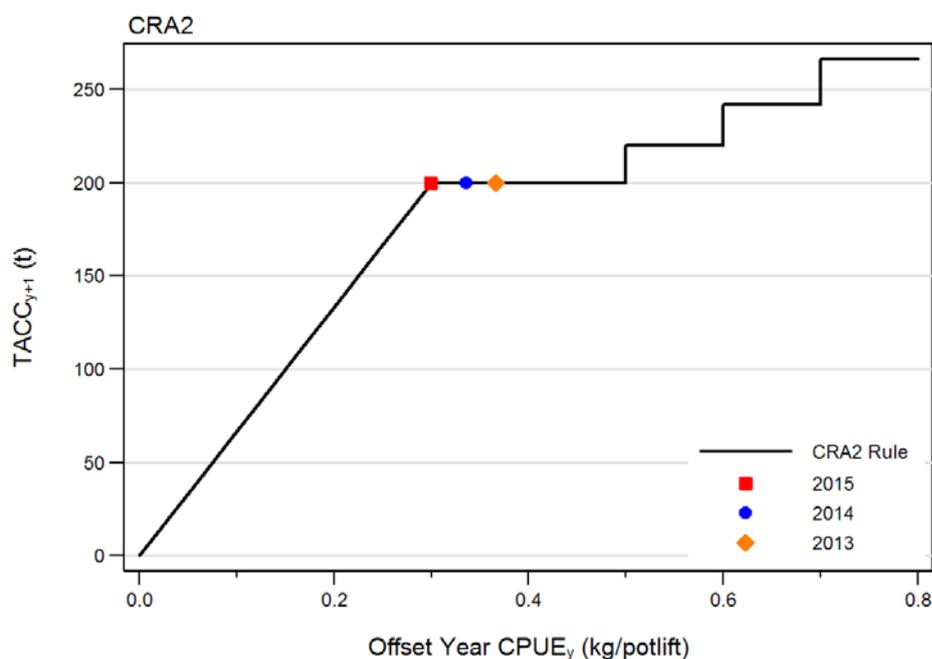


Figure 5: History of the current CRA 2 management procedure. The coloured points show the 2013, 2014 and 2015 offset-year CPUE and resulting TACCs. Note that the functional TACC for 2016 is 150 t after shelving.

5. CRA 3 MANAGEMENT PROCEDURE

5.1 Summary:

	CRA 3
First year with MP	2010
First year of current MP	2015
Review scheduled	2019
Input CPUE	offset year F2-LFX
Output	TACC
Type of rule	modified plateau slope rule
Latent year?	no
Minimum change	5%
Maximum change	none
2016–17 TAC	389.95
2016–17 customary allowance	20
2016–17 recreational allowance	20
2016–17 other mortality allowance	89
Total non-commercial allowance	129
2016–17 TACC	260.95

The rule is based on work conducted 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 6) and c) having an inexplicably different slope equation from the generalised rule. Rule parameters (Table 6) are defined differently from those in the other rules.

The equations below define this harvest control rule. The Minister adopted rule 4, for which the specific parameter values are shown in Table 6.

Table 6: Parameters for the CRA 3 plateau slope rule evaluated in 2014, and values for the rule agreed by the Minister in 2015.

Par	Function	CRA 3 rule 4 value
<i>par1</i>	rule type	6
fixed	CPUE at TACC = 0	0.0
<i>par2</i>	CPUE at first inflection	1.0
<i>par3</i>	left plateau	2.0
<i>par4</i>	right plateau	3.0
<i>par5</i>	plateau height	260
<i>par6</i>	slope	50
<i>par7</i>	TACC at first inflection	180
<i>par8</i>	minimum change	0.05
<i>par9</i>	maximum change	0
<i>par10</i>	latent year	0

The 2015 CRA 3 rule is described by:

$$TAC_{y+1} = par7 \left(\frac{I_y}{par2} \right) \quad \text{for } I_y \leq par2$$

$$TAC_{y+1} = par7 + (par5 - par7) \left(\frac{I_y - par2}{par3 - par2} \right) \quad \text{for } par2 < I_y \leq par3$$

$$TAC_{y+1} = par5 \quad \text{for } par3 < I_y \leq par4$$

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

where TAC_{y+1} is the provisional TAC (before thresholds operate) and I_y is the CPUE (kg/potlift) in the preceding year.

