



Review of Rock Lobster Sustainability Measures for 2022/23

**Proposal to Alter Total Allowable Catches, Allowances,
and Total Allowable Commercial Catches**

Fisheries New Zealand Discussion Paper No: 2021/27

**ISBN No: 978-1-99-101994-3 (online)
ISSN No: 2624-0165 (online)**

December 2021



Disclaimer

While every effort has been made to ensure the information in this publication is accurate, Fisheries New Zealand does not accept any responsibility or liability for error of fact, omission, interpretation or opinion that may be present, nor for the consequences of any decisions based on this information.

This publication is also available on the Ministry for Primary Industries website at <http://www.mpi.govt.nz/news-and-resources/publications/>

Front page photo credit: Tony and Jenny Enderby.

© Crown Copyright – Fisheries New Zealand

Contents

Page

1	How to get more information and have your say	1
2	Legal basis for managing fisheries in New Zealand	1
3	Questions for submitters on the proposals	1
4	Rock lobster stocks being reviewed	2
5	Summary	2
6	Treaty of Waitangi Obligations	4
6.1	Input and participation of tangata whenua	4
6.2	Kaitiakitanga	5
7	Background information	6
7.1	Management approach for rock lobster	6
7.2	Rock lobster science and monitoring information	7
7.3	Estimation of B_{MSY} reference levels	8
7.4	Rock lobster exports	8
8	Review of the CRA 1 (Northland) rock lobster fishery	9
8.1	CRA 1 fishery overview	9
8.2	CRA 1 stock status	12
8.3	Proposed CRA 1 options	16
9	Review of the CRA 7 (Otago) rock lobster fishery	20
9.1	CRA 7 fishery overview	20
9.2	CRA 7 stock status	22
9.3	Proposed CRA 7 options	27
10	Review of the CRA 8 (Southern) rock lobster fishery	28
10.1	CRA 8 fishery overview	28
10.2	CRA 8 stock status	30
10.3	Proposed CRA 8 options	31
11	Other relevant matters	33
11.1	Deemed values	37
12	Further Information	37
13	Appendix One: Other management issues	39
14	Appendix Two: CRA 1 (Northland) catch projection tables	41

1 How to get more information and have your say

Fisheries New Zealand (FNZ) invites you to make a submission on the proposals set out in this discussion document. Consultation closes at 5pm on 8 February 2022.

Please see the FNZ sustainability consultation webpage (<https://www.mpi.govt.nz/consultations/review-of-sustainability-measures-2022-april-round>) for related information, a helpful submissions template, and information on how to submit your feedback. If you cannot access to the webpage or require hard copies of documents or any other information, please email FMSubmissions@mpi.govt.nz.

2 Legal basis for managing fisheries in New Zealand

1. The Fisheries Act 1996 (the Act) provides the legal basis for managing fisheries in New Zealand, including the Minister's responsibilities for setting and varying sustainability measures. See the separate document *Overview of legislative requirements and other considerations in relation to sustainability measures* at <https://www.mpi.govt.nz/dmsdocument/48880> for more information.

3 Questions for submitters on the proposals

- What stock(s) are you submitting on and do you support the need for review of these stock(s)?
- Which option do you support for revising the TAC and allowances? Why?
- If you do not support any of the options listed, what alternative(s) should be considered? Why?
- Are the allowances for customary Māori, recreational and other sources of mortality appropriate? Why?
- Do you think these options adequately provide for social, economic, and cultural wellbeing?
- Do you have any concerns about potential impacts of the proposed options on the aquatic environment?

4 Rock lobster stocks being reviewed

Red or spiny rock lobster¹

(CRA 1, CRA 7, CRA 8)

Jasus edwardsii, kōura, crayfish

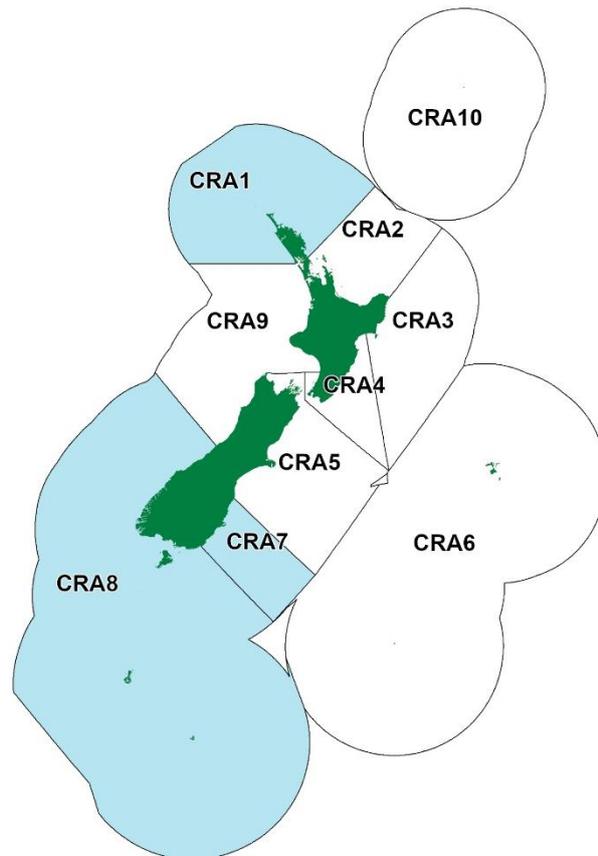


Figure 1: Map of rock lobster Quota Management Areas, showing stocks under review in blue.

5 Summary

2. The National Rock Lobster Management Group (NRLMG)² proposes that the Total Allowable Catch (TAC), allowances and the Total Allowable Commercial Catch (TACC) be reviewed for rock lobster in Quota Management Areas CRA 1 (Northland), CRA 7 (Otago), and CRA 8 (Southern) (Figure 1).
3. Rock lobster stocks support important shared fisheries. Rock lobsters are ecologically important, taonga for tangata whenua, popular species for recreational fishers to catch, and also support valuable export markets, regionally important industries, and employment. New Zealand's rock lobster stocks are regularly reviewed to provide for ongoing sustainable use, reflecting a responsive management approach.
4. The proposals presented in this paper are based on results from new stock assessments, or rapid assessment updates, from 2021. These assessments reflect best available information on the abundance of CRA 1, CRA 7 and CRA 8 stocks. Stock biomass for all three stocks will increase over the next four years under current catch settings. There is no agreed management target for rock lobster, but there is an agreed B_{MSY} (the biomass, or weight of fish, which

¹ Hereafter referred to as rock lobster.

² The NRLMG is a national-level, multi-stakeholder group comprising representatives of customary, recreational and commercial fishing sectors, environmental interests, fisheries compliance, and FNZ. For more information about the NRLMG, visit www.fisheries.govt.nz/nrlmg

produces the maximum sustainable yield (MSY)³ reference level for these stocks. CRA 7 and CRA 8 are projected to increase by a moderate degree and stay well above the B_{MSY} reference level, while CRA 1 is projected to increase slightly and remain just above the B_{MSY} reference level. All three rock lobster stocks are expected to remain well above the level where a formal rebuild plan is required.

5. Table 1 provides a summary of the options proposed for rock lobster. Any changes decided on as a result of this review will come into effect on 1 April 2022. In summary, it is proposed that:
 - **CRA 1** – the TAC is maintained or decreased by up to 15% to increase the likelihood of biomass increasing.
 - **CRA 7** – the TAC is maintained or increased by up to 16%, reflecting the healthy state of the fishery and the potential for increased utilisation.
 - **CRA 8** – the TAC is maintained or increased by up to 11%, reflecting the healthy state of the fishery and the potential for increased utilisation.
6. Rapid assessment update results suggest that no TAC changes are needed for the CRA 3 (Gisborne), CRA 4 (Wellington/Hawke’s Bay), and CRA 5 (Canterbury/Marlborough) rock lobster fisheries for 1 April 2022.⁴ There is no new stock assessment information available to suggest that TAC changes are needed for CRA 6 (Chatham Islands), and CRA 9 (Taranaki/Westland) rock lobster fisheries, or for the PHC 1 (all of New Zealand) packhorse rock lobster⁵ fishery.
7. A rebuilding strategy has been in place for the CRA 2 fishery since April 2018. The 2021 rapid assessment update results suggest abundance has increased since 2018 and is projected to keep rebuilding. In July 2020, the CRA 2 recreational daily limit was reduced from six to three rock lobsters, and telson clipping was introduced for recreationally caught rock lobsters.⁶ These measures are intended to manage recreational catch to the recreational allowance that was set in 2018, and to reduce illegal take. An annual survey of key access points for recreational fishers has been initiated to track relative changes in amateur harvest in CRA 2.
8. The results of the next CRA 2 stock assessment (currently proposed for 2022), will guide decisions on whether future adjustments to the TAC, allowances and TACC are needed. Given the high interest in the stock, it is proposed that thorough community engagement occurs in 2022/23 before any management settings are reviewed.

Table 1: Proposed management options (in tonnes) for CRA 1, 7 and 8 from 1 April 2022. (continued over the page)

Stock	Option	TAC	TACC	Allowances		
				Customary Māori	Recreational	Other mortality
CRA 1 Northland	Option 1.1: Status quo	203	110		32	
	Option 1.2: Decrease the TAC by 5%	193 ↓ (5%)	105 ↓ (5%)		27 ↓ (5 t)	
	Option 1.3: Decrease the TAC by 9%	185 ↓ (9%)	99 ↓ (10%)	20	25 ↓ (7 t)	41
	Option 1.4: Decrease the TAC by 12%	179 ↓ (12%)	94 ↓ (15%)		24 ↓ (8 t)	

³ Maximum Sustainable Yield (MSY) is the greatest yield that can be achieved over time while maintaining the stock’s productive capacity, having regard to the population dynamics of the stock and any environmental factors that influence the stock.

⁴ For more information, see the relevant rock lobster stock chapters in the November Plenary; see <https://www.mpi.govt.nz/dmsdocument/49036>.

⁵ Pawharu, green rock lobster, *Sagmariasus verreauxi*.

⁶ For more information on CRA 2 management including information about regulatory changes and telson clipping see the FNZ website: <https://www.mpi.govt.nz/cra2-review>

Stock	Option	TAC	TACC	Allowances		
				Customary Māori	Recreational	Other mortality
CRA 7 Otago	Option 7.1: Status quo	126.2	106.2			5
	Option 7.2: Increase the TAC by 16%	146.5 ↑ (16%)	111.5 ↑ (5%)	10	5	20 ↑ (15 t)
CRA 8 Southern	Option 8.1: Status quo	1282.7	1191.7			28
	Option 8.2: Increase the TAC by 9%	1394.5 ↑ (9%)	1215.5 ↑ (2%)	30	33	116 ↑ (88 t)
	Option 8.3: Increase the TAC by 11%	1430 ↑ (11%)	1251 ↑ (5%)			

- Any proposed changes to catch settings will come into effect from 1 April 2022, subject to a decision by the Minister for Oceans and Fisheries (the Minister). If the Minister decides to reduce the TAC for CRA 1, and in doing so reduces the recreational allowance, then a regulatory process to amend recreational controls (such as recreational daily limits) would need to follow to manage recreational harvest on average to the new allowance.
- Appendix One provides information on other rock lobster management issues under consideration in the NRLMG.

6 Treaty of Waitangi Obligations

6.1 Input and participation of tangata whenua

- The Act and the Fisheries Settlement make particular provision for customary non-commercial use and management of fisheries resources.
- The Minister has a legislative obligation to provide for the input and participation of tangata whenua into the sustainability decision-making process under section 12(1)(b) of the Act. FNZ has established Iwi Fisheries Forums to support that engagement. Each Iwi Fisheries Forum can develop an Iwi Fisheries Forum Plan that describes how the iwi in the Forum exercise kaitiakitanga over the fisheries of importance to them, and their objectives for the management of their rights and interest in fisheries. Particular regard must be given to kaitiakitanga when making sustainability decisions.
- The CRA 1 management area is relevant to the rohe of the Te Hiku o Te Ika and the Mid-North Iwi Fisheries Forums. Whereas CRA 7 and CRA 8 are relevant to the rohe of the Te Waka a Māui me Ōna Toka Iwi Forum. Input and participation on the proposed review of these stocks was sought in November and the views these forums are outlined in the table below.

Table 2: Iwi Fisheries Forum input received on the rock lobster stocks under review (continued over the page)

Iwi Fisheries Forum	Stock	Input into CRA stock
Te Hiku o Te Ika	CRA 1	The Forum had mixed views, but generally supported retaining the status quo, noting that even a small decrease in the stock would have a big impact on small annual catch entitlement (ACE) fishers and Māori fishing assets. The Forum noted that the minimum legal size (MLS) for rock lobster is very small and considered that the MLS should be increased before considering a reduction to the TAC.
Mid-North	CRA 1	The Forum would like this fishery reviewed and supports a decrease to catch limits. Rock lobster has declined in abundance and the Forum would like abundance to increase back to historical levels. Regarding commercial

Iwi Fisheries Forum	Stock	Input into CRA stock
		fishing, the Forum notes that rock lobster are abundant where there is no commercial fishing pressure. The Forum does not support targeting rock lobster while they are migrating and would like to explore ways to restrict this.
Te Waka a Māui me Ōna Toka Iwi Forum	CRA 7 & 8	<p>CRA 7 & 8 are entirely within the Ngāi Tahu Takiwā. Otago and Southland Ngāi Tahu Papatipu Rūnanga, and their Tangata Tiaki expressed continual concern with the lack of information on recreational fishing levels for these stocks, and with the lack of management of recreational charter fishing in the Fiordland Marine Area in particular. This is concern shared by the Fiordland Marine Guardians. Ngāi Tahu Seafood are supportive of conservative TACC increases for both stocks.</p> <p>In order to fulfil customary fishing needs, tangata whenua are generally reliant on commercial fishers, and are generally unable to find sufficient rock lobsters in inshore waters outside of mātaītai and taiāpure. There is concern that recreational fishing is putting pressure on rock lobster stocks and inhibiting tangata whenua’s customary needs, particularly in nearshore waters.</p>

14. Additional input and participation of tangata whenua is provided through the NRLMG. A Te Waka a Māui me Ōna Toka Iwi Forum representative is a member of the NRLMG, who directly inputs into decision-making on behalf of South Island tangata whenua. A representative of Te Ohu Kaimoana is also a member of the NRLMG and supports North Island and Chatham Island Mandated Iwi Organisations to provide feedback on rock lobster proposals each year.

6.2 Kaitiakitanga

15. Rock lobster is listed as a taonga species in the fisheries plans of the Te Hiku o Te Ika and Te Waka a Māui me Ōna Toka Iwi Forum.
16. The NRLMG considers that the options proposed are generally consistent with the management objectives of the Iwi Fisheries Forum plans. The options proposed align with the following objectives:
- In relation to CRA 1, Te Hiku o te Ika Fisheries Forum Fisheries Management Plan:
 - i. To ensure fish stocks are healthy and support the social, cultural and economic prosperity of Te Hiku iwi and Hapu.
 - In relation to CRA 7 and 8, Te Waka a Māui me Ōna Toka Iwi Forum’s Fisheries Plan:
 - i. To develop environmentally responsible, productive, sustainable and culturally appropriate commercial fisheries that create long-term commercial benefits and economic development opportunities for South Island Iwi.
17. Customary tools utilised under the Fisheries (Kaimoana Customary Fishing) Regulations 1998, the Fisheries (South Island Customary Fishing) Regulations 1999, and the Fisheries Act 1996, provide for tāngata whenua to manage local fisheries in ways that best fit local customary practices in the form of mātaītai, taiāpure and temporary closures.
18. There are several mātaītai, taiāpure, and section 186A/B area closures that fall within each of the rock lobster stocks under review, which are set out in Table 3. It is not anticipated that the options proposed would negatively impact the availability of rock lobster in these areas in CRA 1, however any positive impacts are unknown. In CRA 7 & 8, the proposed TAC increases could potentially result in reduced rock lobster abundance and availability in these areas. While these impacts are unknown, they may be modest, given biomass is projected to increase overall.

Table 3: Customary fisheries management areas in CRA1, CRA 7 & CRA 8.

Quota Management Area	Customary Area	Management type
CRA 1 Northland	Te Puna	
CRA 7 Otago	Moeraki Ōtākou Puna-wai-Toriki	
CRA 8 Southern	Waikawa Harbour/Tumu Toka Motupōhue Oreti Pikomamaku Te Whaka a Te Wera Kaihuka Horomamae Waitutu Okuru Tauparikaka Mahitahi Manakaiaua Okarito Lagoon	Mātaitai Reserve <i>Commercial fishing is not permitted within mātaitai reserves unless regulations state otherwise.</i>
CRA 7 Otago	East Otago	Taiāpure <i>All types of fishing are permitted within a taiāpure. The management committee can recommend regulations for commercial and recreational fishing.</i>
CRA 1 Northland	Maunganui Bay ⁷ Marsden Bank and Mair Bank ⁸	Temporary closures <i>These areas are temporarily closed to all fishing or certain fishing methods, for everyone. These closures are issued under sections 186A or 186B of the Act and apply for 2 years.</i>

7 Background information

7.1 Management approach for rock lobster

19. Within New Zealand, rock lobsters are managed using a range of both output (catch controls) and input controls (regulations including area and gear restrictions, and bag limits). For commercial fishing, the output control is implemented through the Quota Management System (QMS). The fishing year for rock lobster runs from 1 April to 31 March. For more information about the QMS go to: www.mpi.govt.nz/law-and-policy/legal-overviews/fisheries/quota-management-system/.
20. The overall management approach for rock lobster fisheries is to monitor and manage them to provide for use while ensuring sustainability. The use of regular scientific assessments and reviews of rock lobster TACs is consistent with this approach. Being able to respond to changes in rock lobster abundance is important because rock lobster populations can fluctuate rapidly in response to changes in the environment which can affect recruitment, abundance, and availability.

⁷ Applies to all fisheries resources except kina.

