Fisheries New Zealand
Tini a Tangaroa

Review of sustainability measures for spiny rock lobster (CRA 2) for 2024/25

Fisheries New Zealand Discussion Paper No: 2024/33
ISBN: 978-1-991330-55-0 (online)
ISSN: 2624-0165 (online)

December 2024

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Guide to this discussion document and consultation

We are consulting on changes to the catch limits and allowances for spiny rock lobster in CRA 2 under the Fisheries Act 1996 (**the Act**). We welcome your feedback on the proposed options for this stock and any alternatives. Your feedback will be incorporated into our final advice to the Minister for Oceans and Fisheries and will help to inform their decisions on any changes.

Further information

If you are interested in the evidence used to develop the proposals, you can refer to the Fisheries Assessment Plenary.

Sending us your views

Submissions on these proposals will be received by Fisheries New Zealand through to **5pm on 29 January 2025**, by email to FMSubmissions@mpi.govt.nz. More information about how to send us feedback is on page 22 of this document.

Spiny rock lobster / Crayfish, Kōura papatea (CRA 2) – Hauraki Gulf, Coromandel, and Bay of Plenty

Part 1: Overview

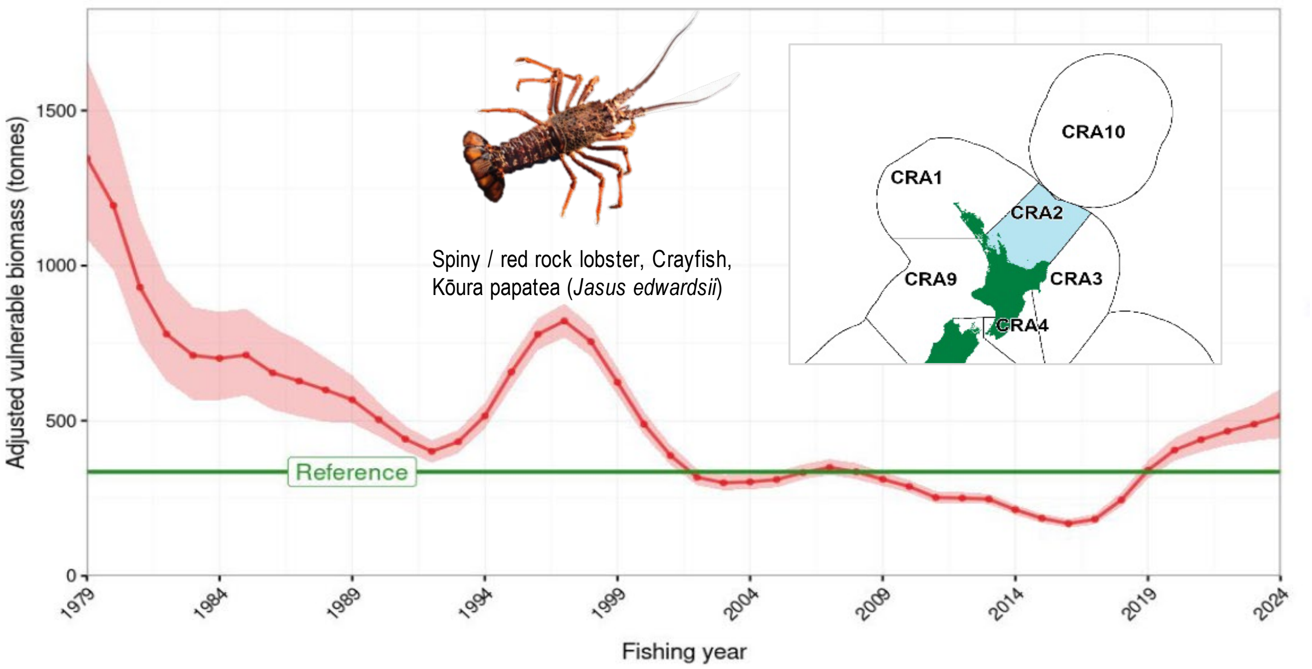

Figure 1: Quota Management Areas (QMAs) for spiny rock lobster with CRA 2 highlighted, and modelled vulnerable biomass (in tonnes) since 1979 in CRA 2.