The Final Advice Paper (NRLMG 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%. There is no maximum change threshold for the TACC.

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 (NRLMG 2015), the Minister chose rule 4 for the 2015–16 fishing year.

In November 2014, standardised offset-year CPUE was 2.2139 kg/potlift, which gave a TACC on the main plateau (Table 7). The Minister accepted this result and retained the previous non-commercial allowances (customary 20 t, recreational 20 t and illegal 89 t).

In November 2015, standardised F2-LFX offset-year CPUE decreased and was no longer on the plateau; the preliminary rule result was a TACC of 250.736 t. Because this would have been a TACC change of 3.9%, which was below the minimum change threshold of 5%, the MP result was no change in the TACC. This result was accepted by the Minister.

Table 7: History of the current CRA 3 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

Year	Applied to fishing year	Offset CPUE (kg/potlift)	Rule result: TACC (t)	Applied TACC (t)	Applied TAC (t)
2014	2015–16	2.2139	260.00	260.95	389.95
2015	2016–17	1.8842	260.00	260.95	389.95

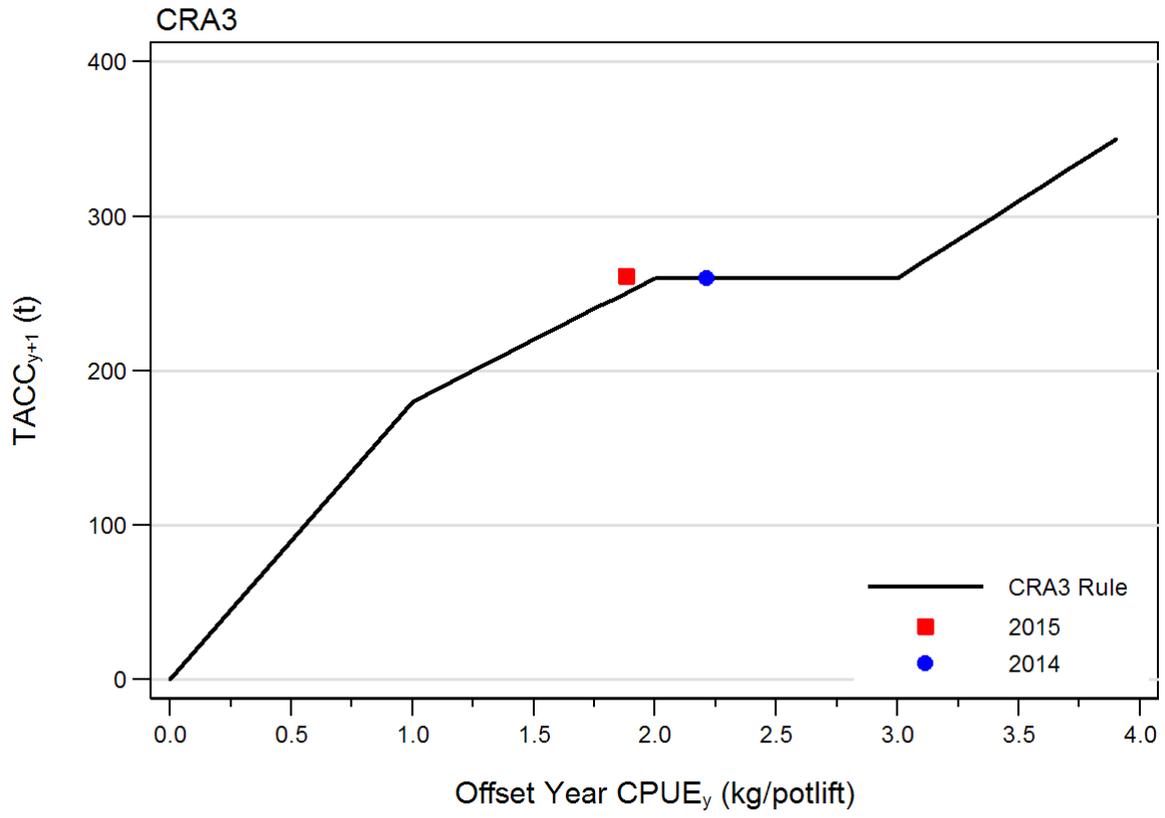


Figure 6: The current CRA 3 harvest control rule; the coloured symbols show the 2014 and 2015 CPUE and resulting TACCs.