⁸ Applies to all shellfish (including rock lobster).

21. Since 1992, the NRLMG has acted as the primary advisor to Ministers on catch limits, regulatory and other management actions that apply specifically to rock lobster fisheries. The NRLMG is a national-level, multi-stakeholder group comprising representatives of tangata whenua, recreational and commercial fishing sectors, environmental interests, and FNZ.
22. The NRLMG's management goal is for all rock lobster fisheries: "to be managed and maintained at or above the assessed and agreed reference levels, using a comprehensive approach that recognises a range of customary Māori, recreational, commercial, and environmental concerns and values".
23. The NRLMG is supportive of discussing initiatives to progress FNZ's pathway to ecosystem-based fisheries management, in line with the environmental principles of the Act. In developing advice to the Minister, the NRLMG must consider the purpose (section 8 of the Act) and the environmental principles (section 9 of the Act) which include the elements of ecosystem-based management.
24. Additional detail about other management issues that relate to rock lobster is given in Appendix One.

7.2 Rock lobster science and monitoring information

25. Full scientific assessments of all rock lobster stocks except CRA 9 (Westland/Taranaki)⁹ are carried out every four to five years. These assessments estimate the current status of the stock relative to requirements of the Act, the desired levels of abundance and show how the stock has responded to previous management controls.
26. Until April 2020, management procedures were used in most rock lobster stocks (including CRA 1, 7 and 8) between full assessment years. Management procedures set out pre-agreed management actions that would be taken in response to changes in commercial catch rates (catch per unit effort - CPUE), an indicator of relative rock lobster abundance. Management procedures were designed to set a TACC that maintained the stock at or above a level that could produce the maximum sustainable yield.
27. Electronic reporting of catch and effort information was implemented in New Zealand's commercial fisheries during 2019. In 2020, the Rock Lobster Working Group reviewed the data from the first year of electronic reporting (1 April 2019 to 31 March 2020), by comparing these data with those generated from the previous paper reporting system. The Working Group concluded that CPUE estimated under the new electronic reporting system was likely to differ from CPUE estimated under the paper form system and is not comparable. The reasons for this appear to include data being collected on a different spatial and temporal scale, new reporting codes and some issues with operators incorrectly interpreting the new reporting requirements. The New Zealand Rock Lobster Industry Council (NZ RLIC) convened a series of workshops in collaboration with Ministry for Primary Industries (MPI) Fisheries Compliance and the three electronic logbook platform providers between March and June 2021 to address these reporting issues.
28. The disruption to the time series of CPUE data means that previously used management procedures can no longer be operated as they rely on a consistent time series of CPUE. Rapid assessment updates are being undertaken as an interim alternative to management procedures. In 2021, rapid assessment updates were conducted for CRA 1, CRA 2, CRA 3, CRA 4 and CRA 5. These rapid assessment updates use new information (such as updated commercial catch information, recreational harvest estimates, length frequency and growth information) to update the most recent full stock assessment model. Results from these rapid assessments provide estimates of stock status and projections of stock biomass to guide management settings in between full stock assessment years.

⁹ The small number of fishers in CRA 9 and low fishing pressure means that there is no currently accepted stock assessment for CRA 9. The stock is monitored using commercial catch and biological information from the fishery. The CRA 9 TAC and TACC are the smallest of the nine fished rock lobster stocks.

29. The Rock Lobster Working Group will continue to develop the rapid assessment update approach. There is potential to use the rapid assessments as the basis for development of a new type of management procedure that could guide decisions on future TAC changes.

7.3 Estimation of B_{MSY} reference levels

30. For rock lobster, research to determine B_{MSY} has been undertaken from 2019 to 2021. These new B_{MSY} reference levels are tailored to the biological and fishery characteristics of each rock lobster stock. They are constructed to be consistent with the requirements of the Act to maintain stocks at or above a level that can produce MSY, while meeting the risk constraints in the Harvest Strategy Standard for New Zealand Fisheries, and therefore represent an interim management target.
31. B_{MSY} reference levels for CRA 1, CRA 7 and CRA 8 were accepted by the Rock Lobster Working Group in 2021. These reference levels provide a trade-off between fixed catch (higher stability of catch levels between years, lower average annual yield) and fixed fishing mortality (F) (higher average annual yield, lower stability of catch levels between years). The NRLMG notes that the estimated B_{MSY} reference levels provide some guidance for the rock lobster stocks under review, but that further work needs to occur, including stakeholder engagement, to recommend management targets for all rock lobster stocks to the Minister.
32. Management targets could be at or above the B_{MSY} reference level, depending on social, cultural, and economic factors, as well as stakeholder aspirations for each rock lobster fishery. These would need to be agreed by the Minister. Management targets should take into account stock implications (yield and catch rate), and the approach that will be used to move stocks toward these new targets or maintain the stock at or above any targets. The role of rock lobster in maintaining biodiversity in a healthy marine environment will also be a consideration. Management targets could also consider the ability to measure and constrain catch, and the approach to allocate access under section 21 of the Act.
33. Work to determine management targets for rock lobster stocks commenced in 2021 and is intended to inform future reviews of catch settings. The NRLMG supports the development of management targets and intends to progress the matter in 2022.
34. Table 4 provides a summary of the stock assessment model outputs that are relevant to the evaluation of the proposals presented in this document for each stock.

Table 4: Summary of key stock model outputs and definitions that are discussed for each stock in this document.

Model outputs	Description	Stock	
		CRA 1	CRA 7 & 8
Vulnerable biomass (B)	Beginning of season autumn-winter vulnerable biomass (legal males and legal females not bearing eggs)	✓	✓
Spawning biomass (SSB)	Beginning of season autumn-winter spawning biomass (mature females)	✓	✓
Total biomass (B_{TOT})	Beginning of season autumn-winter total biomass (all males and females; includes rock lobster under the legal size limit)	✓	✓
B_{MSY}	Biomass that can produce the maximum sustainable yield (MSY)	✓	✓

7.4 Rock lobster exports

35. Rock lobster is New Zealand's most valuable wild caught fishery, generating more than \$300 million annually in export revenue. Rock lobster fishing supports a range of businesses and

regional and coastal communities. The majority of New Zealand's rock lobsters (more than 90%) are exported live, with China being the primary market. Rock lobster exports typically target periods of higher market price, including the lunar New Year.

36. There is no estimate of recreational or customary asset value of the fishery or non-market values of rock lobster.

8 Review of the CRA 1 (Northland) rock lobster fishery

8.1 CRA 1 fishery overview

Māori customary fishing

37. CRA 1 (Northland) customary Māori catch is provided for by the Fisheries (Kaimoana Customary Fishing) Regulations 1998, and regulation 50 of the Fisheries (Amateur Fishing) Regulations 2013 (Amateur Regulations). In the last five years, 302 unspecified units¹⁰ of rock lobster were reported as customary harvest from CRA 1 on average each year. This information is considered incomplete, because customary take that occurs under the Amateur Regulations for the purposes of hui and tangi is not required to be reported.
38. An estimate of 10 tonnes was used in the 2019 CRA 1 stock assessment model and the 2021 rapid assessment update to represent customary catches.

Recreational fishing

39. Relevant sources of information for estimating recreational catch include the results of National Panel Surveys and creel surveys¹¹, the model estimate from the most recent stock assessment, and estimates from the more recent rapid assessment update.
40. For the 2019 CRA 1 stock assessment, recreational catch estimates from the 1994 and 1996 Otago University surveys, the 2011/12 and 2017/18 National Panel Surveys, and the 2013/14 Blue Water Marine Research (Holdsworth) survey were used to construct a recreational catch trajectory. It was assumed that recreational catch was proportional to CRA 1 abundance, estimated from trends in spring-summer commercial CPUE from statistical areas 903 and 904 (the east coast of Northland where the majority of recreational fishing takes place in CRA 1) (Figure 2)¹².
41. The 2019 stock assessment model input of CRA 1 recreational catch was 31.5 tonnes for 2018. The 2017/18 National Panel Survey estimate of CRA 1 recreational catch, while uncertain, was 15.9 tonnes (± 14.7 tonnes). For the 2020/21 fishing year, the recreational catch estimate assumed for the rapid assessment update model was 28.04 tonnes.
42. The COVID-19 outbreak will have reduced recreational participation and catch over the lockdown period(s) in 2020 and 2021.

¹⁰ Customary harvest of rock lobster is usually reported as kilograms or number of individuals, but in some cases the unit used is not specified, which is the case in CRA 1.

¹¹ Creel surveys involve interviewing fishers, asking how many fish were caught, and measuring any fish caught.

¹² The National Panel Surveys occurred over an October fishing year (October to September), and the Blue Water Marine Research Survey occurred over an April fishing year (April to March).

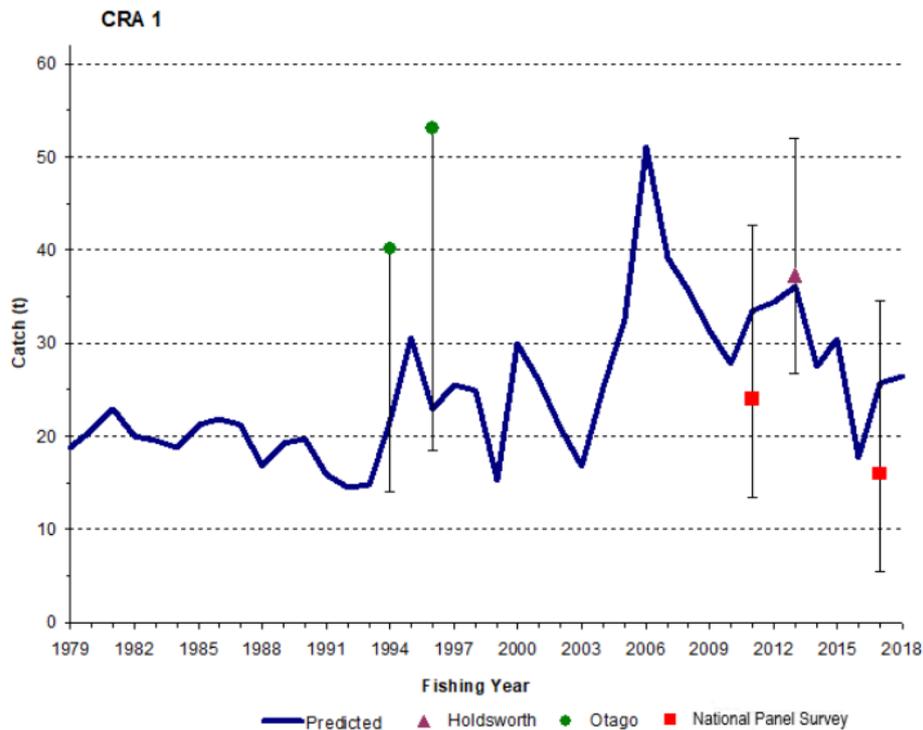


Figure 2: CRA 1 recreational catch trajectory for the 2019 CRA 1 stock assessment (error bars are ± 2 standard errors, with the upper bounds of the Otago University survey estimates suppressed).

Other mortality

43. In the 2019 CRA 1 stock assessment, the Rock Lobster Working Group agreed that illegal catch would be assumed to be 20% of the total commercial catch from 1981 to 2018, scaled proportionally to the commercial CPUE for each year over the same period. This acknowledged that illegal take was likely to be influenced by available abundance (Figure 3). Before 1980, export discrepancies (the difference between reported catch totals and total exported weight) were used to estimate illegal catch. For the 2020/21 fishing year, the illegal catch estimate assumed for the rapid assessment update model was 35.4 tonnes.
44. The CRA 1 stock assessment also assumed that handling mortality was 10% of returned lobsters until 1990, and then 5% thereafter. The model estimate of handling mortality was 2.4 tonnes for 2018, and 1.8 tonnes for 2020 based on the new rapid assessment update.

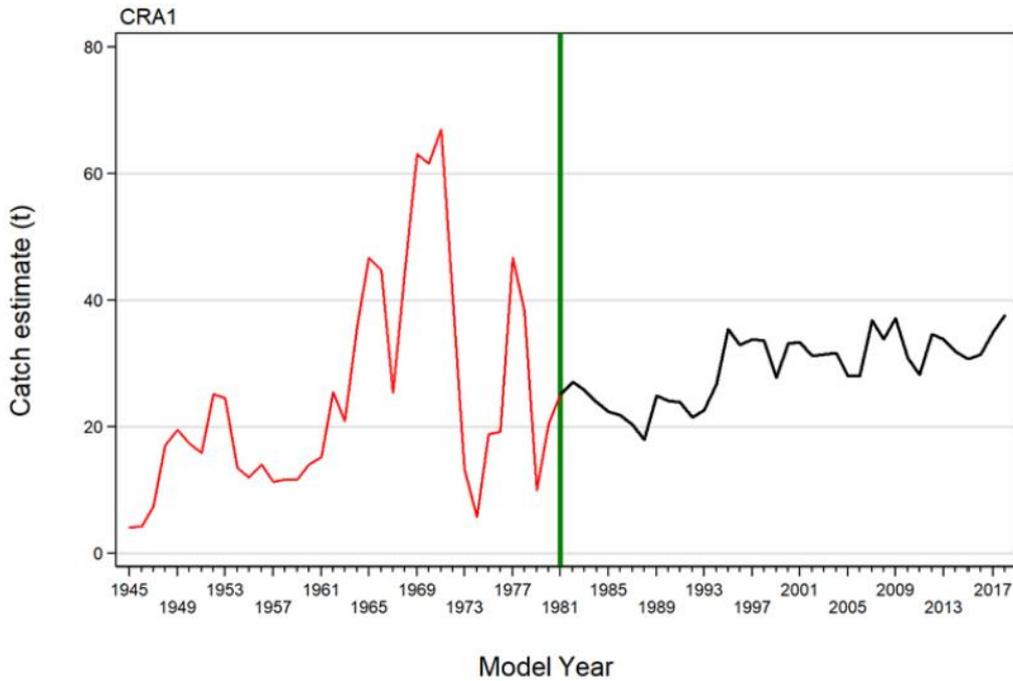


Figure 3: CRA 1 illegal catch trajectory assumed for the 2019 CRA 1 stock assessment.¹³

Commercial fishing

45. CRA 1 commercial landings have remained at or near the TACC since the early 1990s (Figure 4). The TACC was 131 tonnes from the early 1990s until 1 April 2020, when it was reduced to 110 tonnes. The COVID-19 outbreak, particularly the effective closure of the Chinese export market for a period coupled with low prices for exports, contributed to an under-catch of the TACC in 2019/20. Between 2015 and 2019 a formally adopted CRA 1 management procedure was used to annually review the TACC to ensure that catches reflected available abundance.

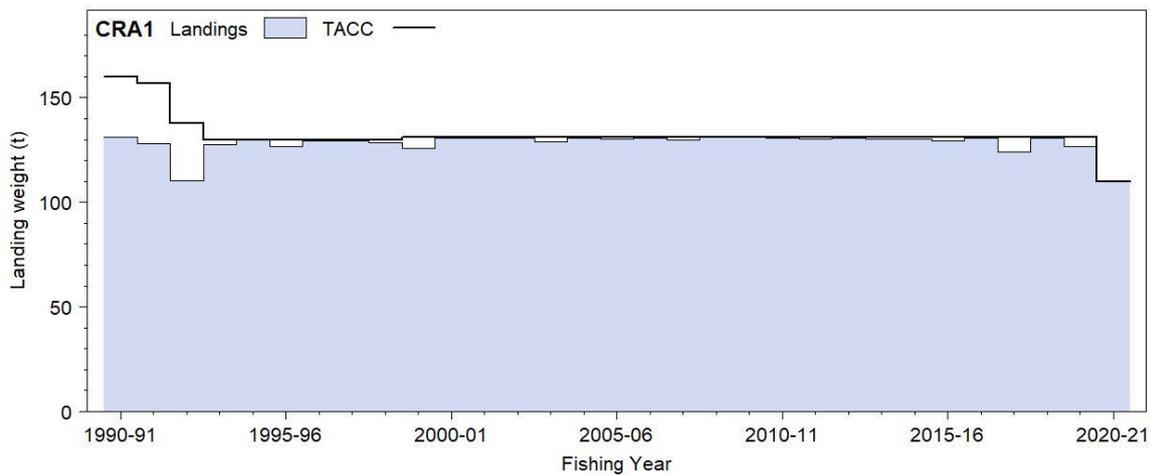


Figure 4: CRA 1 commercial landings and the TACCs from 1990 to 2020.

46. The current asset value of CRA 1 quota is estimated to be over \$112 million based on the current TACC and the average quota share price for the 2017/18 fishing year.¹⁴ The average price of CRA 1 ACE (the earnings quota owners receive when selling their ACE) for the

¹³ The vertical green line refers to when a new approach to estimating illegal catch was applied in 1981.

¹⁴ 2017/18 is the most recent fishing year with sufficient quota trades to calculate an average price for CRA 1.

2020/21 fishing year was \$29,484.64 per tonne. For more detail on CRA 1 ACE and quota prices over the last five years, see Table 5.

Table 5: Number of transfers and average prices of Annual Catch Entitlement (ACE) and quota for CRA 1.¹⁵

April Fishing Year	Annual Catch Entitlement (ACE)		Quota	
	Number of transfers	Average price (per tonne)	Number of transfers	Average price (per tonne)
2016/17	89	\$40,799.32	0	
2017/18	86	\$40,576.41	5	\$1,026,119.05
2018/19	75	\$42,322.79	0	
2019/20	76	\$43,525.05	0	
2020/21	64	\$29,484.64	1	

47. In the 2020/21 fishing year, 14 vessels reported landing at least 1 tonne of rock lobster.

8.2 CRA 1 stock status

48. A stock assessment for CRA 1 was conducted in 2019, and a new rapid assessment update was performed in 2021.

Summary of 2019 stock assessment results

49. The 2019 stock assessment results suggested that vulnerable biomass was 16% of the unfished level and total biomass was 26% of the unfished level. Spawning biomass in 2019 was 37% of the unfished level, well above the soft limit of 20% where it is FNZ policy to implement a formal, time-constrained rebuilding plan. The projections to 2023, with 2019 catch levels and recent recruitment, suggested that vulnerable and total biomass would both decline, while spawning biomass was projected to remain constant.
50. As a result of the 2019 assessment results, the CRA 1 TAC was reduced from 1 April 2020. The TAC was reduced from 273 tonnes to 203 tonnes (16%), the recreational allowance was reduced from 50 tonnes to 32 tonnes (36%), the allowance for other sources of mortality caused by fishing was reduced from 72 tonnes to 41 tonnes (43%), and the TACC was reduced from 130 tonnes to 110 tonnes (15%).