Rationale for review

1. Fisheries New Zealand (**FNZ**) is reviewing sustainability measures for spiny rock lobster (*Jasus edwardsii,* referred to as **rock lobster** from here on) in Quota Management Area (**QMA**) CRA 2 for the 1 April 2025 fishing year (Figure 1).

2. Rock lobster is highly valued by customary, recreational, and commercial fishers. The CRA 2 fishery, which includes the Hauraki Gulf, Coromandel, and Bay of Plenty, has a particularly high profile due to its value (an estimated $10.17 million annually from commercial fishery exports), and proximity to large population centres including Auckland and Tauranga. The ecological role of rock lobster as a predator of sea urchins is also a key consideration in this fishery due to the prevalence of urchin barrens[1] on the north-east coast of New Zealand, including parts of CRA 2. Kina (*Evechinus chloroticus*) is the main barren-forming urchin in CRA 2, although the long-spined urchin (*Centrostephanus rodgersii*) is becoming increasingly common at more exposed localities across CRA 2.

3. In 2018, the Total Allowable Catch (**TAC**) for CRA 2 was reduced from 416.5 tonnes to 173 tonnes, including a 60% reduction in the Total Allowable Commercial Catch (**TACC**) from 200 tonnes to 80 tonnes. This reduction was made in response to sustainability concerns about critically low levels of abundance in the fishery, with the intention that this decision would lead to a doubling of abundance within four to eight years.[2] To further support this rebuild, the recreational daily limit was reduced in 2020 from six to three rock lobsters per fisher per day to help ensure recreational catch does not exceed the 34-tonne annual recreational allowance.

4. A full CRA 2 stock assessment was conducted in 2022. In addition to calculating biomass of the stock, the assessment also determined the vulnerable biomass[3] level that can produce the maximum sustainable yield (**MSY**)

[1] Urchin barrens are sea urchin dominated areas of rocky reef that would normally support healthy kelp forest but have little or no kelp due to overgrazing by sea urchins.

[2] Minister's decision letter on fisheries sustainability measures for 1 April 2018.

[3] Vulnerable biomass, also known as exploitable biomass, is the biomass of lobsters vulnerable to fishing, i.e., legally harvestable adult rock lobsters. For rock lobsters this is limited to male and female fish above the minimum legal size (**MLS**) at the beginning of the autumn-winter season, excluding females carrying eggs (known as *'in-berry'*).

from the fishery.[4] Using B_{MSY}[5] as a reference level (a management target, also known as $\mathbf{B_R}$) that is tailored to the biological and fishery characteristics of CRA 2 is consistent with the requirement of the Fisheries Act 1996 (**the Act**) to maintain stocks at or above a level that can produce the *MSY*.[6]

5. The 2022 stock assessment and subsequent 2023 and 2024 rapid update assessments all indicated that CRA 2 biomass has increased significantly following the 2018 and 2020 catch reductions. The 2024 rapid update estimated vulnerable biomass to be 515 tonnes, which is 54% above B_R (335 tonnes), and that it is projected to increase over the next five years under current catch levels (see Part 3 '*Stock status*'). Consequently, there may be an opportunity to increase utilisation.

6. Fish stock management targets are often set at B_{MSY} by default, but they can be set higher depending on social, cultural, and economic factors, as well as environmental or ecosystem considerations. While the vulnerable biomass target that CRA 2 is managed to is a single-stock target (a traditional method that focuses on managing individual fish stocks), the Act requires the incorporation of wider ecosystem considerations.

7. Rock lobster, as reef predators that feed on sea urchins, among other species, are an important part of the ecological health and biodiversity of coastal rocky reefs in north-eastern New Zealand. There has been extensive discussion around the need to increase the abundance of large[7] rock lobster (as well as other urchin predators, such as large snapper and packhorse rock lobster) in Fisheries Management Area 1 (**FMA 1** - which includes both the CRA 1 and CRA 2 QMAs), to reduce the prevalence of urchin barrens (discussed further under Part 3 '*Urchin barrens*').