6. CRA 4 MANAGEMENT PROCEDURE

6.1 Summary:

	CRA 4
First year with MP	2007
First year of current MP	2012
Review scheduled	2016
Input CPUE	offset year B4-L
Output	TACC
Type of rule	generalised plateau step rule
Latent year?	no
Minimum change	none
Maximum change	25%*
2016–17 TAC	592
2016–17 customary allowance	35
2016–17 recreational allowance	85
2016–17 other mortality allowance	75
Total non-commercial allowance	195
2016–17 TACC	397

*maximum change threshold applies only to increases when TACC is to the left of the plateau

The CRA 4 MP is based on work conducted in 2011 by Breen et al. (2012), who used an operating model based on the CRA 4 stock assessment done in that same year. Rules evaluated were generalised plateau step rules as described above. From the options recommended (NRLMG 2012), the Minister adopted rule 28a, for which the specific parameter values are shown in Table 8.

Table 8: Parameters for the CRA 4 generalised plateau step rule.

Par	Function	CRA 4 rule 28a
		value
<i>par1</i>	rule type	4
<i>par2</i>	CPUE at TACC = 0	0.5
<i>par3</i>	left plateau	0.9
<i>par4</i>	right plateau	1.3
<i>par5</i>	plateau height	467
<i>par6</i>	step width	0.1
<i>par7</i>	step height	0.07
<i>par8</i>	minimum change	0
<i>par9</i>	maximum change	0.25*
<i>par10</i>	latent year switch	0

*applies only to increases when TACC is below the plateau, i.e. when CPUE is less than *par3*

The Final Advice Paper (NRLMG 2012) for the 2012–13 fishing year described the rule as follows:

- 1) *It is proposed that the expired CRA 4 Management Procedure is replaced by a recommended new Management Procedure from the 2012–13 fishing year onwards. A new 2011 stock assessment was used to set the operating model for evaluating the new CRA 4 Management Procedure.*
- 2) *Some important elements of the new CRA 4 Management Procedure are:*
 - a. *The output variable is TACC (tonnes) and that standardised CPUE (kg/potlift) is to be used as the input variable;*
 - b. *Standardised CPUE is to be based on the offset year from 1 October;*
 - c. *CPUE is to be standardised according to the recent usage described in annual Fishery Assessment Reports (FARs), using a data extract obtained in November to ensure that sufficient data from the most recent autumn-winter season have been entered;*
 - d. *The management procedure is to be evaluated every year (no "latent year"), based on offset-year CPUE; and*

e. It has no thresholds for minimum and maximum change, except a maximum 25% increase limit below the first plateau.

Below a CPUE of 0.5 kg/potlift, the TACC is zero; between a CPUE of 0.5 and 0.9 kg/potlift, the TACC increases linearly with CPUE to a plateau of 467 tonnes, which extends to a CPUE of 1.3 kg/potlift. As CPUE increases above 1.3 kg/potlift, TACC increases in steps with a width of 0.1 kg/potlift and a height of 7% of the preceding TACC.

6.2 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 2012 for the 2012–13 fishing year. The input standardised offset-year CPUE for 2011 was 1.194, giving a TACC of 466.9 t and a TAC of 661.9 t (Figure 7) when the non-commercial allowances of 195 t were added (Table 9); these were customary 35 t, recreational 85 t and other mortality 75 t.

In November 2012, CPUE was 1.374, giving a TACC of 499.69 t. The Minister accepted this result, rounding the TACC to 499.7 t, and retained the current allowances to give a TAC of 694.7 t.

In November 2013, CPUE was 1.293, giving a TACC of 467 t. The Minister accepted this result and retained the current allowances to give a TAC of 662 t.

In November 2014, CPUE was 1.168 giving a TACC on the plateau of 467 t. The Minister accepted this result and retained the current allowances to give a TAC of 662 t.

In November 2015, standardised B4-L offset-year CPUE had decreased and was to the left of the plateau. The rule gave a TACC of 446.219 t. Although this was a change of only 4.5%, the CRA 4 MP has no minimum change threshold, so the result was a TACC of 446.219 t. CRA 4 industry decided that a bigger cut was required; they made representations to the NRLMG and conducted a vote, resulting in a TACC reduced by 15% to 397 t. In the history of MP management of New Zealand lobsters, this is the third instance (after CRA 5 and CRA 9 for 2015–16) where the management procedure was not followed.