Summary of the 2021 rapid assessment update

51. The results of the 2021 rapid assessment update suggest that CRA 1 vulnerable biomass is 15% of the unfished level. Over the next four years, with 2021 catch levels and recent recruitment, CRA 1 vulnerable biomass is projected to increase with a 65% probability to 17% of the unfished level (Figure 5 and Table 5).

¹⁵ Quota and ACE trading prices registered with FishServe may include transactions between related commercial entities and the averages may understate true market/transfer price.

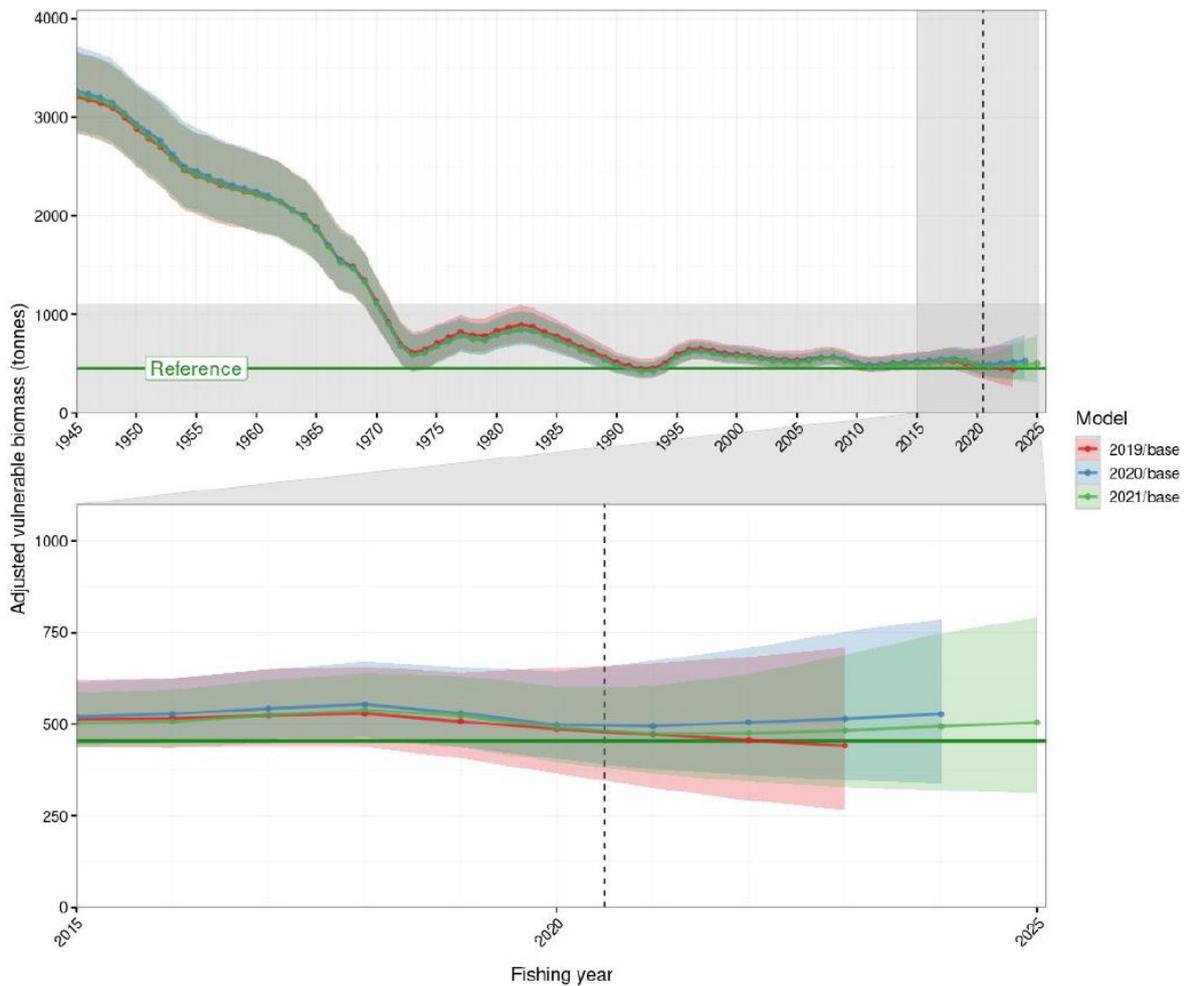


Figure 5: CRA 1 vulnerable biomass trajectories from the 2019 stock assessment (red line and shading), the 2020 rapid assessment update (blue line and shading) and the 2021 rapid assessment update (green line and shading), including the B_{MSY} reference level (solid green line). The solid line and points represent the median and the shaded region represents the 90% credible interval.

52. The rapid assessment results suggest that CRA 1 spawning biomass is 36% of unfished levels. Spawning biomass is expected to stay constant relative to 2021 levels and remain well above the soft limit of 20% where a formal, time constrained rebuilding plan is required (Figure 6).

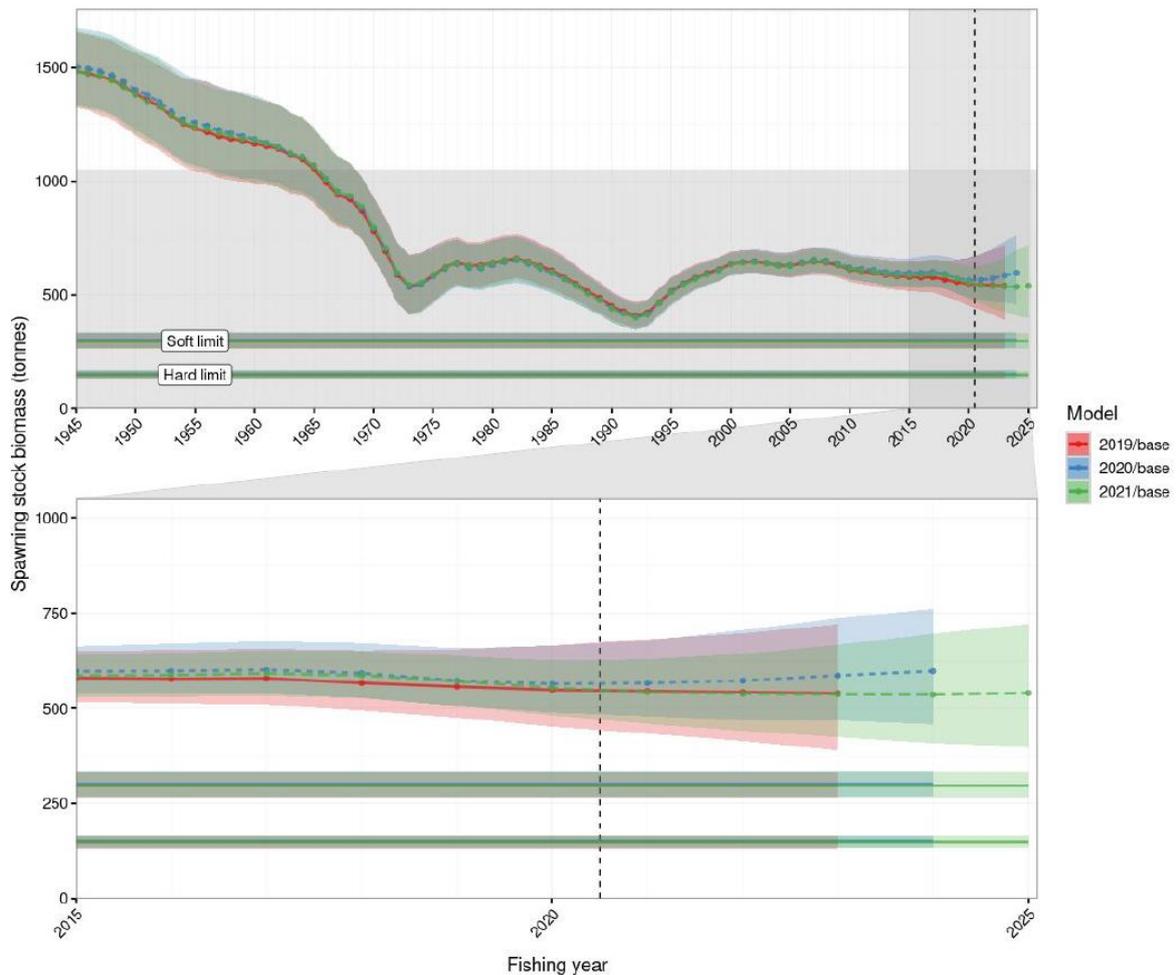


Figure 6: CRA 1 spawning biomass (SSB) trajectories from the 2019 stock assessment (red line and shading), the 2020 rapid assessment update (blue line and shading) and the 2021 rapid assessment update (green line and shading), including the soft limit (20% SSB_0)¹⁶, and the hard limit (10% SSB_0)¹⁷. The solid line and points represent the median and the shaded region represents the 90% credible interval.

53. Table 6 provides further results of the 2021 rapid assessment update in terms of vulnerable, total and spawning stock biomass, with the uncertainties in the results also shown. For example, with 2021 catch levels, vulnerable biomass in 2025 could be at 15.8% (or 0.158) of unfished levels (median result), with a range of 9.2% (or 0.092) and 26.8% (or 0.268) of unfished levels (5% and 95% quantiles).

¹⁶ The soft limit is 20% of the unfished spawning biomass; the level at which it is FNZ policy to implement a formal, time-constrained rebuilding plan.

¹⁷ The hard limit is 10% of the unfished spawning biomass level; the level at which it is FNZ policy to consider closing the fishery.

Table 6: Median results from the 2021 CRA 1 rapid assessment update. 5% and 95% quantiles are provided to show the spread and uncertainty of the data.¹⁸

Performance indicators	5% quantile	Median	95% quantile	Interpretation of the <u>median</u> results
Vulnerable biomass (B)				
B_{2021} / B_0	0.109	0.146	0.198	Vulnerable biomass in 2021 was 15% of unfished levels
B_{2025} / B_0	0.092	0.158	0.268	Vulnerable biomass in 2025 will be 16% of unfished levels
B_{2025} / B_{2021}	0.745	1.095 ↑	1.569	Vulnerable biomass in 2025 will be 110% of 2021 levels (an increase of 10%)
Total biomass (Btot) – Beginning of season autumn-winter total biomass (all males and females)				
$B_{tot2025} / B_{tot2021}$	0.842	1.040 ↑	1.277	Total biomass in 2024 will be 104% of 2021 levels (an increase of 4%)
Spawning stock biomass (SSB)				
SSB_{2021} / SSB_0	0.307	0.363	0.438	Spawning biomass in 2021 was 36% of unfished levels
SSB_{2025} / SSB_0	0.264	0.364	0.496	Spawning biomass in 2021 will be 36% of unfished levels
SSB_{2025} / SSB_{2021}	0.823	0.998	1.211	Spawning biomass in 2025 will be 100% of 2021 levels (no change)
Probabilities				
$P(B_{2025} > B_{2021})$		0.654		65% probability that 2025 vulnerable biomass will be greater than 2021 levels
$P(B_{tot2025} > B_{tot2021})$		0.630		63% probability that 2025 total biomass will be greater than 2021 levels
$P(SSB_{2025} > SSB_{2021})$		0.494		49% probability that 2025 spawning biomass will be greater than 2021 levels

50. The B_{MSY} reference level was calculated based on the 2021 CRA 1 rapid update assessment as a vulnerable biomass level of 454 tonnes. The results, given in Figure 5 above and Table 6 below, suggest that vulnerable biomass was above the reference level in 2021 (with a 60% probability), and is projected to increase further above the B_{MSY} reference level (115% of the B_{MSY} reference level) by 2025.

51. Table 7 provides further results of the 2021 B_{MSY} reference level calculation in terms of vulnerable biomass, with the uncertainties in the results also shown. For example, vulnerable biomass in 2021 is estimated to be at 475 tonnes (median result), with a range of 364 tonnes and 604 tonnes (5% and 95% quantiles).

Table 7: B_{MSY} reference level results for CRA 1 and estimated vulnerable biomass level in 2021 (B_{2021}) from the 2021 rapid assessment update. 5% and 95% quantiles are provided to show the uncertainty of the biomass estimates. (continued over the page)

Vulnerable biomass (tonnes)	5% quantile	Median	95% quantile	Interpretation of the <u>median</u> results
B_R , reference level (tonnes)		454		The vulnerable biomass that can produce MSY is 454 tonnes
Probability B_{2021} greater than B_R		0.603		60% probability that vulnerable biomass in 2021 was greater than the B_{MSY} reference level
B_{2021}	364	475	604	Vulnerable biomass in 2021 was 475 tonnes

¹⁸ The median is the midpoint of a distribution of possible values, such that there is an equal probability of falling above or below it. The 5% and 95% quantiles represent the lower 5% and upper 5% of a distribution of values.

Vulnerable biomass (tonnes)	5% quantile	Median	95% quantile	Interpretation of the <u>median</u> results
B ₂₀₂₁ / B _R	0.802	1.044	1.330	Vulnerable biomass in 2021 was 1.04 times (104%) the reference level
B ₂₀₂₅	295	521	841	Vulnerable biomass in 2025 will be 525 tonnes
B ₂₀₂₅ / B _R	0.649	1.147	1.850	Vulnerable biomass in 2025 will be 1.15 times (115%) the reference level

52. A rapid assessment update will be conducted for CRA 1 in 2022 and will provide an opportunity to consider a review of the catch settings for April 2023.

8.3 Proposed CRA 1 options

54. Table 8 provides a summary of options proposed for CRA 1 (Northland). The results from the 2021 rapid assessment update of the 2019 CRA 1 stock assessment have been used to guide the options for varying the TAC. There is no agreed target biomass for CRA 1.

Table 8: Proposed management options (in tonnes) for CRA 1 from 1 April 2022.

Stock	Option	TAC	TACC	Allowances		
				Customary Māori	Recreational	Other mortality
CRA 1 Northland	Option 1.1: Status quo	203	110		32	
	Option 1.2: Decrease the TAC by 5%	193 ↓ (10 t, 5%)	105 ↓ (5 t, 5%)		27 ↓ (5 t)	
	Option 1.3: Decrease the TAC by 9%	185 ↓ (18 t, 9%)	99 ↓ (11 t, 10%)	20	25 ↓ (7 t)	41
	Option 1.4: Decrease the TAC by 12%	179 ↓ (24 t, 12%)	94 ↓ (16 t, 15%)		24 ↓ (8 t)	

Stock biomass projections for different catch setting proposals

55. Projections of vulnerable and spawning biomass for the next four years under different levels of catch are given in Figures 7 and 8 below. The different catch levels reflect three of the four proposed options:

- current catch levels (Option 1.1);
- a 10% reduction (Option 1.3); and
- a 15% reduction (Option 1.4).

56. As per the proposed options the projected catch adjustments are made to commercial and recreational catch and assume that illegal catch and customary catch are unchanged from 2021 levels. Biomass projections are not available for Option 1.2 (5% TAC decrease); however, it can be assumed that vulnerable and spawning biomass under this option are between the current catch projection and the 10% decrease in catch projection.

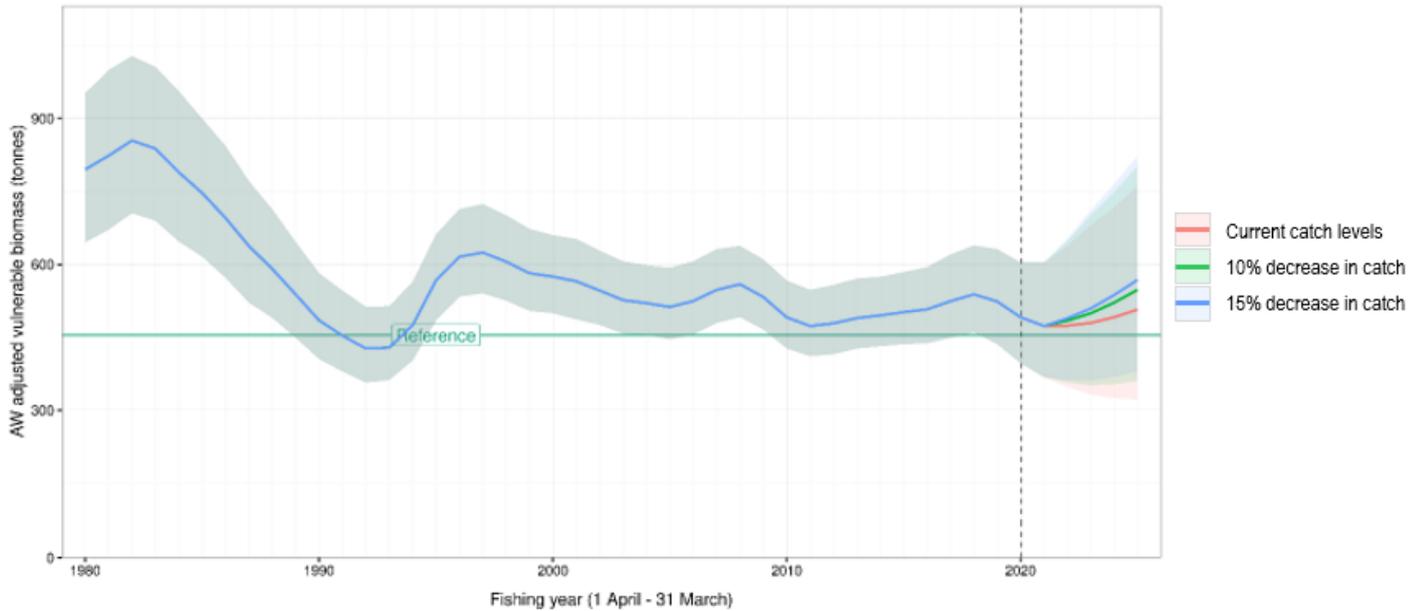


Figure 8: Projections of CRA 1 autumn/winter (AW) adjusted vulnerable biomass over the next four years at a range of catch levels (catch reductions apply to commercial and recreational catch only). The solid lines represent the median and the shaded region represents the 90% credible interval. The horizontal green line shows the B_{MSY} reference level.