8. FNZ has heard from tangata whenua and stakeholders of ongoing concerns about the abundance of rock lobster in parts of CRA 2, with particular concern about the localised scarcity of rock lobster and the prevalence of urchin barrens within the Hauraki Gulf.

9. FNZ is seeking feedback from stakeholders, tangata whenua, and the public on three different aspects of CRA 2 management. These are:

   (a) **What is an appropriate CRA 2 biomass management target (i.e. the amount of rock lobster that FNZ aims to have present in the CRA 2 QMA)?**
   FNZ is considering whether the default B_{MSY} management target (B_R) and our approach to managing CRA 2 is sufficient to support biodiversity outcomes under the Fisheries Act and address[8] the issue of urchin barrens which is an adverse effect of fishing.[9] This document outlines the trade-offs of managing the CRA 2 stock to a higher biomass target (relative to B_R) at several levels of biomass. Your feedback will inform the development and setting of a new longer term biomass management target for CRA 2. Any adjustments to the catch settings for CRA 2 for the 2025 April fishing year must be gazetted prior to 1 April 2025 (see '*Analysis of TAC options*' below) but decisions on management targets or other management measures can be implemented any time. A full stock assessment of CRA 2, planned for mid-2025, will provide revised estimates of stock biomass and recruitment and updated stock biomass projections. It is intended that this new assessment model will inform the development of new management procedures[10] for CRA 2 that will be designed to iteratively manage the stock biomass at or around the new management target level. Public feedback from this consultation will be used in setting an appropriate long term biomass management target.

   (b) How should the CRA 2 TAC be set for the upcoming 2025 April fishing year?
   In the absence of both an agreed management target and a known biomass and density at which rock lobster will fulfil their ecosystem role as a predator of urchins, FNZ considers it appropriate to set a preliminary biomass management target of 2x B_R (twice the current management target) to underpin options for setting the TAC, TACC, and allowances. With the CRA 2 biomass modelled to increase towards the preliminary biomass management target under all proposed TAC options, this approach will support increasing both the overall

[4] 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.

[5] The vulnerable biomass that produces the MSY.

[6] Where the target vulnerable biomass reference level is referred to, this is an estimate of B_{MSY} calculated from the stock assessment model that is accepted by the Rock Lobster Working Group (also known as the interim target). This is usually the default target until an agreed management target is set by the Minister.

[7] It has been established that large spiny rock lobster (with a carapace (body) length greater than 130 mm) are unique in their ability to pry large urchins from rocks and consume the animal via the unprotected mouthparts (Flood, 2021). Therefore, increasing the abundance of not just spiny rock lobster but also large spiny rock lobster is required to reduce the prevalence of urchin barrens and support the recovery of kelp forests within CRA 2.

[8] This can be avoiding, remedying, or mitigating adverse effects of fishing on the aquatic environment (discussed further under Part 3 '*Urchin barrens*').

[9] Doheny et al., 2023.

[10] Management procedures are set 'decision rules' that can be used to guide the Minister's setting of commercial catch limits (TACCs) based on changes in abundance (measured by changes in commercial catch rates ('catch-per-unit-effort' or 'CPUE')). Management procedures allow FNZ to respond quickly to changes in stock abundance on an annual basis, as there is a more settled approach for responding to different levels of abundance.

abundance of rock lobsters and specifically of large rock lobsters in CRA 2. FNZ notes that managing the CRA 2 biomass at 2x B_R supports managing CRA 2 to a higher long-term biomass target in the future. All three TAC options proposed (see Table 1) are projected to lead towards the CRA 2 stock reaching 2x B_R, but the rate at which the stock will increase to that target will depend on the TAC option adopted (i.e. the time taken to reach 2x B_R). Stakeholder feedback will assist the Minister in deciding how the CRA 2 TAC will be set. Any adjustment to the TAC would be made under section 13(2)(c) of the Act and apply from 1 April 2025 (the beginning of the next fishing year).