Table 9: History of the CRA 4 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

Year	Applied to fishing year	Offset CPUE (kg/potlift)	Rule result: TACC (t)	Applied TACC (t)	Applied TAC (t)
2011	2012–13	1.194	466.9	466.9	661.9
2012	2013–14	1.374	499.69	499.7	694.7
2013	2014–15	1.293	467	467	662
2014	2015–16	1.168	467	467	662
2015	2016–17	0.882	446.219	397	592

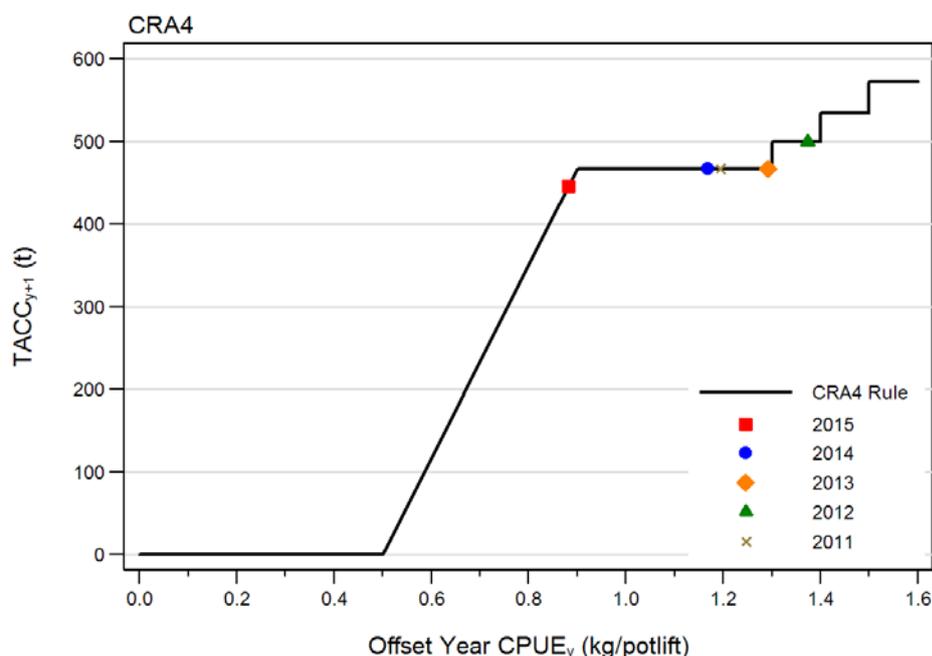


Figure 7: History of the current CRA 4 management procedure. The 2016 TACC is that specified by the rule, not the lower TACC that was adopted.

7. CRA 5 MANAGEMENT PROCEDURE

7.1 Summary:

	CRA 5
First year with MP	2009
First year of current MP	2016
Review scheduled	2020
Input CPUE	offset year F2-LFX
Output	TACC
Type of rule	generalised plateau step rule
Latent year?	no
Minimum change	5%
Maximum change	none
2016–17 TAC	514
2016–17 customary allowance	40
2016–17 recreational allowance	87
2016–17 other mortality allowance	37
Total non-commercial allowance	164
2016–17 TACC	350

The previous CRA 5 MP was based on MPEs made in 2010 (Haist et al. 2011), using an operating model that was based on a stock assessment in the same year, and on further evaluations made later with the same operating model (Breen 2011), using TACC-generating rules. In 2015, a new stock assessment was conducted, then new MPs were evaluated (Starr & Webber 2016).

Rules evaluated were generalised plateau step rules. From the options recommended to them, the NRLMG (2016) chose, and the Minister accepted, rule 45, for which the specific parameter values are shown in Table 10. The input CPUE was changed to that collated with the F2-LFX procedure, in line with most other stocks. The Minister increased the recreational allowance from 40 to 87 t to conform with best available information.

Table 10: Parameters for the CRA 5 generalised plateau step rule.

Par	Function	CRA 5 2015-45 rule	
			value
par1	rule type		4
par2	CPUE at TACC = 0		0.3
par3	left plateau		1.2
par4	right plateau		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
r10	latent year switch		0

The Final Advice Paper (NRLMG 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, illustrated in Figure 8.3 above. 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.