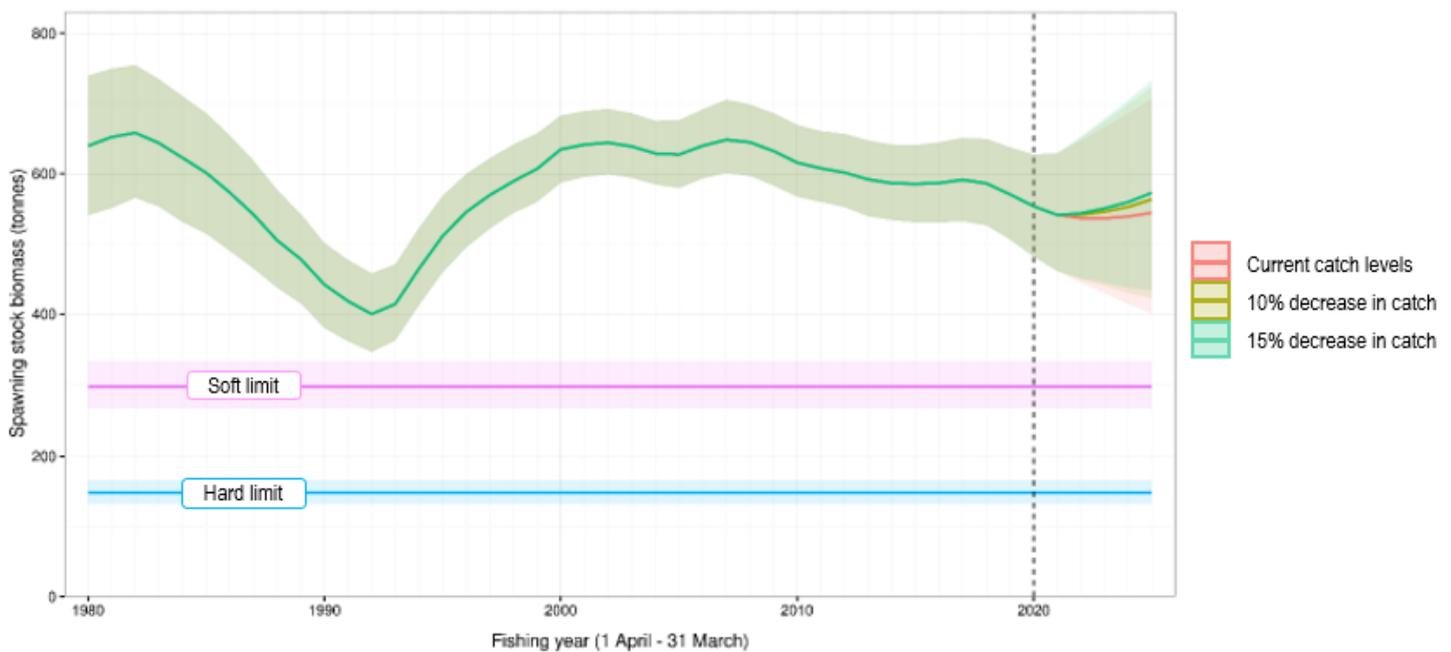


Figure 9: Projections of CRA 1 spawning stock biomass over the next four years at a range of catch levels (catch reductions apply to commercial and recreational catch only) including the soft limit (20% SSB_0), and the hard limit (10% SSB_0). The solid lines represent the median and the shaded region represents the 90% credible interval.

57. Tables showing the projected change in biomass and the stock status relative to the B_{MSY} reference level in more detail for these catch level projections are provided in Appendix Two.

Varying the TAC

58. Under Option 1.1 (status quo), the CRA 1 TAC would remain unchanged at 203 tonnes. This option acknowledges that the TAC has recently been decreased and that this decrease has assisted in maintaining CRA 1 above the B_{MSY} reference level (at 104% in 2021). Under this option, over the next four years, vulnerable biomass is projected to increase by 10%, the stock

is projected to increase to 115% of the B_{MSY} reference level, and spawning biomass is predicted to stay constant at well above the soft limit of 20%.

59. Options proposing decreases to the TAC recognise that CRA 1 is near the B_{MSY} reference level and aim to increase the certainty that the stock will remain at or above this level. It is also noted that tangata whenua and stakeholders' views on the performance of the fishery vary, with some preferring to see the stock managed more cautiously, while others are satisfied that the TAC reduction of 2019 has enabled the rebuild to commence.
60. Under Option 1.2 (5% TAC decrease), the TAC would be decreased to 193 tonnes. Model projections are not available for this option, though it can be assumed projections will fall between those of Option 1.1 and Option 1.3. Vulnerable biomass and spawning stock biomass are projected to increase over the next four years – vulnerable biomass is likely to increase between 10 and 20%, and spawning biomass is projected to stay stable or increase up to 3%. Under this option the stock is likely to be in the range of 115 and 127% of the B_{MSY} reference level by 2025, and to stay above the soft limit.
61. Under Option 1.3 (9% TAC decrease), the TAC would be decreased to 185 tonnes. Vulnerable biomass and spawning stock biomass are projected to increase under this option over the next four years, to a greater degree than Option 1.1 (status quo), and, presumably, Option 1.2 (5% TAC decrease). Under this option, over the next four years, vulnerable biomass is projected to increase by 20%, the stock is projected to increase to 127% of the B_{MSY} reference level, and spawning biomass is predicted to increase by 3% and stay constant at well above the soft limit of 20%.
62. Under Option 1.4 (12% TAC decrease), the TAC would be decreased to 179 tonnes. Under this option, over the next four years, vulnerable biomass is projected to increase by 26%, the stock is projected to increase to 132% of the B_{MSY} reference level, and spawning biomass is predicted to increase by 5% and stay constant at well above the soft limit of 20%. This option gives the greatest increased likelihood of vulnerable and spawning biomass increasing in the next four years and is projected to increase the stock to the highest level above the B_{MSY} reference level of the four options.

Varying allowances and the TACC

63. Table 9 provides a summary of information on current non-commercial allowances for CRA 1 (Northland) and stock assessment assumptions of non-commercial catch.

Table 9: Current CRA 1 allowances and model assumptions of non-commercial catches (in tonnes).

CRA 1 (Northland)	Customary Māori	Recreational	Other mortality	Total
Current allowances	20	32	41	93
Non-commercial catch assumptions for the 2019 stock assessment	10	Assumed to vary with biomass. Estimated at 31.5 for 2018.	40.4 (38 illegal + 2.4 handling mortality)	81.9
Non-commercial catch assumptions for the 2021 rapid assessment update	10	Assumed to vary with biomass. Estimated at 28.0 for 2020	37.2 (35.4 illegal + 1.8 handling mortality)	75.5

Māori customary fishing

64. No change is proposed to the 20 tonne CRA 1 customary Māori allowance. While noting the incompleteness and uncertainty in the CRA 1 customary harvest information, it is assumed that current harvest is within the 20 tonne allowance for customary Māori interests at this time.

Recreational fishing

65. Under Option 1.1 (status quo), no change would be made to the 32 tonne recreational allowance for CRA 1, which was reduced from 50 to 32 tonnes for 1 April 2020. While noting the uncertainty in the CRA 1 recreational harvest information (the 2017/18 National Panel Survey estimate of recreational catch was 15.9 tonnes \pm 14.7 tonnes), it is assumed that current harvest is within the 32 tonne recreational allowance. The 2021 rapid assessment used a model input of 28.3 tonnes for CRA 1 recreational catch.
66. Under Option 1.2 (5% TAC decrease), the recreational allowance would be decreased to 27 tonnes. This is a 5% decrease from the 2021 rapid assessment update estimate of 28 tonnes.
67. Under Option 1.3 (9% TAC decrease), the recreational allowance would be decreased to 25 tonnes. This is a 10% decrease from the 2021 rapid assessment update estimate of 28 tonnes.
68. Under Option 1.4 (12% TAC decrease), the recreational allowance would be decreased to 24 tonnes. This is a 15% decrease from the 2021 rapid assessment update estimate of 28 tonnes.
69. Under Option 1.2 (5% TAC decrease), Option 1.3 (9% TAC decrease) and Option 1.4 (12% TAC decrease) the recreational allowance would be reduced, and it is expected that vulnerable biomass will increase. As recreational catch is likely to increase under these options as stock abundance increases, the NRLMG suggests that consideration needs to be given to initiating a process for reducing the CRA 1 recreational daily limit. This would increase the likelihood that the increase in CRA 1 biomass is able to be achieved while maintaining recreational harvest within the allowance on average.
70. The NRLMG welcomes feedback on whether a change to CRA 1 recreational management controls should be considered. This approach reflects the shared nature of this fishery and that all fishing interests should contribute to any rebuild of the stock.
71. Depending on the Minister's decision on the CRA 1 TAC, a regulatory change process could be commenced in 2022 to reduce the recreational daily limit in CRA 1 with the objective of maintaining recreational harvest within the proposed allowance. Such a step would be subject to further formal consultation on the precise settings, through feedback on this matter would also be welcomed in submissions on the CRA 1 TAC review.

Other mortality

72. No change is proposed to the 41 tonne CRA 1 allowance for other sources of fishing-related mortality (i.e., illegal catch and handling mortality). While noting the incompleteness and uncertainty in the CRA 1 information, it is assumed that current illegal harvest and handling mortality is within the 41 tonne allowance. The NRLMG propose that no change is needed to the other mortality allowance, as the rapid assessment update estimate is within the current allowance.

Total Allowable Commercial Catch

73. Under Option 1.1 (status quo), the CRA 1 TACC would stay at its current level of 110 tonnes. This option would maintain current commercial utilisation opportunities.
74. Under Option 1.2 (5% TAC decrease) the TACC would be reduced to 105 tonnes. The proposed 5 tonne TACC decrease has the potential to result in a loss of annual revenue to the catching sector alone of approximately \$340,000 (based on 2020/21 average port price information of \$68.23 per kg). Reduced availability of ACE and revenue loss may lead to vessels becoming unviable, the extent of which is expected to increase with greater levels of TACC reduction. Downstream impacts to associated businesses and communities are also

anticipated, though these impacts are difficult to estimate. This is true of all options where a decrease to the CRA 1 TACC is proposed.

75. Under Option 1.3 (9% TAC decrease) the TACC would be reduced to 99 tonnes. The proposed 11 tonne TACC decrease has the potential to result in a loss of annual revenue alone to the catching sector of approximately \$750,000 (based on 2020/21 average port price information of \$68.23 per kg).
76. Under Option 1.4 (12% TAC decrease) the TACC would be reduced to 94 tonnes. The proposed 16 tonne TACC decrease has the potential to result in a loss of annual revenue to the catching sector of approximately \$1.09 million (based on 2020/21 average port price information of \$68.23 per kg). Of the four proposed options, this option has the greatest predicted negative financial impact on the commercial sector, and on associated businesses, communities, and employment.

9 Review of the CRA 7 (Otago) rock lobster fishery

9.1 CRA 7 fishery overview

Māori customary fishing

77. Rock lobster (kōura) is a taonga species for tangata whenua. Reporting of customary Māori catch of rock lobster is fully operational in CRA 7 (Otago). In the last five years, an average of approximately 2,000 lobsters per year were reported as harvested from CRA 7.
78. An estimate of 1 tonne was used in the 2021 CRA 7 stock assessment model to represent customary catches in CRA 7.

Recreational fishing

79. The CRA 7 rock lobster fishery supports a relatively small recreational fishery off the Otago coastline.
80. There are no reliable recreational catch survey estimates for CRA 7. In the absence of any reliable information, recreational catch estimates for CRA 7 in the 2021 CRA 7 & 8 stock assessment were assumed to be at 1 tonne in 1945 and were increased to 5 tonnes in 1979. A constant estimate of 5 tonnes was assumed from 1979 to 2020 for CRA 7 recreational catch. In addition, 1.7 tonnes of rock lobster were assumed to be taken in CRA 7 by commercial fishers for non-commercial purposes under section 111 of the Act. There is no reliable National Panel Survey estimate for CRA 7 given the low number of fishers and events covered in the survey and the high variance (0.09 tonnes in 2017/18 (± 0.2 tonnes)).

Other mortality

81. In the 2021 CRA 7 & 8 stock assessment, the Rock Lobster Working Group assumed illegal catch in CRA 7 was 10% of the total commercial catch before 1990, and 2% of the summed commercial catch beginning in 1990, with illegal catch scaled proportionately to CPUE where possible. This acknowledges that illegal take is likely to be influenced by available abundance (Figure 7). For the 2020/21 fishing year, the illegal catch estimate assumed in Region 1 for the model (which includes all of CRA 7 and the Southland part of CRA 8) was approximately 8.4 tonnes. An estimate of handling mortality was generated for the first time of approximately 16.4 tonnes for Region 1 (which includes part of CRA 8).

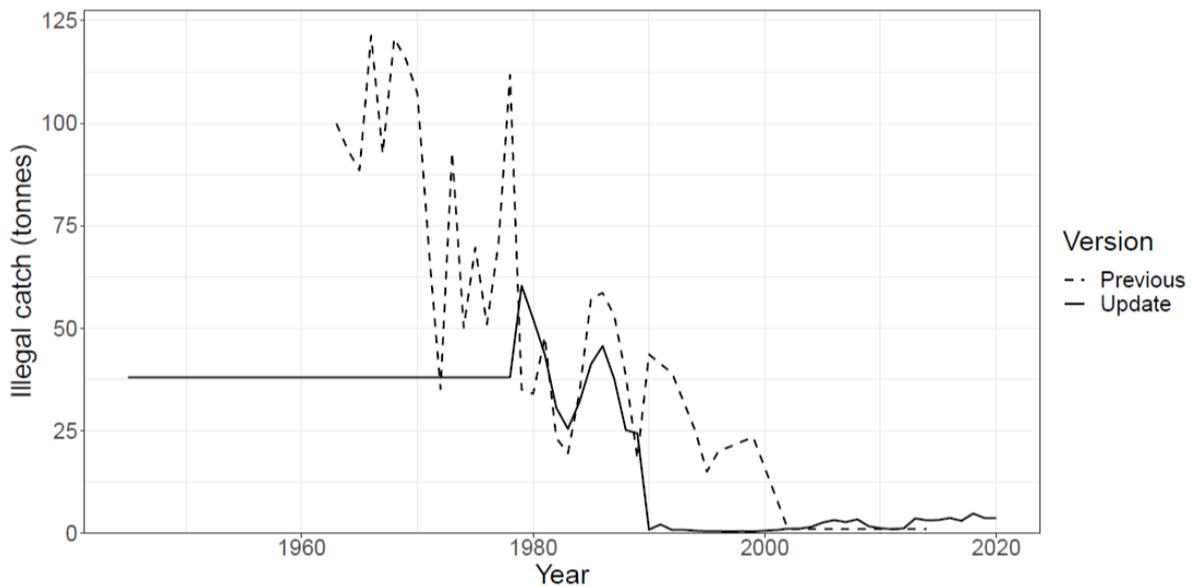


Figure 7: CRA 7 illegal catch trajectory assumed for the 2021 CRA 7 & 8 stock assessment (solid black line), showing the trajectory from the previous stock assessment in 2015 (dashed line).

Commercial fishing

82. Annual landings and the TACC for CRA 7 (Otago) since 1990 are shown in Figure 8. The COVID-19 outbreak, particularly the effective closure of the Chinese export market for a period coupled with low prices for exports, contributed to a slight under-catch of the TACC in 2019/20. Between 1996 and 2019 a formally adopted CRA 7 management procedure was used annually to review the TACC to ensure that catches reflected available abundance.

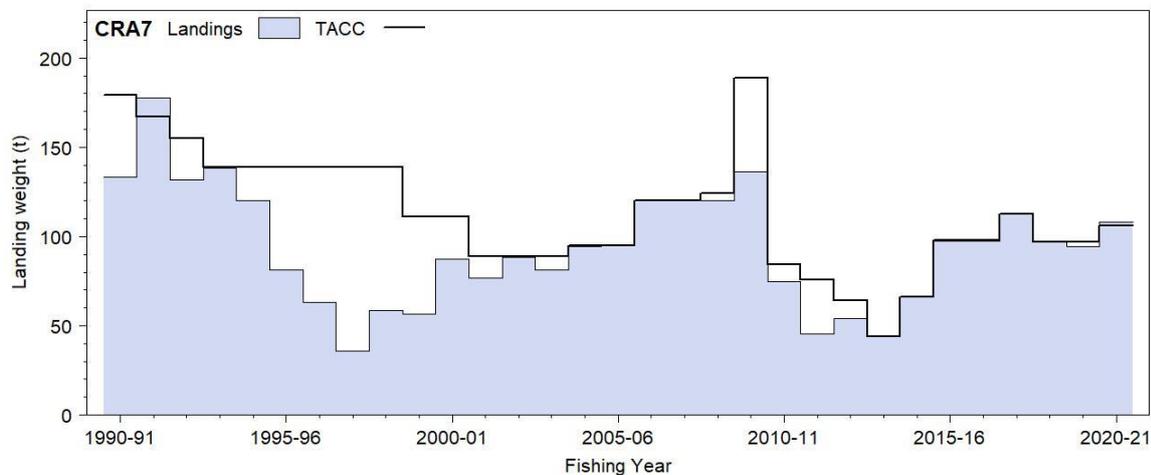


Figure 8: CRA 7 commercial landings and TACCs from 1990 to 2020. The under-catch in 2019/20 due to the COVID-19 outbreak led to approved ACE carry-forward in 2020/21.