7.2 History

The current rule was adopted by the Minister for the 2016–17 fishing year. In November 2015, standardised F2-LFX offset-year CPUE was 1.789, which specified a TACC of 350 t, on the plateau. The Minister retained the customary allowance of 40 t and the illegal allowance of 37 t, but increased the recreational allowance from 40 to 87 t, giving a TAC of 514 t (Table 11 and Figure 8).

Table 11: History of the current CRA 5 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

Year	Applied to fishing year	Offset CPUE (kg/potlift)	Rule result: TACC (t)	Applied TACC (t)	Applied TAC (t)
2015	2016–7	1.789	350	350	514

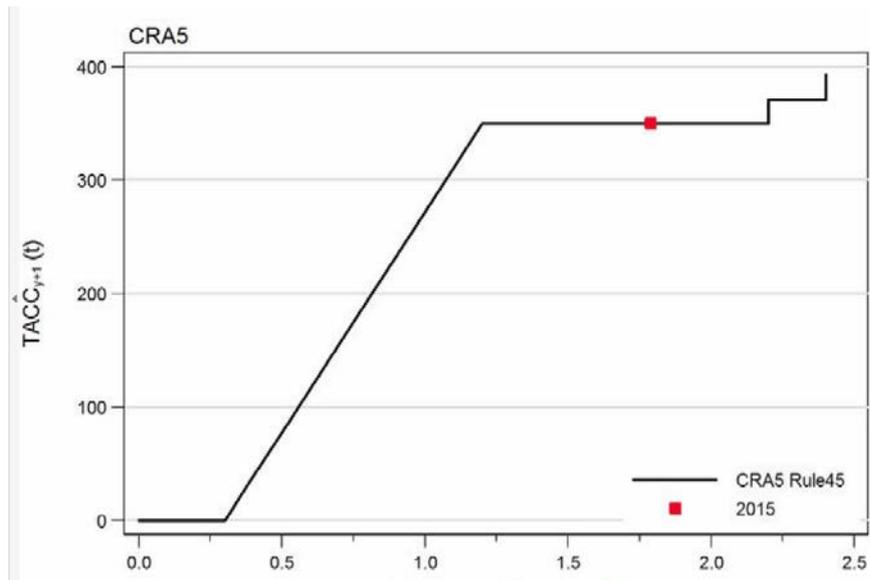


Figure 8: History of the current CRA 5 management procedure.

8. CRA 7 MANAGEMENT PROCEDURE

8.1 Summary

	CRA 7
First year with MP	1996
First year of current MP	2013
Review scheduled	2020
Input CPUE	offset year F2-LFX
Output	TACC
Type of rule	generalised plateau slope rule
Latent year?	no
Minimum change	10%
Maximum change	50%
2016–17 TAC	117.72
2016–17 customary allowance	10.0
2016–17 recreational allowance	5.0
2016–17 other mortality	5.0
Total non-commercial allowance	20.0
2016–17 TACC	97.72

The CRA 7 MP is based on MPEs made 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 (NRLMG 2013) the Minister adopted rule 39, for which specific parameter values are shown in Table 12. This rule replaced an earlier rule and is the latest in a series (Starr et al. 1997; Bentley et al. 2003b; Breen et al. 2008).

Table 12: Parameters for the CRA 7 generalised plateau slope rule.

CRA 7 rule 39		
Par	Function	value
<i>par1</i>	rule type	3
<i>par2</i>	CPUE at TACC = 0	0.17
<i>par3</i>	left plateau	1.00
<i>par4</i>	right plateau	1.75
<i>par5</i>	plateau height	80
<i>par6</i>	slope	3.0
<i>par7</i>	step height	n.a.
<i>par8</i>	minimum change	0.1
<i>par9</i>	maximum change	0.5
<i>par10</i>	latent year switch	0

The Final Advice Paper (NRLMG 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:*
 - *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%.*

8.2 History

The Minister adopted this rule in 2013 for the 2013–14 fishing year. The standardised offset-year CPUE in November 2012 was 0.625, giving a TACC of 44.96 t. The Minister accepted this result and used the same allowances as for previous years (customary 10 t, recreational 5 t, other mortality 5 t) to set a TAC of 64 t (Table 13, Figure 9).

In November 2013 the offset-year CPUE had more than doubled to 1.356, which suggested a TACC of 80 t. 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 t.

In November 2014 the offset-year CPUE had increased to 2.3036, giving a TACC of 97.72 t. The Minister accepted this result and retained the same allowances as before, giving a TAC of 117.72 t.