83. FNZ estimates the current asset value of CRA 7 quota to be over \$78 million based on the current TACC and the average quota share price for the 2019/20 fishing year (Table 13).¹⁹ The average price of CRA 7 ACE (the earnings quota owners receive when selling their ACE) for the 2020/21 fishing year was \$34,894.16 per tonne (Table 10). For more detail on CRA 7 ACE and quota prices over the last five years, see Table 10 below.

¹⁹ 2019/20 is the most recent fishing year with sufficient quota trades to calculate an average price for CRA 7.

Table 10: Number of transfers and average prices of Annual Catch Entitlement (ACE) and quota for CRA 7.²⁰

April Fishing Year	Annual Catch Entitlement (ACE)		Quota	
	Number of transfers	Average price (per tonne)	Number of transfers	Average price (per tonne)
2016/17	35	\$41,893.10	3	\$619,252.44
2017/18	33	\$36,486.81	3	\$750,062.19
2018/19	46	\$36,883.30	2	
2019/20	43	\$41,088.95	3	\$738,971.98
2020/21	32	\$34,894.16	1	

84. In the 2020/21 fishing year, 12 vessels reported landing at least 1 tonne of rock lobster.

9.2 CRA 7 stock status

85. A new stock assessment was conducted for CRA 7 & 8 in 2021. The stock assessment modelled CRA 7 & 8 as one biological stock with two regions (Figure 9):

- **Region 1 (Otago/Southland):** CRA 7 and statistical areas 922, 923, 924 and 925; and
- **Region 2 (Fiordland):** Statistical areas 926, 927 and 928.

²⁰ Quota and ACE trading prices registered with FishServe may include transactions between related commercial entities and the averages may understate true market/transfer price.

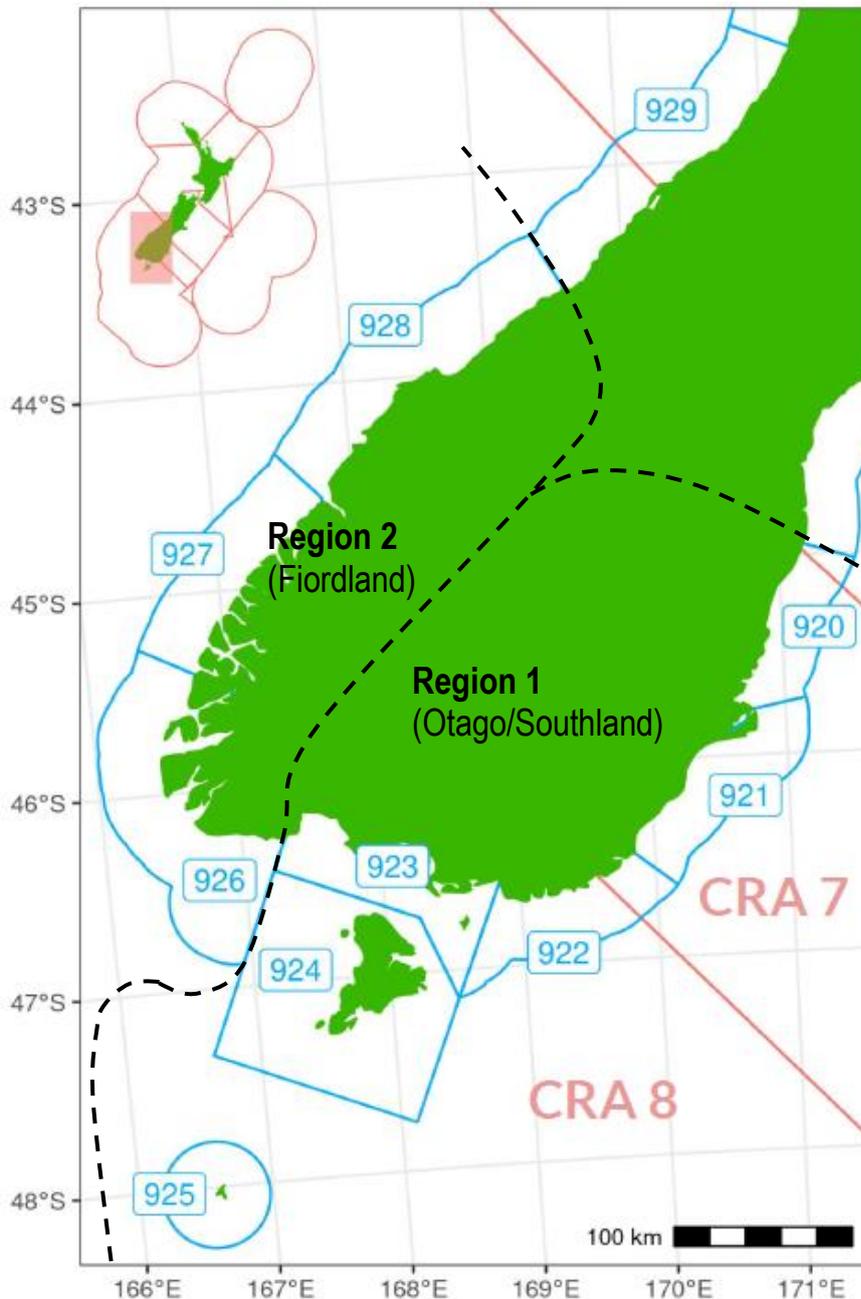


Figure 9: The CRA 7 (Otago) and CRA 8 (Southern) Quota Management Areas and statistical areas, showing approximate boundary of the two regions used in the 2021 CRA 7 & 8 stock assessment model (black dashed lines).

86. The assessment results are summarised in Figures 10 and 11 and Table 8 below. They suggest that, for the combined CRA 7 & 8 fishery, 2021 vulnerable biomass is 21% of the unfished level, and total biomass is 38% of the unfished level. Spawning biomass in 2021 was 48% of the unfished level, well above the soft limit of 20% where it is FNZ policy to implement a formal, time-constrained rebuilding plan.

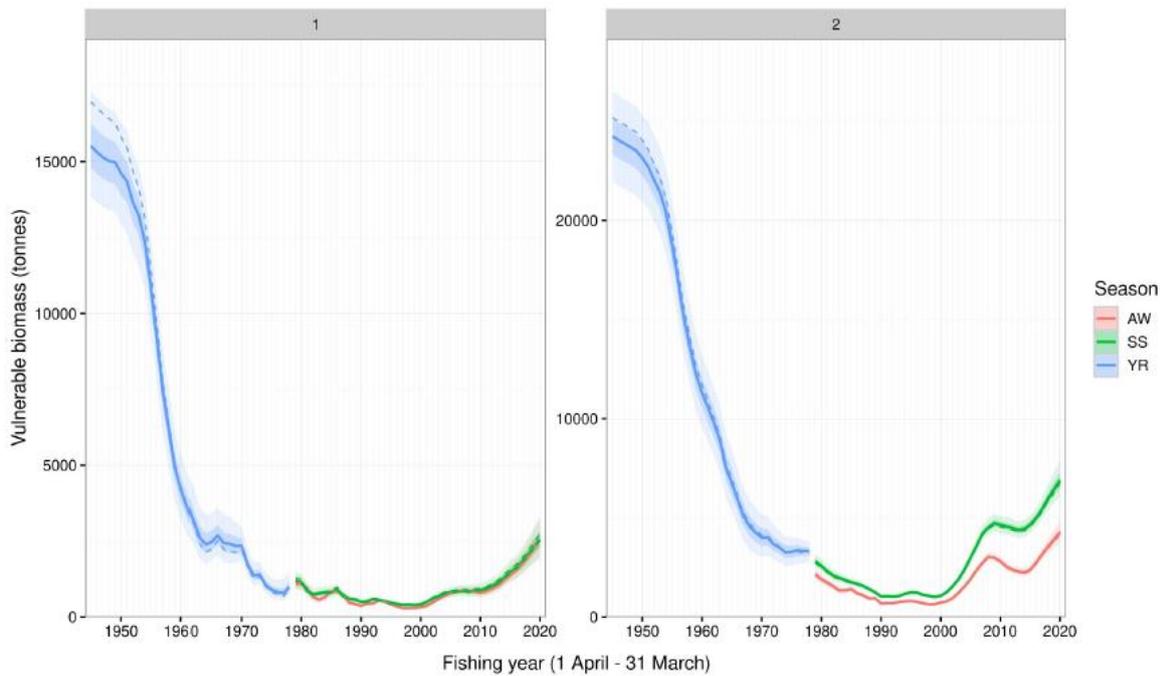


Figure 10: CRA 7 & 8 combined vulnerable biomass trajectory for Region 1 (Otago/Southland) and Region 2 (Fiordland) from the 2021 CRA 7 & 8 stock assessment by season. The solid line indicates the median, the dashed line indicates the MAP (maximum a posteriori) estimate, and variable shading intensity indicates the 50% and 90% credible intervals.

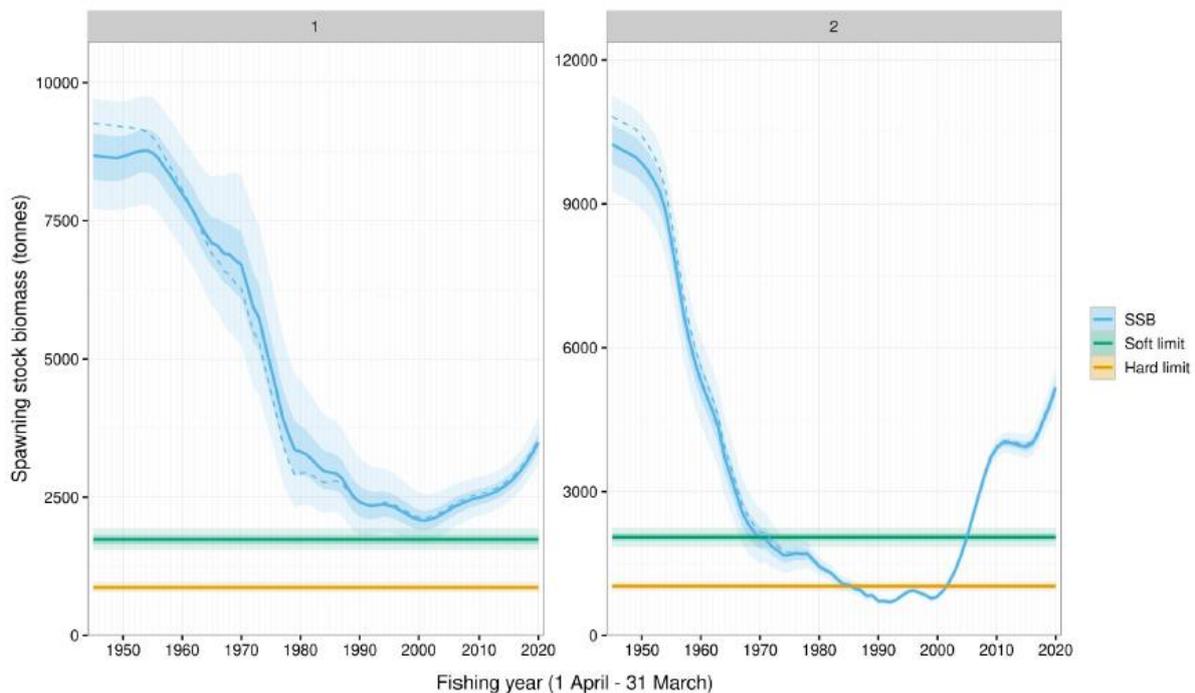


Figure 11: CRA 7 & 8 combined spawning biomass (SSB) trajectory for Region 1 (Otago/Southland) and Region 2 (Fiordland) from the 2021 CRA 7 & 8 stock assessment, including the soft limit (20% SSB_0), and the hard limit (10% SSB_0). The solid line indicates the median, the dashed line indicates the MAP (maximum a posteriori) estimate, and variable shading intensity indicates the 50% and 90% credible intervals.

87. Table 11 provides further results of the 2021 stock assessment in terms of vulnerable, total and spawning stock biomass, with uncertainties in the results also shown.

88. Over the next four years, with 2021 catch levels²¹ and recent recruitment, vulnerable biomass, total biomass, and spawning biomass for the entire CRA 7 & 8 area are all projected to increase in comparison to current levels. Vulnerable biomass is projected to increase to 25% (or 0.25) of unfished levels by 2025 with a range of 19% (or 0.19) and 32% (or 0.32) (5% and 95% quantiles).
89. Total biomass is projected to increase to 42% of unfished levels by 2025, and spawning biomass is projected to increase to 54% of unfished levels by 2025. There is currently about 89% probability that the overall combined CRA 7 & 8 vulnerable biomass will increase by 2025 and a 100% probability that spawning stock biomass will increase.

Table 11: Median results from the 2021 CRA 7 & 8 stock assessment. 5% and 95% quantiles are provided to show the uncertainty of the biomass ratios.

Performance indicators	5% quantile	Median	95% quantile	Interpretation of the <u>median</u> results
Vulnerable biomass (B) – Beginning of season autumn-winter vulnerable biomass (legal males and females not bearing eggs)				
B_{2021} / B_0	0.18	0.21	0.25	Vulnerable biomass in 2021 was 21% of unfished levels
B_{2025} / B_0	0.19	0.25	0.32	Vulnerable biomass in 2025 will be 25% of unfished levels
B_{2025} / B_{2021}	0.96	1.15 ↑	1.37	Vulnerable biomass in 2025 will be 115% of 2021 levels (an increase of 15%)
Total biomass (Btot) – Beginning of season autumn-winter total biomass (all males and females)				
$B_{tot2021} / B_{tot0}$	0.33	0.38	0.43	Total biomass in 2021 was 38% of unfished levels
$B_{tot2025} / B_{tot0}$	0.35	0.42	0.49	Total biomass in 2025 will be 42% of unfished levels
$B_{tot2025} / B_{tot2021}$	1.02	1.10 ↑	1.19	Total biomass in 2025 will be 110% of 2021 levels (an increase of 10%)
Spawning stock biomass (SSB) – Beginning of season autumn-winter spawning biomass (mature females)				
SSB_{2021} / SSB_0	0.44	0.48	0.52	Spawning biomass in 2021 was 48% of unfished levels
SSB_{2025} / SSB_0	0.48	0.54	0.61	Spawning biomass in 2025 will be 54% of unfished levels
SSB_{2025} / SSB_{2021}	1.04	1.12 ↑	1.20	Spawning biomass in 2025 will be 112% of 2021 levels (an increase of 12%)
Probabilities				
$P(B_{2025} > B_{2021})$		0.89		89% probability that 2025 vulnerable biomass will be greater than 2021 levels
$P(B_{tot2025} > B_{tot2021})$		0.97		97% probability that 2025 spawning biomass will be greater than 2021 levels
$P(SSB_{2025} > SSB_{2021})$		1.00		100% probability that 2025 total biomass will be greater than 2021 levels

B_{MSY} reference level

90. The B_{MSY} reference level for the combined CRA 7 & 8 stock was calculated based on the 2021 CRA 7 & 8 stock assessment as a vulnerable biomass level of 4,863 tonnes. The results, given in Figure 12 and Table 12 below, suggest that vulnerable biomass was above the reference level (the green line) in 2021 (1.46 times the B_{MSY} reference level), and is projected to increase

²¹ CRA 7 & 8 commercial catch was assumed to be 1,411.59 tonnes in 2020 (available ACE in 2020 due to ACE carry-forward into the 2020/21 fishing year as a result of COVID-19), and 1,298 tonnes (the combined 2021 CRA 7 & 8 TACCs) from 2021-2025.

further above the B_{MSY} reference level (1.69 times the B_{MSY} reference level) under current catch levels by 2025.

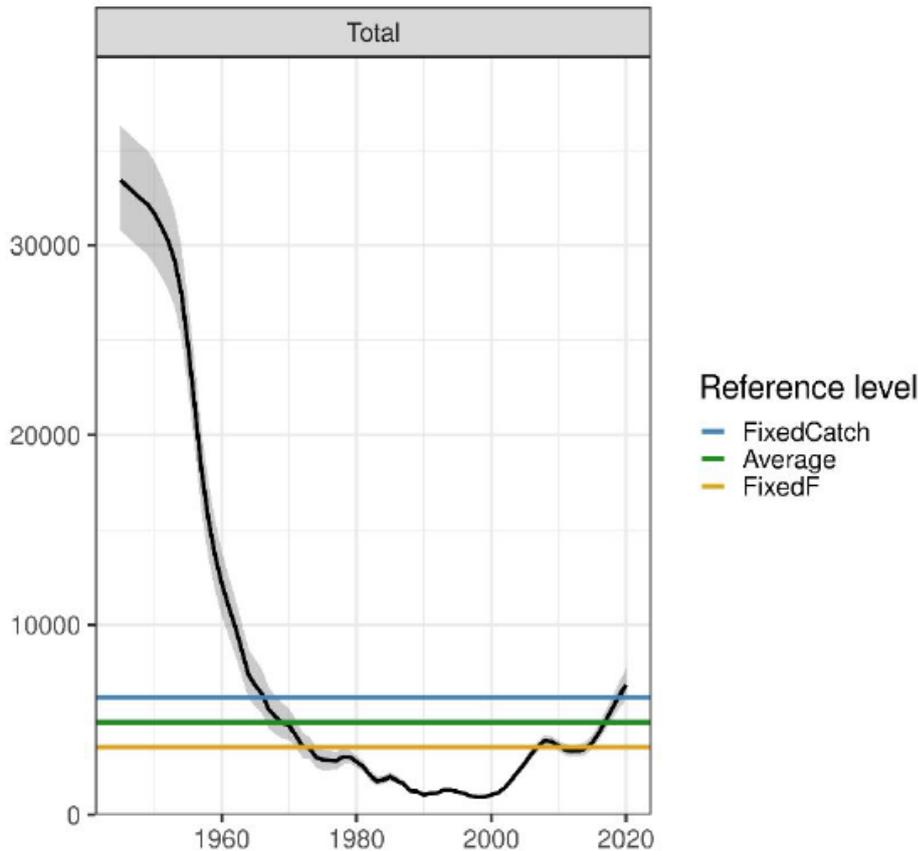


Figure 12: CRA 7 & 8 combined vulnerable biomass from the 2021 stock assessment, showing the B_{MSY} reference level (green line), which is the average of the fixed catch (blue line) and fixed fishing mortality (F) (yellow line) levels that maximise catch while meeting risk constraints.

91. Table 12 provides further results of the 2021 B_{MSY} reference level calculation in terms of vulnerable biomass, with the uncertainties in the results also shown. For example, vulnerable biomass in 2021 was estimated to be at 7,114 tonnes (median result), with a range of 6,178 tonnes and 8,209 tonnes (5% and 95% quantiles).

Table 12: B_{MSY} reference level results for CRA 7 & 8, and estimated vulnerable biomass level in 2025, from the 2021 stock assessment. 5% and 95% quantiles are provided to show the uncertainty of the biomass estimates. (continued over the page)

Vulnerable biomass (tonnes)	5% quantile	Median	95% quantile	Interpretation of the <u>median</u> results
B_R , reference level (tonnes)		4863		The vulnerable biomass that can produce MSY is 4,863 tonnes
B_{2021}	6178	7114	8209	Vulnerable biomass in 2021 was 7,114 tonnes
B_{2021} / B_R	1.27	1.46	1.69	Vulnerable biomass in 2021 was 1.46 times (146%) the reference level
B_{2025}	6355	8203	10 310	Vulnerable biomass in 2025 will be 8,203 tonnes
B_{2025} / B_R	1.31	1.69	2.12	Vulnerable biomass in 2025 will be 1.69 times (169%) the reference level

92. A rapid assessment update will be conducted for CRA 7 and CRA 8 in 2022 and will provide an opportunity to consider a review of the catch settings and management controls for April 2023.

9.3 Proposed CRA 7 options

93. Table 13 provides a summary of options proposed for CRA 7 (Otago). The results from the new CRA 7 & 8 stock assessment have been used to guide the options for varying the TAC. There is no agreed target biomass for CRA 7.

Table 13: Proposed TAC, allowance and TACC options (in tonnes) for CRA 7 and CRA 8 from 1 April 2022.

Stock	Option	TAC	TACC	Allowances		
				Customary Māori	Recreational	Other mortality
CRA 7 Otago	Option 7.1: Status quo	126.2	106.2			5
	Option 7.2: Increase the TAC by 16%	146.5 ↑ (16%)	111.5 ↑ (5%)	10	5	20 ↑ (15 t)

Varying the TAC

94. The best available information suggests the combined CRA 7 & 8 stock biomass is well above the B_{MSY} reference level and projected to increase over the next four years under current catches.
95. Under Option 7.1 (status quo), the CRA 7 TAC would stay at its current level of 126.2 tonnes from 1 April 2022. Compared with Option 7.2 (16% TAC increase), this option could result in increased abundance in the CRA 7 fishery in the short-term, increased non-commercial catches and catch rates, and higher CPUE for commercial fishers, which may result in reduced harvesting costs. It may also allow rock lobster to inhabit a greater role in the ecosystem. However, this option does not reflect the updated estimate of handling mortality and forgoes the opportunity for increased utilisation given the stock is well above the B_{MSY} reference level and projected to continue to increase.
96. Under Option 7.2 (16% TAC increase), the CRA 7 TAC would be increased to 146.5 tonnes. Vulnerable biomass and spawning stock biomass are projected to continue to increase with this catch level over the next four years, and the stock would remain more than 150% of the B_{MSY} reference level. This option would enable the level of the stock, which is above that which can produce MSY, to be altered in a way and at a rate that will result in the stock moving towards or above a level that can produce MSY, having regard to the interdependence of stocks. This has the effect of enabling increased utilisation.

Varying allowances and the TACC

97. Table 14 provides a summary of information on current non-commercial allowances for CRA 7 (Otago) and stock assessment assumptions of non-commercial catch.

Table 14: Current CRA 7 allowances and model assumptions of non-commercial catches (in tonnes).

CRA 7 (Otago)	Customary Māori	Recreational	Other mortality	Total
Current allowances	10	5	5	20
Non-commercial catch assumptions for the 2021 stock assessment (note: Region 1, which includes CRA 7 and part of CRA 8)	1	Assumed to vary with biomass. Estimated at 6.7 for 2020.	23 (8 illegal + 15 handling ²²)	26.7

²² The handling mortality estimate for CRA 7 & 8 combined from the 2021 CRA 7 & 8 stock assessment is 98 tonnes. When this estimate is divided by the current percentage split of other mortality allowance between these two stocks, this results in CRA 7 (15% of the combined other mortality allowance) having an estimated 15 tonnes of handling mortality.

Māori customary fishing

98. No change is proposed to the 10 tonne customary Māori allowance. Current harvest is considered to be conservative and is well within the allocation for this interest at this time. Ngāi Tahu Tangata Tiaki consider that their customary allowance is not able to be fished due to low abundance in nearshore waters.

Recreational fishing

99. No change is proposed to the 5 tonne recreational allowance for CRA 7. The 2021 CRA 7 & 8 stock assessment model estimate of recreational catch is 6.7 tonnes for Region 1, which includes CRA 7 and part of CRA 8, but there is considerable uncertainty in the current estimate of recreational take, and it is likely that, on average, the current 5 tonne allowance adequately allows for recreational take in CRA 7.

Other mortality

100. A 15 tonne increase is proposed to the 5 tonne CRA 8 allowance for other sources of fishing-related mortality, based on the new illegal take estimate and estimate of handling-related mortality from the 2021 CRA 7 & 8 stock assessment.

Total Allowable Commercial Catch

101. Under Option 7.1 (status quo), the CRA 7 TACC would stay at its current level of 106.2 tonnes. This option maintains the current level of commercial utilisation.
102. Under Option 7.2 (16% TAC increase) the TACC would be increased by 5.3 tonnes to 111.5 tonnes. If the TACC is increased under this option, it would allow the commercial sector to realise some increase in the utilisation benefits. This is unlikely to affect current utilisation benefits for non-commercial fishers.
103. The proposed 5.3 tonne TACC increase under Option 7.2 (16% TAC increase) has the potential to result in an increase of annual revenue to the catching sector alone of approximately \$361,600 (based on 2020/21 average port price information of \$68.23 per kg). Downstream benefits to associated businesses and communities are also anticipated, though these benefits are more difficult to measure.

10 Review of the CRA 8 (Southern) rock lobster fishery

10.1 CRA 8 fishery overview

Māori customary fishing

104. Rock lobster (kōura) is a taonga species for tangata whenua. Reporting of customary Māori catch of rock lobster is fully operational in CRA 8 (Southern). In the last five years, an annual average of approximately 19,200 rock lobsters, plus 680 kg, were reported as harvested from CRA 8.
105. An estimate of 6 tonnes was used in the 2021 CRA 8 stock assessment model to represent customary catches from 1963 to 2012, which was then increased proportionately to 15 tonnes in 2014. An estimate of 15 tonnes was used each year from 2014 to 2020.

Recreational fishing

106. The CRA 8 fishery has a number of areas closed to commercial fishing, which provide non-commercial fishers with exclusive access to rock lobsters. In Fiordland, the inner fiords are closed to commercial rock lobster fishing. These closures were established in 2005 by the Fiordland Marine Guardians.

107. The Fiordland Marine Guardians have expressed concerns about increased recreational fishing effort in Fiordland, particularly from amateur charter-fishing vessels (ACVs). They are proposing changes to the rules for recreational fishing to reduce the level of catch. The Fiordland Marine Guardians consider that the current recreational fishing rules for Fiordland are no longer fit for purpose due to an increasing number of recreational fishers. Central to this advice is the Guardians' concept of "Fish for a Feed (and not to fill the freezer)". Fisheries New Zealand will continue to engage with the Fiordland Marine Guardians in the coming months to progress this proposal.
108. Overall, little is known about recreational catch in CRA 8. In the 2021 CRA 7 & 8 stock assessment, a recreational catch trajectory was constructed for CRA 8 as follows: beginning at 1 tonne in 1945, recreational catch was increased to 5 tonnes in 1979, and then from 1979 to 2020 recreational catch was assumed to be a constant 20 tonnes. In addition, 18.8 tonnes of rock lobster were assumed to be taken each year in CRA 8 by commercial fishers for non-commercial purposes under section 111 of the Act. The 2017/18 National Panel Survey estimate of CRA 8 recreational catch was 16.17 tonnes (± 11.4 tonnes) but came from a relatively low number of fishers in the survey.

Other mortality

109. In the 2021 CRA 7 & 8 stock assessment, the Rock Lobster Working Group assumed illegal catch in CRA 8 was 10% of the total commercial catch before 1990, and 2% of the summed commercial catch beginning in 1990, with illegal catch scaled proportionately to CPUE where possible. This acknowledges that illegal take is likely to be influenced by available abundance (Figure 13). For the 2020/21 fishing year, while uncertain, the illegal catch estimate assumed in Region 2 (the Fiordland part of CRA 8) for the model was approximately 38.8 tonnes. An estimate of handling mortality was generated for the first time of approximately 16.4 tonnes for Region 1 (which includes part of CRA 7) and approximately 81.4 tonnes for Region 2 (the Fiordland area of CRA 8).

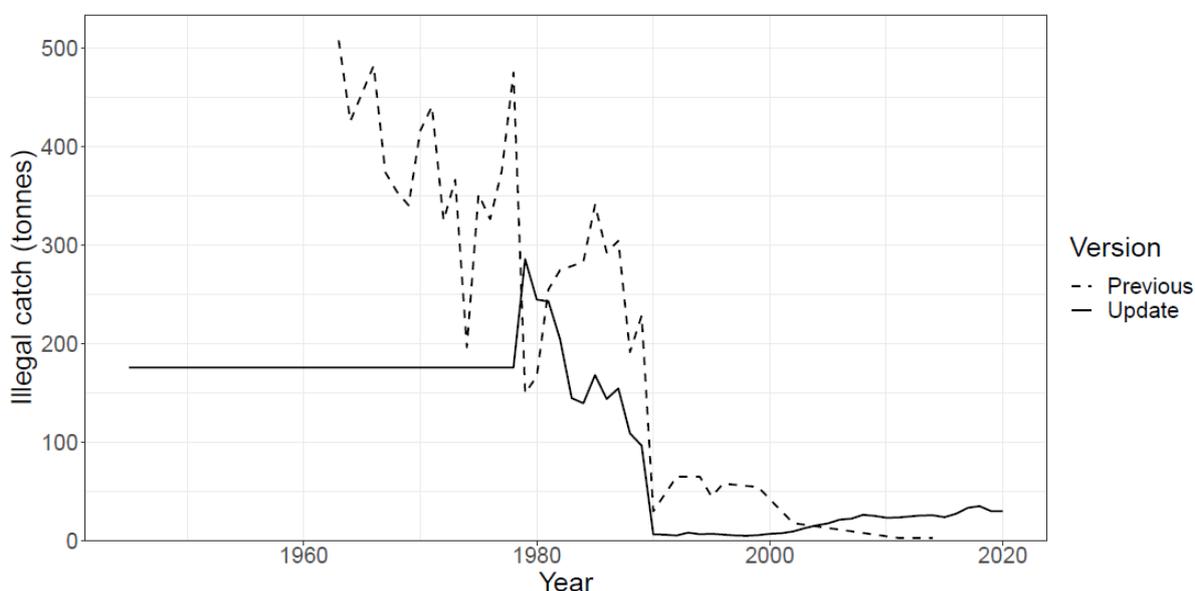


Figure 13: CRA 8 illegal catch trajectory assumed for the 2021 CRA 7 & 8 stock assessment (solid black line), showing the trajectory from the previous stock assessment in 2015 (dashed line).

Commercial fishing

110. CRA 8 is the largest commercial rock lobster fishery in New Zealand. Annual landings and the TACC for CRA 8 since 1990 are shown in Figure 14. The COVID-19 outbreak, particularly the effective closure of the Chinese export market for a period coupled with low prices for exports, contributed to an under-catch of the TACC in 2019/20. Carry-forward provided for a catch greater than the TACC in 2020/21. Between 1996 and 2019 a formally adopted CRA 8

management procedure was used to annually review the TACC to ensure that catches reflected available abundance.

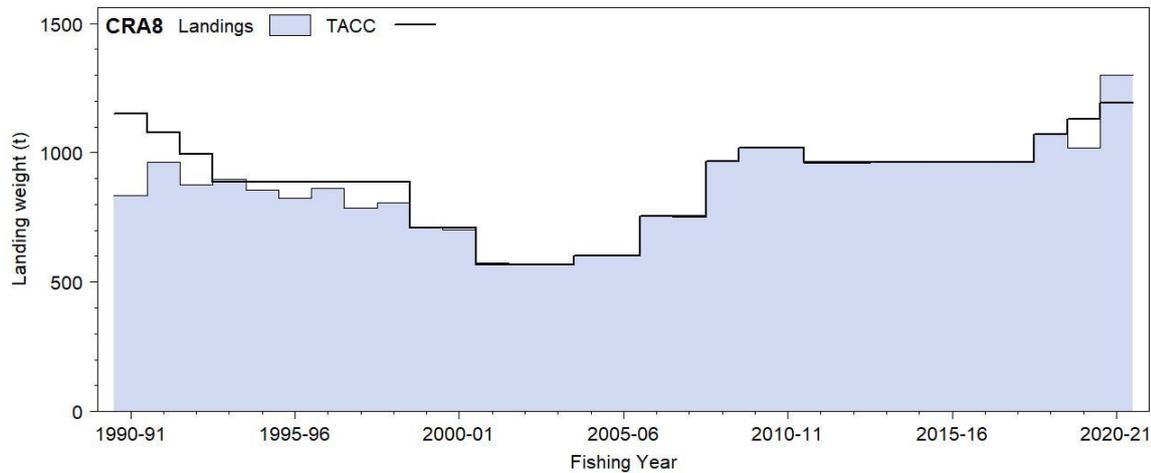


Figure 14: CRA 8 commercial landings and TACCs from 1990 to 2020. The under-catch in 2019/20 due to the COVID-19 outbreak led to approved ACE carry-forward in 2020/21.

111. FNZ estimates the current asset value of CRA 8 quota to be approximately \$1.8 billion based on the current TACC and the average quota share price for the 2019/20 fishing year (Table 18). The average price of CRA 8 ACE (the earnings quota owners receive when selling their ACE) for the 2020/21 fishing year was \$44,439.21 per tonne (Table 15). For more detail on CRA 8 ACE and quota prices over the last five years, see Table 15 below.

112. In the 2020/21 fishing year, 67 vessels reported landing at least 1 tonne of rock lobster.

Table 15: Number of transfers and average prices of Annual Catch Entitlement (ACE) and quota for CRA 8.²³

April Fishing Year	Annual Catch Entitlement (ACE)		Quota	
	Number of transfers	Average price (per tonne)	Number of transfers	Average price (per tonne)
2016/17	251	\$58,549.58	28	\$1,275,969.46
2017/18	264	\$47,217.25	19	\$1,279,989.39
2018/19	306	\$51,037.82	24	\$1,525,323.52
2019/20	293	\$56,647.37	11	\$1,441,139.60
2020/21	226	\$44,439.21	14	\$1,487,508.51

10.2 CRA 8 stock status

113. The new quantitative stock assessment conducted in 2021 combined CRA 7 & 8 to reflect that they behave as one biological stock. See 9.2 – CRA 7 stock status above for a summary of the combined CRA 7 & 8 stock status and B_{MSY} reference level.

114. A rapid assessment update will be conducted for CRA 7 and CRA 8 in 2022 and will provide an opportunity to consider a review of the catch settings and management controls for April 2023.

²³ Quota and ACE trading prices registered with FishServe may include transactions between related commercial entities and the averages may understate true market/transfer price.

10.3 Proposed CRA 8 options

115. Table 16 provides a summary of options proposed for CRA 8 (Southern). The results from the new CRA 7 & 8 stock assessment, being the best available information, have been used to guide the options for varying the TAC. There is no agreed target biomass for CRA 8.

Table 16: Proposed TAC, allowance and TACC options (in tonnes) for CRA 7 and CRA 8 from 1 April 2022.

Stock	Option	TAC	TACC	Allowances		
				Customary Māori	Recreational	Other mortality
CRA 8 Southern	Option 8.1: Status quo	1282.7	1191.7			28
	Option 8.2: Increase the TAC by 9%	1395.5 ↑ (9%)	1215.5 ↑ (2%)	30	33	117 ↑ (89 t)
	Option 8.3: Increase the TAC by 11%	1431 ↑ (11%)	1251 ↑ (5%)			

Varying the TAC

116. The best available information suggests the combined CRA 7 & 8 stock biomass is well above the B_{MSY} reference level and projected to increase over the next four years under current catches.
117. Under Option 8.1 (status quo), the CRA 8 TAC would stay at its current level of 1282.7 tonnes from 1 April 2022. This option could result in increased abundance in the CRA 8 fishery in the short-term, increased non-commercial catches and catch rates compared with Option 8.2 (9% TAC increase) and Option 8.3 (11% TAC increase), and higher CPUE for commercial fishers, which may result in reduced harvesting costs. It may also allow rock lobster to inhabit a greater role in the ecosystem. However, this option does not reflect the updated estimate of handling mortality, and forgoes the opportunity for increased utilisation given the stock is well above the B_{MSY} reference level.
118. Under Option 8.2 (9% TAC increase) and Option 8.3 (11% TAC increase), vulnerable biomass and spawning stock biomass are projected to continue to increase over the next four years, and the stock would likely remain at more than 150% of the B_{MSY} reference level. Option 8.3 (11% TAC increase) provides for a comparatively greater utilisation opportunity, noting that the stock is well above the B_{MSY} reference level and expected to stay there. Option 8.2 (9% TAC decrease) reflects a more cautious approach and is expected to ensure that the stock is maintained at a higher level of biomass than Option 8.3 (11% TAC decrease), though it forgoes some of the utilisation opportunity of the larger TAC increase proposed for Option 3.