In November 2015, standardised F2-LFX offset-year CPUE had decreased slightly to 2.2124 and the preliminary rule result was a TACC of 94.797 t. 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.

Table 13: History of the CRA 7 management procedure. "Rule result" is the result of the management procedure after operation of all its components including thresholds.

Year	Applied to fishing year	Offset CPUE (kg/potlift)	Rule result: TACC (t)	Applied TACC (t)	Applied TAC (t)
2012	2013–14	0.625	43.96	44.0	64.0
2013	2014–15	1.356	66.0	66.0	86.0
2014	2015–16	2.304	97.72	97.72	117.72
2015	2016–17	2.212	97.72	97.72	117.72

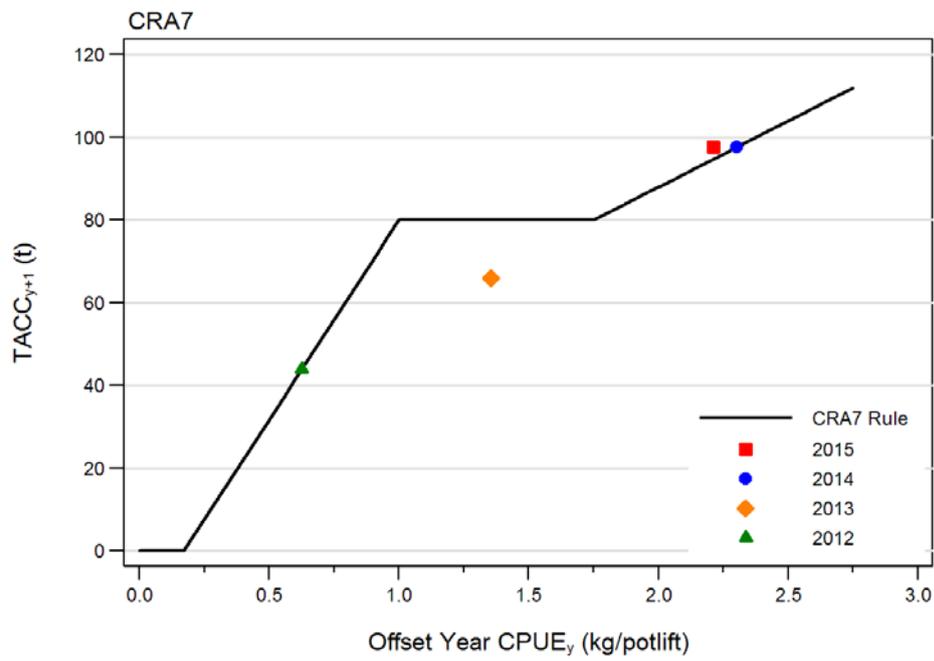


Figure 9: History of the current CRA 7 management procedure.

9. CRA 8 MANAGEMENT PROCEDURE

9.1 Summary

	CRA 8
First year with MP	1996
First year of current MP	2016
Review scheduled	2020
Input CPUE	offset year F2-LF
Output	TACC
Type of rule	generalised plateau step rule
Latent year?	no
Minimum change	5%
Maximum change	no
2016–17 TAC	1053
2016–17 customary allowance	30
2016–17 recreational allowance	33
2016–17 other mortality allowance	28
Total non-commercial allowance	91
2016–17 TACC	962

The previous CRA 8 MP was based on MPEs made in 2012, using an operating model that was based on the combined CRA 7 / CRA 8 stock assessment conducted in 2012 (Haist et al. 2013). The CRA 8 industry requested an early re-evaluation of this MP: they requested evaluation of more aggressive rules, although none of these was chosen; they requested evaluation of plateau step rules to replace the plateau slope rule; and they requested that CPUE be based only on the sizes of fish that are landed, not on all sizes including the larger ones that are not economic. This is called \$CPUE or money-fish CPUE.

The evaluations were conducted in 2015 after a new stock assessment (Haist et al. 2016). The input CPUE was collated by considering as catch only the lobsters landed to L or F destinations (licensed fish receivers and section 111 recreational catch respectively) (see Starr 2016). The more usual F2-LFX procedure also considers destination X, legal lobsters returned to the sea. MP evaluations were based on the observed relation between conventional seasonal CPUE and the offset-year F2-LF CPUE.