Varying allowances and the TACC

119. Table 17 provides a summary of information on current non-commercial allowances for CRA 8 (Southern) and stock assessment assumptions of non-commercial catch.

Table 17: Current CRA 8 allowances and model assumptions of non-commercial catches (in tonnes).

CRA 8 (Southern)	Customary Māori	Recreational	Other mortality	Total
Current allowances	30	33	28	91
Non-commercial catch assumptions for the 2021 stock assessment (note: Region 2, which is only part of CRA 8)	15	38.8	117 (34 illegal + 83 handling ²⁴)	176

Māori customary fishing

120. No change is proposed to the 30 tonne customary Māori allowance. Current harvest is considered to be conservative and is well within the allocation for this interest at this time. Ngāi Tahu Tangata Tiaki consider that their customary allowance is not able to be fished due to low abundance in nearshore waters.

Recreational fishing

121. No change is proposed to the 33 tonne recreational allowance for CRA 8. The Rock Lobster Working Group assumed recreational harvest of 38.8 tonnes in recent years for use in the 2021 CRA 7 & 8 stock assessment model. There is no new information at this time to change the current 33 tonne allowance for recreational take in CRA 8; noting the uncertainty in the information, it is believed that recreational take on average is within the current allowance.

Other mortality

122. An 89 tonne increase is proposed to the 28 tonne CRA 8 allowance for other sources of fishing-related mortality, based on the new illegal take estimate and estimate of handling-related mortality from the 2021 CRA 7 & 8 stock assessment.

Total Allowable Commercial Catch

123. Under Option 8.1 (status quo), the CRA 8 TACC would stay at its current level of 1191.7 tonnes. This option maintains the current level of commercial utilisation.

124. Under Option 8.2 (9% TAC increase) the TACC would be increased by 23.8 tonnes to 1215.5 tonnes. If the TACC is increased under this option, it would allow the commercial sector to realise some increase in the utilisation benefits. This is unlikely to affect current utilisation benefits for non-commercial fishers.

125. The proposed 23.8 tonne TACC increase under Option 8.3 (9% TAC increase) has the potential to result in an increase of annual revenue to the catching sector alone of approximately \$1.62 million (based on 2020/21 average port price information of \$68.23 per kg). Downstream benefits to associated businesses and communities are also anticipated, though these benefits are more difficult to measure.

126. Under Option 8.3 (11% TAC increase) the TACC would be increased by 59.3 tonnes to 1251 tonnes. If the TACC is increased under this option, it would allow the commercial sector to realise a larger increase in the utilisation benefits than Option 8.2 (9% TAC increase). This is unlikely to affect current utilisation benefits for non-commercial fishers.

127. The proposed 59.3 tonne TACC increase under Option 8.3 (11% TAC increase) has the potential to result in an increase of annual revenue to the catching sector alone of approximately \$4.05 million (based on 2020/21 average port price information of \$68.23 per

²⁴ The handling mortality estimate for CRA 7 & 8 combined from the 2021 CRA 7 & 8 stock assessment is 98 tonnes. When this estimate is divided by the current percentage split of other mortality allowance between these two stocks, this results in CRA 8 (85% of the combined other mortality allowance) having an estimated 83 tonnes of handling mortality.

kg). Downstream benefits to associated businesses and communities are also anticipated, though these benefits are more difficult to measure.

11 Other relevant matters

128. There are several relevant factors that are required to be considered before setting or varying a sustainability measure, such as the TAC. See the separate document *Overview of legislative requirements and other considerations in relation to sustainability measures* at <https://www.mpi.govt.nz/dmsdocument/45235-Fisheries-New-Zealand-review-of-sustainability-measures-Overview-of-legislative-requirements-and-other-considerations-in-relation-to-sustainability-measures> for more information. Where not otherwise addressed throughout this document, matters of relevance for CRA 1, 7 and 8 are discussed in the sections below.

The effects of fishing on any stock and the aquatic environment

129. Potting is the method commercial fishers use to target rock lobsters. This method is considered to have little direct effect on non-target species and benthic species. Nationally, the most frequently reported incidental species caught via commercial rock lobster potting, in decreasing order of catch across all stocks are: octopus, conger eel, blue cod, trumpeter, sea perch, red cod, butterfish and leatherjackets. This is based on an analysis of estimated incidental catches for the period 1989 to 2003.
130. Of these species, six are in the QMS: blue cod, trumpeter, sea perch, red cod, butterfish, and leatherjacket. Of the stocks that overlap with the CRA 1, 7 & 8 Quota Management Areas, their status is generally estimated to be at or above the management level or soft and/or hard limits (blue cod²⁵ and Southern red cod and leatherjacket) or unknown (trumpeter, sea perch, butterfish, and Northland red cod and leatherjacket). Little is known about the status of the non-QMS species.

Existing controls that apply to CRA 1, 7 and 8

131. A range of management controls apply to the stocks discussed in this paper including minimum legal sizes, daily limits for recreational fishers, method restrictions, and required release of soft-shelled animals and egg-bearing females.
132. In CRA 7 and CRA 8, differential minimum legal sizes apply for commercial fishers. In CRA 7, commercial fishers can take male and female rock lobsters at or above 127 mm tail length from 1 June to 19 November. In CRA 8, commercial fishers can take female rock lobsters at or above 57 mm tail width at any time of year.

The natural variability of rock lobster stocks

133. A variety of environmental factors are thought to influence the productivity of rock lobster populations, including water temperature, ocean currents, shelter availability, and food availability. Lobsters grow at different rates around New Zealand and female lobsters mature at different sizes.
134. Rock lobster recruitment is highly variable and this was taken into account during the stock assessments used to inform development of options discussed in this paper. Rock lobsters have a long larval life, swimming and drifting in the ocean for 8-24 months. This means that larvae hatched in one area may be retained in that area by local eddy systems, carried to other areas by currents, or lost to New Zealand entirely. For most areas, larvae may originate a considerable distance from the settlement site. The number of 'puerulus', the final phase that

²⁵ Blue cod is managed using the National Blue Cod strategy. BCO 1 (Auckland (East)), which overlaps with CRA 1, is about as likely as not to be at or above the management target and very likely to be above both the soft and hard limits. The status of BCO 3 (South East (Coast)), which overlaps with CRA 7, is unknown relative to the management target and overfishing threshold, but is likely to be above the soft limit and very likely to be above the hard limit. BCO 5 (Southland), which overlaps with CRA 8, is very likely to be above the soft limit but is unlikely to be at or above the management target, and overfishing is likely to be occurring. In 2020 the TAC and TACC were reduced for BCO 5 and recreational catch limits were reduced.

moults into a juvenile rock lobster, that settle to the sea floor varies among areas and from year to year.

135. Puerulus settlement may be affected by environmental factors such as the amount of suitable habitat available, the persistence of storms, prevailing ocean currents, sea temperature, food availability, and predation. Large numbers of puerulus larvae also die before reaching suitable habitat, which is due in part to predation, but may also be a result of unfavourable environmental conditions.
136. Information on variability in growth, maturity, available abundance, mortality and recruitment is incorporated into the stock assessments that inform rock lobster management.

Interdependence of stocks

137. Regard to the interdependence of stocks is required when setting a TAC for any stock. In New Zealand, rock lobster fisheries extend from the Three Kings Islands in the north to the Auckland Islands in the south, and east to the Chatham Islands. The long larval phase and long-distance movements of adults in some areas suggest a single rock lobster stock around the mainland.
138. The interdependence of stocks also involves the consideration of the effects of fishing on associated stocks affected by fishing for the target stock (as discussed above).
139. In terms of trophic relationships, rock lobsters feed on a wide range of small shellfish, crabs, sea stars and kina, depending on local availability. Predation on rock lobsters is known from octopus, blue cod, groper, southern dogfish, rig, and seals.
140. There is evidence from northern New Zealand that decreased predation from large reef predators such as rock lobsters, snapper and other fishes is responsible for population increases in sea urchins and destruction of kelp forests, creating kina barrens (e.g., Babcock et al 1999, Shears & Babcock 2003). However, kina barrens do not occur along large areas of the coastline of New Zealand, and in these areas other factors, including bottom-up forces, environmental and climatic influences, species' demographics, and catchment-derived sedimentation are key drivers for kelp communities (Schiel 2013).
141. The main evidence for decreased predation leading to increased kina abundance and barrens comes from Northern areas, from trends over time from some areas closed to fishing (Shears & Babcock 2003), and also comparisons between protected areas and nearby unprotected areas (Shears et al 2008, Salomon et al 2008). However, there is limited data from other protected areas to assess the support for or against the hypothesis in other parts of New Zealand. On northern New Zealand reefs, the strength of trophic cascade effects varies with environmental context, e.g. depth and wave exposure (Shears et al 2008, Salomon et al 2008, 2010).
142. Barrens are common in northern New Zealand and less common, but not absent, in more southern areas (Barker 2013). In parts of the South Island kina barrens are extensive covering >60% of shallow reefs (Shears & Babcock, 2004). In areas such as the Bay of Islands where barrens are common, their distribution varies in relation to environmental factors (Grace & Kerr 2005a, b; Froude 2016). While urchin barrens can be patchy and vary over time, a number of studies from northern New Zealand have demonstrated consistent and large-scale patterns in the extend and depth distribution of urchin barrens across environmental gradients (Choat & Schiel, 1982; Shears & Babcock, 2004; Cole, 1993; Grace, 1983).

Habitats of particular significance for fisheries management

143. That habitats of particular significance for fisheries management (HPSFM) should be protected is an environmental principle under the Act. Recent attention has been given to this part of the Act through the Prime Minister's Chief Science Advisor's report titled *The Future of Commercial Fishing in Aotearoa New Zealand (March 2021)*.²⁶ As an initial response to this report, FNZ has introduced more detail as to what is known about HPSFM in advice relating to the review of sustainability measures.

²⁶ Accessible at: <https://www.pmcasa.ac.nz/topics/fish/>

144. Table 18 provides a summary of HPSFM for rock lobster.

Table 18: Summary of information on habitats of particular significance for fisheries management for New Zealand rock lobster.

Fish Stock	Rock Lobster
Habitat	<p><u>Juveniles:</u></p> <ul style="list-style-type: none"> • Rock lobsters have high fecundity and an extensive pelagic larval stage of up to two years, which results in larval dispersal over wide areas by ocean currents. • During this pelagic phase, larvae are dispersed in the open ocean and carried by currents. The open ocean environment is important during this stage of rock lobster development. • After the pelagic larval phase, larvae metamorphose into the post larval puerulus stage and settle on coastal shelf rocky reefs. Puerulus and juvenile rock lobsters preferentially inhabit holes and crevices in hard substrates where light levels are low. <p><u>Adults:</u></p> <ul style="list-style-type: none"> • Adult rock lobsters are found in reef habitats up to depths of 200 m, where they inhabit crevices, caves, and rocky overhangs. • Migrations related to moulting, reproduction and feeding are known to take place, resulting in seasonal changes in the depth distribution, sex ratios, size frequency and density. • Rock lobsters are predators that forage on benthic invertebrates such as pāua, ophiuroids and sea urchins. The presence of macroalgae on reef habitats increases structural complexity and provides habitat and food for prey species, thus benefitting rock lobsters. • Rock lobsters are also known to forage for bivalves on sand flats surrounding reefs, usually nocturnally.
Attributes of habitat	<ul style="list-style-type: none"> • Complex rocky habitats provide critical habitats for rock lobsters, including: <ul style="list-style-type: none"> - Settlement substrata for juveniles - Shelter and refuge from predation - Feeding opportunities
Reasons for particular significance	<ul style="list-style-type: none"> • Successful reproduction, development of juvenile stages, and growth to mature adult sizes is critical to supporting the productivity of rock lobster stocks.
Risks/Threats	<ul style="list-style-type: none"> • Land-based practices can impact coastal reef habitats, including through sedimentation and eutrophication. • In the long-term oceanographic circulation patterns (currents, gyres, eddies) could be impacted by climate change, and changes in seawater temperature and predation may affect survival and settlement of rock lobster larvae. • Seawater change is known to affect larval energy, swimming, and presumed survival in packhorse rock lobster.²⁷ • Settlement processes for rock lobster are complex, involving larval behaviour, biological and environmental factors, and oceanographic processes.²⁸ There is evidence from New Zealand and Australia that environmental conditions can lead to different settlement strengths in different areas of a stock, which means that there may be some stock-level resilience to climate change.²⁹

²⁷ García-Echauri, L., Liggins, G., Cetina-Heredia, P., Roughan, M., Coleman, M. A. & Jeffs, A. 2020. Future ocean temperature impacting the survival prospects of post-larval spiny lobsters. *Marine Environment Research*, 156, 104918.

²⁸ Hinojosa, I. A., Gardner, C., Green, B. S., Jeffs, A., Leon, R. & Linnane, A. 2016. Differing environmental drivers of settlement across the range of southern rock lobster (*Jasus edwardsii*) suggest resilience of the fishery to climate change. *Fisheries Oceanography*, 26 (1): 49-64.

²⁹ See previous footnote.

145. As noted in Table 18 above, the open ocean is important for the survival of rock lobster larvae, and structurally complex rocky reefs are important for the settlement and survival of juvenile and adult rock lobster. These habitats are common throughout New Zealand, and are included in a range of spatial protection measures throughout NZ. Whether these protected areas are HSPFM for particular life cycle stages of rock lobster is unknown.
146. Urchin barrens, other grazing on kelp (e.g., butterflyfish³⁰), and other impacts on marine plants such as sedimentation and eutrophication, could potentially negatively impact the suitability of rocky reef habitat for juvenile and adult rock lobster as a refuge, as well as the availability of prey species.
147. Further work to explore particular areas of significance for rock lobster will be considered. Further work to address adverse impacts on these areas may then be considered in a separate process using the appropriate tools under the Act and relevant Regulations.

Relevant plans, strategies and statements

Regional Plans

148. There are three Regional Councils that have coastline within CRA 1, 7 & 8 boundaries respectively. Each of these regional councils have multiple plans to manage the coastal and freshwater environments, including terrestrial and coastal linkages, ecosystems and habitats.
149. The NRLMG considers that the proposed management options presented are in keeping with the objectives of relevant regional plans, which generally relate to the maintenance of healthy and sustainable ecosystems to provide for the needs of current and future generations.

Conservation Management Strategies

150. The three Regional Councils that have coastline within CRA 1, 7 & 8 boundaries have Conservation Management Strategies in place. Conservation Management Strategies are required under the Conservation Act 1987 and are recognised under the Resource Management Act 1991. They guide what the Department of Conservation intends to do, how it will set priorities about what has to be done and how it can respond to requests to use the natural and historic resources it manages. The strategies include objectives, outcome statements and policies. While of general relevance, there is nothing in them specific to the fishstocks being reviewed.

Te Mana o te Taiao (Aotearoa New Zealand Biodiversity Strategy)

151. Te Mana o te Taiao – the Aotearoa New Zealand Biodiversity Strategy sets a strategic direction for the protection, restoration and sustainable use of biodiversity, particularly indigenous biodiversity, in Aotearoa New Zealand. The Strategy sets a number of objectives across three timeframes. The most relevant to setting sustainability measures for CRA 1, 7 & 8 are objectives 10 and 12:
- Objective 10: Ecosystems and species are protected, restored, resilient and connected from mountain tops to ocean depths.
 - Objective 12: Natural resources are managed sustainably.
152. The Ministry for Primary Industries (MPI) is undertaking work to define specific terms used in the Strategy (e.g., 'environmental limits') but is required by the Fisheries Act to manage fisheries to provide for utilisation of fisheries resources while ensuring sustainability. Ensuring sustainability includes avoiding, remedying or mitigating any adverse effects of fishing on the aquatic environment.

³⁰ Taylor, D.I., Schiel, D.R. (2010). Algal populations controlled by fish herbivory across a wave exposure gradient on southern temperate shores. *Ecology*, 91, 201-211. <https://doi.org/10.1890/08-1512.1>

11.1 Deemed values

153. Deemed values are charges commercial fishers must pay for every kilogram of stocks landed in excess of their Annual Catch Entitlement (ACE) holdings. The purpose of the deemed value framework is to encourage commercial fishers to balance their catch with ACE. The current deemed value rates for rock lobster stocks are presented in Table 19 below.

Table 19: Standard deemed value rates (\$/kg) for all rock lobster stocks.

Interim	Annual 100-120%	Differential rates (\$/kg) for excess catch (% of ACE)				
		120-140%	140-160%	160-180%	180-200%	>200%
99.00	110.00	132.00	154.00	176.00	198.00	220.00

154. FNZ notes that the interim deemed value rate is 90% of the annual deemed value rate for all rock lobster stocks, which is consistent with the Deemed Value Guidelines. The Deemed Value Guidelines set out the operational policy FNZ uses to inform the development of advice to the Minister on the setting of deemed values. The deemed values for CRA 1, 7 and 8 are set at the same rate and FNZ has found them to be operating in accordance with the Guideline. Therefore, there are no changes proposed to the deemed value rates of the rock lobster stocks under review for 1 April 2022.

12 Further Information

Rapid updates for New Zealand rock lobster (*Jasus edwardsii*) stocks in 2020:

<https://www.mpi.govt.nz/dmsdocument/48013-FAR-202161-Rapid-updates-for-New-Zealand-rock-lobster-Jasus-edwardsii-stocks-in-2020>

Rock lobster catch and effort data: summaries and CPUE standardisations, 1979/80 to 2018/19:

<https://www.mpi.govt.nz/dmsdocument/42439/direct>.

November 2022 Fisheries Assessment Plenary Report: <https://www.mpi.govt.nz/dmsdocument/49036>

National Panel Survey of Marine Recreational Fishers 2017/18:

<https://fs.fish.govt.nz/Doc/24728/FAR-2019-24-National-Panel-Survey-Marine-Recreational-Fishers.pdf.ashx>.

National Panel Survey of Marine Recreational Fishers 2011/12:

https://fs.fish.govt.nz/Doc/23718/FAR_2014_67_2847_MAF2010-01.pdf.ashx.

Harvest Strategy Standard for New Zealand Fisheries. (2008). Compiled by the Ministry of Fisheries, Wellington, New Zealand: <https://fs.fish.govt.nz/Doc/16543/harveststrategyfinal.pdf.ashx>.

Guidelines for the review of deemed value rates for stocks managed under the Quota Management System: <https://www.mpi.govt.nz/dmsdocument/40250/direct>

Recent reviews of rock lobster stocks:

CRA 1 Sustainability Round Review April 2021:

<https://www.fisheries.govt.nz/consultations/review-of-sustainability-measures-2021-april-round/>

CRA 1, 3, 4, 7 and 8 Sustainability Round Review April 2020:

<https://www.fisheries.govt.nz/news-and-resources/consultations/review-of-sustainability-measures-for-1-april-2020/>

CRA 3, 4 and 8 Sustainability Round Review April 2019:

<https://www.mpi.govt.nz/dmsdocument/33523-review-of-rock-lobster-sustainability-measures-for-1-april-2019>

Works cited regarding trophic cascades and kina barrens:

- Babcock, R.C.; Kelly, S.; Shears, N.T.; Walker, J.W.; Willis, T.J. (1999). Changes in community structure in temperate marine reserves. *Marine Ecology Progress Series* 189: 125–134.
- Barker, M. (2013). The ecology of *Evechinus chloroticus*. In: Lawrence, J. M. (Ed.). *Sea urchins: biology and ecology*. pp. 356-368. Elsevier.
- Choat, J.H.; Schiel, D.R. 1982: Patterns of distribution and abundance of large brown algae and invertebrate herbivores in subtidal regions of northern New Zealand. *Journal of Experimental Marine Biology & Ecology* 60: 129–162.
- Cole, R.G. 1993: Distributional relationships among subtidal algae, sea urchins and reef fish in northeastern New Zealand. University of Auckland, Auckland. 160 p.
- Froude V.A. (2016). Kelp cover and urchin barrens in the Bay of Islands: a 2016 baseline. A report prepared for the Bay of Islands Maritime Park Inc. Russell, by Pacific Eco-Logic Ltd. 71pp. Retrieved from:
https://fishforever.org.nz/images/ff/documents/reports/Kelp_cover_and_urchin_barrens_in_the_Bay_of_Islands_FINAL_Dec_2016.pdf
- Grace R.; Kerr V. (2005b). Mimiwhangata marine monitoring programme summer 2005. Unpublished report prepared for the Department of Conservation. 28 pp.
- Grace, R.; Kerr V. (2005a). Intertidal and subtidal habitats of Doubtless Bay, Northland, N.Z. Unpublished report to Department of Conservation, Northland Conservancy, Whangarei. 34 pp. available at:
<http://www.livingseadoubtlessbay.org.nz/Documents/Grace%20&%20Kerr%202005%20Doubtless%20Bay%20Habitats%20low%20res%20no%20appendix.pdf>
- Grace, R.V. 1983: Zonation of sublittoral rocky bottom marine life and its changes from the outer to the inner Hauraki Gulf, northeastern New Zealand. *Tane* 29: 97–108.
- Salomon, A.K.; Gaichas, S.K.; Shears, N.T.; Smith, J.E.; Madin, E.M.P.; Gaines, S.D. (2010). Key features and context-dependence of fishery-induced trophic cascades. *Conservation Biology* 24(2): 382–394.
- Salomon, A.K.; Shears, N.T.; Langlois, T.J.; Babcock, R.C. (2008). Cascading effects of fishing can alter carbon flow through a temperate coastal ecosystem. *Ecological Applications* 18: 1874–1887.
- Schiel, D.R. (2013). The other 93%: trophic cascades, stressors and managing coastlines in non-marine protected areas. *New Zealand Journal of Marine and Freshwater Research* 47 (3): 374–391.
- Shears, N.T.; Babcock, R.C. (2003). Continuing trophic cascade effects after 25 years of no-take marine reserve protection. *Marine Ecology Progress Series* 246: 1–16.
- Shears, N.T.; Babcock, R.C. 2004a: Community composition and structure of shallow subtidal reefs in northeastern New Zealand. *Science for Conservation* 245. Department of Conservation, Wellington, New Zealand. 65 p.
- Shears, N.T., Babcock, R. C. 2004b: Indirect effects of marine reserve protection on New Zealand's rocky coastal marine communities. DOC Science Internal Series 192. 17pp. Available at:
<https://www.doc.govt.nz/globalassets/documents/science-and-technical/dsis192.pdf>
- Shears, N.T.; Babcock, R.C.; Salomon, A.K. (2008). Context-dependent effects of fishing: variation in trophic cascades across environmental gradients. *Ecological Applications* 18 (8): 1860–1873.

13 Appendix One: Other management issues

More responsive decision-making

155. Changes to catch settings (TACs, allowances and TACCs) and regulatory measures (such as bag limits, MLS measures, and seasonal closures) are made under different legislative mechanisms, and as a result it can take much longer to implement a regulatory change than catch settings. The NRLMG support measures to align the legislative requirements of catch settings and regulatory changes, so that the implementation of management measures for all sectors of a fishery can be co-ordinated and come into effect in similar timeframes.
156. A Fisheries Amendment Bill is in progress to amend fisheries legislation so that decisions on recreational bag limits and legal sizes can be implemented quickly. If approved, this Bill will reduce the delay between implementing changes to TACCs and changes to bag limits.

Recreational catch estimation

157. Rock lobster is a popular recreational species to catch throughout the country. Recreational fishers are not required to report the quantities of rock lobsters they catch, other than reporting requirements for recreational charter-fishing operators. Recreational fishers generally co-operate with surveys to estimate harvest, including periodic National Panel Surveys (NPS) and creel survey approaches, but NRLMG sector members consider that these estimates are too infrequent (five or six years apart) and not precise enough to track changes in harvest for use in management decisions. The most recent NPS surveys provide good harvest estimates for large fisheries, but for fisheries like rock lobster with relatively few participants the estimates had large error bounds.
158. More frequent surveys, or revised approaches that are available, need to be evaluated for their cost and utility for rock lobster fisheries. Information is also needed to inform the adjustment of controls to achieve management targets. This will be a focus area for the NRLMG in 2022 and will be progressed through the Marine Amateur Fisheries Working Group.

Illegal catch estimation

159. Current illegal take estimates are highly uncertain, but for some stocks they are large compared to the catch by legitimate sectors. Illegal take estimates for some stocks can introduce considerable uncertainty and risk into stock assessments, directly reduce the harvest that can be taken by legitimate users and the benefits they can attain from sustainable use of rock lobster fisheries, and can compromise stock rebuilds.
160. Estimating illegal take is challenging because of the nature of the activity. The NRLMG considers that information can be collected and analysed to improve those estimates so they can be taken into account in the stock assessments and can inform management and compliance responses.
161. In 2020/21, rock lobster fisheries were an area of national priority for MPI Fisheries Compliance. The NRLMG will continue to work with MPI Fisheries Compliance in 2022 to improve illegal take estimates and reduce illegal take, incorporating improved information collected during compliance activities, and the Compliance findings from 2020/21.

Recreational accumulation limits

162. For most Quota Management Areas (other than CRA 5), at present there is no effective limit on the amount of rock lobster people can have in their possession at any one time, provided the bag limit was not exceeded on any one day while fishing. The availability of the defence provision in regulation 29(3) of the Amateur Regulations (where a person can be in possession of many times the daily limit if they can satisfy the court that the fish were taken over a number of fishing days) is currently exploited by illegal operators.
163. Some NRLMG members suggest an accumulation limit and the associated 'bag and tag' conditions that limit the ability to store and transport large quantities of rock lobster should be

applied in all Quota Management Areas. This would assist in addressing circumstances where people deliberately exceed the daily limit or where the daily limit is consistently taken for sale or barter. This measure would complement the other measures in place to address illegal take.

164. The NRLMG will continue to monitor and assess the effectiveness of the accumulation limit that was implemented in the CRA 5 on 1 July 2020. The NRLMG may consider proposing further accumulation limits in other rock lobster Quota Management Areas as necessary.

Telson clipping

165. Telson clipping is cutting off the bottom third of the telson (the central part of the tail fan) so that it is noticeably shorter than the other sections of the tail fan. This marks a lobster as having been recreationally caught and therefore not able to be sold, bartered or traded. The intent of telson clipping is to discourage the illegal sale of rock lobsters. Poaching and black-market activity (i.e., taking rock lobsters for sale or barter outside of commercial entitlements) is a significant issue in a number of lobster fisheries.
166. Illegal removals slow or prevent the rebuild of fisheries, can contribute to localised depletion, and deprive legitimate users of the catch they are entitled to, and depress the catch rate they could otherwise expect.
167. The prevalence and scale of illegal activity is unknown but in some rock lobster fisheries is assumed to be significant, and has the potential to impact on stock sustainability. The allowance made in TAC setting for illegal unreported removals can reduce the TACCs that might otherwise be set, and therefore represent a direct economic loss to New Zealand.
168. Telson clipping provides Fishery Officers with an additional 'tool in the toolbox' to address illegal take for sale in rock lobster fisheries by:
- a) Opportunistic non-commercial fishers who sell or barter their catch for financial gain; or
 - b) Dedicated fish thieves who conceal their activity under legitimate non-commercial fishing.
169. Compulsory telson clipping for recreational fishers and voluntary specification of telson clipping on customary permits/authorisations could complement enforcement activities carried out by the Ministry and can be relatively easily enforced in the course of normal inspections of amateur fishers.
170. Based on the Kaikōura experience, the measure should help address the potential for illegally taken lobsters to end up being sold and displacing legally taken product in the restaurants, retail and hospitality trade. Telson clipping was introduced in the CRA 2 fishery in 2020.
171. Some NRLMG members support the adoption of telson clipping nationally for recreationally caught lobsters by amendment to regulations for all Quota Management Areas. The NRLMG will continue to monitor and assess the effectiveness of the telson clipping measure that was implemented in CRA 2 and CRA 5 on 1 July 2020, and may consider proposing telson clipping in other areas as necessary.

Recreational charter vessel industry

172. The NRLMG supports better management of amateur charter-fishing vessel (ACV) fishing overall, and improvements to the reporting regime. ACVs have been required to report their catch since 2010, however there are some concerns with the completeness, credibility, and quality of these data from some vessels. There is also a need to confirm that catch from these vessels is incorporated into the overall recreational allowance. In 2022, the NRLMG will work to provide advice to the Minister on how to better manage the recreational ACV sector.

14 Appendix Two: CRA 1 (Northland) catch projection tables

173. For each level of modelled catch, the projected effect over the next four years on the vulnerable, spawning, and total biomass, and the probability of being above 2021 levels, are given in Table A1 below. Biomass projections are not available for Option 1.2 (5% TAC decrease) because the catch settings for this option were not specifically modelled; however, it can be assumed that vulnerable and spawning biomass under this option are between current catch settings and a 10% decrease in commercial and recreational catch.

Table A1: Projected change in vulnerable biomass for CRA 1 under three catch levels.³¹ 5% and 95% quantiles are provided to show the spread and uncertainty of the data. (continued over the page)

Performance indicators	Change to recreational and commercial catch	5% quantile	Median	95% quantile	Interpretation of the <u>median</u> results
Vulnerable biomass (B)					
B_{2021} / B_0	All	0.110	0.154	0.198	Vulnerable biomass in 2021 was 15% of unfished levels
B_{2025} / B_0	Status quo	0.095	0.161	0.255	Vulnerable biomass in 2025 will be 16% of unfished levels
	-10%	0.109	0.176	0.272	Vulnerable biomass in 2025 will be 18% of unfished levels
	-15%	0.116	0.185	0.280	Vulnerable biomass in 2025 will be 19% of unfished levels
B_{2025} / B_{2021}	Status quo	0.742	1.095 ↑	1.569	Vulnerable biomass in 2025 will be 110% of 2021 levels (an increase of 10%)
	-10%	0.860	1.203 ↑	1.676	Vulnerable biomass in 2025 will be 120% of 2021 levels (an increase of 20%)
	-15%	0.917	1.257 ↑	1.733	Vulnerable biomass in 2025 will be 126% of 2021 levels (an increase of 26%)
Total biomass (Btot) – Beginning of season autumn-winter total biomass (all males and females)					
$B_{tot2025} / B_{tot2021}$	Status quo	0.840	1.034 ↑	1.293	Total biomass in 2025 will be 103% of 2021 levels (an increase of 3%)
	-10%	0.895	1.086 ↑	1.341	Total biomass in 2025 will be 109% of 2021 levels (an increase of 9%)
	-15%	0.923	1.111 ↑	1.367	Total biomass in 2025 will be 111% of 2021 levels (an increase of 11%)
Spawning stock biomass (SSB)					
SSB_{2021} / SSB_0	All	0.307	0.363	0.438	Spawning biomass in 2021 was 36% of unfished levels
SSB_{2025} / SSB_0	Status quo	0.264	0.364	0.496	Spawning biomass in 2025 will be 36% of unfished levels
SSB_{2025} / SSB_{2021}	Status quo	0.826	0.998	1.209	Spawning biomass in 2025 will be 100% of 2021 levels (no change)
	-10%	0.866	1.032 ↑	1.241	Spawning biomass in 2025 will be 103% of 2021 levels (an increase of 3%)
	-15%	0.888	1.049 ↑	1.257	Spawning biomass in 2025 will be 105% of 2021 levels (an increase of 5%)

³¹ The projections for CRA 1 under different catch levels were conducted separately from the 2021 rapid assessment update. The performance indicators under current catch levels given here differ slightly from the values in Table 5 because of minor variations in how recruitment is estimated, which occur each time the model is run.

Performance indicators	Change to recreational and commercial catch	5% quantile	Median	95% quantile	Interpretation of the <u>median</u> results
Probabilities					
P($B_{2025} > B_{2021}$)	Status quo		0.674		67% probability that 2025 vulnerable biomass will be greater than 2021 levels
	-10%		0.828		83% probability that 2025 vulnerable biomass will be greater than 2021 levels
	-15%		0.889		89% probability that 2025 vulnerable biomass will be greater than 2021 levels
P($B_{tot2025} > B_{tot2021}$)	Status quo		1.051		100% probability that 2025 total biomass will be greater than 2021 levels
	-10%		1.101		100% probability that 2025 total biomass will be greater than 2021 levels
	-15%		1.126		100% probability that 2025 total biomass will be greater than 2021 levels
P($SSB_{2025} > SSB_{2021}$)	Status quo		0.491		49% probability that 2025 spawning biomass will be greater than 2021 levels
	-10%		0.634		63% probability that 2025 spawning biomass will be greater than 2021 levels
	-15%		0.685		69% probability that 2025 spawning biomass will be greater than 2021 levels

174. For each level of modelled catch, the projected effect over the next four years on vulnerable biomass and the probability of being above the B_{MSY} reference level are given in Table A2 below. Biomass projections are not available for Option 1.2 (5% TAC decrease) because the catch settings for this option were not specifically modelled; however, it can be assumed that vulnerable and spawning biomass under this option are between current catch settings and a 10% decrease in commercial and recreational catch.

Table A2: Projected change in B_{MSY} reference level and vulnerable biomass level in 2021 (B_{2021}) for CRA 1 under three catch levels.³² 5% and 95% quantiles are provided to show the uncertainty of the biomass estimates. (continued over the page)

Vulnerable biomass (tonnes)	Change to recreational and commercial catch	5% quantile	Median	95% quantile	Interpretation of the <u>median</u> results
B_R , reference level (tonnes)	All		454		The vulnerable biomass that can produce MSY is 454 tonnes
Probability B_{2021} greater than B_R	All		0.607		61% probability that vulnerable biomass in 2021 was greater than the B_{MSY} reference level
B_{2021}	All	367	473	604	Vulnerable biomass in 2021 was 473 tonnes
B_{2021} / B_R	All	0.809	1.042	1.329	Vulnerable biomass in 2021 was 1.04 times (104%) the reference level
B_{2025}	Status quo	313	525	802	Vulnerable biomass in 2025 will be 525 tonnes
	-10%	359	575	856	Vulnerable biomass in 2025 will be 575 tonnes
	-15%	383	600	882	Vulnerable biomass in 2025 will be 600 tonnes

³² The projected vulnerable biomass for CRA 1 under different catch levels was conducted separately from the 2021 rapid assessment update. The values given here under current catch levels differ slightly from the values in Table 6 because of minor variations in how recruitment is estimated, which occur each time the model is run.

Vulnerable biomass (tonnes)	Change to recreational and commercial catch	5% quantile	Median	95% quantile	Interpretation of the <u>median</u> results
Probability B_{2025} greater than B_R	Status quo		0.680		68% probability that vulnerable biomass in 2025 will be greater than the B_{MSY} reference level
	-10%		0.806		81% probability that vulnerable biomass in 2025 will be greater than the B_{MSY} reference level
	-15%		0.867		87% probability that vulnerable biomass in 2025 will be greater than the B_{MSY} reference level
B_{2025} / B_R	Status quo	0.689	1.154	1.765	Vulnerable biomass in 2025 will be 1.15 times (115%) the reference level
	-10%	0.791	1.265	1.883	Vulnerable biomass in 2025 will be 1.27 times (127%) the reference level
	-15%	0.843	1.320	1.941	Vulnerable biomass in 2025 will be 1.32 times (132%) the reference level