From the options recommended, the NRLMG (2016) chose and the Minister adopted rule 43, for which the parameters are shown in Table 14. This rule replaced a similar rule and is the fourth in a series that began in 1996 (Starr et al. 1997; Bentley et al. 2003b; Breen et al. 2008).

Except for an extended plateau, the adopted rule is the same as the previous CRA 8 MP when the allowances are the same (the previous rule generated a TAC; this rule generates a TACC).

Table 14: Parameters for the CRA 8 generalised plateau slope rule.

Par	Function	CRA 8 rule 13 value
<i>par1</i>	rule type	4
<i>par2</i>	CPUE at TACC = 0	0.5
<i>par3</i>	left plateau	1.9
<i>par4</i>	right plateau	3.2
<i>par5</i>	plateau height	962
<i>par6</i>	step width	0.5
<i>par7</i>	step height	0.055
<i>par8</i>	minimum change	0.05
<i>par9</i>	maximum change	0
<i>par10</i>	latent year switch	0

The Final Advice Paper (NRLMG 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;
- c) 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, illustrated in Figure 9.3 above. 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.

9.2 History

History of the new CRA 8 MP is shown in Table 15. In November 2015, the standardised offset-year F2-LF CPUE was 3.062 kg/potlift, which gave a TACC on the plateau (Table 15 and Figure 10).

Table 15: History of the current CRA 8 management procedure. “Rule result” is the result of the management procedure after operation of all its components including thresholds.

Year	Applied to fishing year	Offset CPUE (kg/potlift)	Rule result: TACC (t)	Applied TACC (t)	Applied TAC (t)
2015	2016–17	3.062	962	962	1053

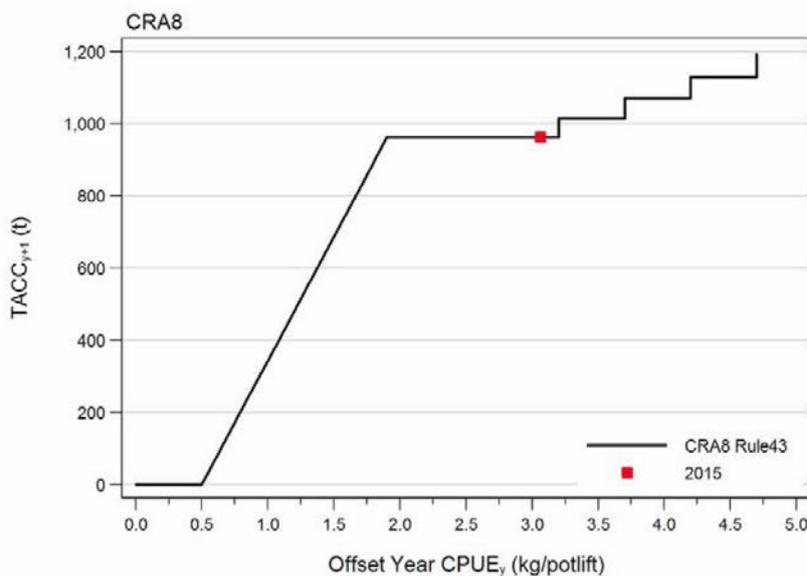


Figure 10: History of the current CRA 8 management procedure.

10. CRA 9 MANAGEMENT PROCEDURE

10.1 Summary

	CRA 9
First year with MP	2014
First year of current MP	n.a.
Review scheduled	n.a.
Input CPUE	n.a.
Output	n.a.
Type of rule	n.a.
Latent year?	n.a.
Minimum change	n.a.
Maximum change	n.a.
2016–17 TAC	115.8
2016–17 customary allowance	20
2016–17 recreational allowance	30
2016–17 other mortality allowance	5
Total non-commercial allowance	55
2016–17 TACC	60.8

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 (NRLMG 2014) the Minister adopted rule 4041. When first 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.

That rule was the first MP to be used in CRA 9. In November 2014, the standardised offset-year CPUE had declined and the MP specified a TACC of 46.0 t. Industry complained vigorously that the decline in TACC did not reflect a decline in the stock, but was a mistake or possibly an artefact of the small number of fishing vessels. The NRLMG advised the Minister not to change the TACC or TAC in 2015 and promised 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 is an index of the abundance of the whole stock (Webber, unpublished data). This analysis and those performed by Starr (unpublished data) 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.

The NRLMG recommended that the MP not be followed for 2016–17, and this marked the end of the CRA 9 MP. The Minister accepted this suggestion:

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.

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