(c) **Should parts of CRA 2 be closed to rock lobster fishing to support recovery of rock lobster populations?** While the rock lobster biomass in CRA 2 has increased since the catch limit reductions in 2018 and 2020, the abundance of rock lobster is not evenly distributed across CRA 2. FNZ considers that spatial closures to rock lobster harvest may be appropriate in areas within CRA 2 where abundance remains very low. This would support the recovery of rock lobster populations, which may in turn help address the issue of kina barrens. As such, FNZ is seeking feedback on whether to prohibit recreational and commercial rock lobster fishing within[11] the inner Hauraki Gulf (Figure 2) to assist rock lobster recovery in what is one of New Zealand's most intensively used marine spaces,[12] and an area where urchin barrens are prevalent (discussed further under '*Proposed spatial closure*'). If implemented, the closure would be applied from 1 April 2025.

10. FNZ is satisfied that the current deemed value rates for rock lobster stocks (including CRA 2) provide sufficient incentives for fishers to balance their catch with ACE, consistent with section 75(2)(a) of the Act and FNZ's Deemed Value Guidelines. Therefore, no changes are currently proposed to the deemed value rates of CRA 2. However, FNZ welcomes any feedback on these settings.

11. For more information on the current management settings for CRA 2, see the Fisheries Infosite. For general information about fisheries management in New Zealand, see our fisheries management webpage, and our webpage about the Quota Management System (QMS).

[11] Evidence from no-take marine reserves has shown that increased abundance of large urchin predators (including rock lobster and snapper) can assist in reversing urchin barrens and support the re-establishment of kelp forest habitat. Recovery of kelp forest habitat within no-take reserves can take decades (Babcock et al., 2010; Shears & Babcock, 2003; Leleu et al., 2012). There are no examples in New Zealand of area closures to rock lobster fishing only that indicate how effective this type of closure would be in mitigating urchin barrens and restoring kelp forests. If implemented, FNZ proposes reviewing the efficacy of this proposed closure after 10 years. An end date for the proposed closure is uncertain as it is not possible to predict how long a recovery would take.

[12] The inner Hauraki Gulf is used for recreational, customary, and commercial fishing, aquaculture, ecotourism such as bird and marine mammal watching, and non-extractive recreational activities such as sailing, diving, kayaking, and surfing. The Hauraki Gulf is also a receiving environment for run off of sediment and contaminants, as well as stormwater and sometimes wastewater.

Proposed options

Table 1: Proposed catch settings (in tonnes) for CRA 2 from 1 April 2025.

Option	TAC	TACC	Allowances		
			Customary Māori	Recreational	All other mortality caused by fishing
Option A1 (status quo)	173	80	16.5	34	42.5
Option A2	174.5 (↑ 1.5)	90 (↑ 10)	16.5	34	34 (↓ 8.5)
Option A3	188.5 (↑ 15.5)	100 (↑ 20)	16.5	34	38 (↓ 4.5)

12. The proposed TAC increases under Options A2 and A3 include increases to the TACC and reductions to the allowance for all other mortality to the stock caused by fishing. The proposed increase to the TACC is therefore greater than the overall TAC increase proposed. Considerations for the other mortality allowance are discussed in Part 1 under '*Fishery characteristics and settings*').

Table 2: Proposed spatial management measures.

Option	Action	Description
Option B1	Maintain status quo	No additional spatial management of rock lobster fishing is proposed beyond the existing marine reserves, mātaitai, and proposed new High Protection Areas (**HPA**s) provided for in the Hauraki Gulf / Tīkapa Moana Marine Protection Bill.[13]
Option B2	Close the inner Hauraki Gulf to all commercial and recreational rock lobster fishing	Closure of the inner Hauraki Gulf (specifically waters south of a straight line that extends from the southern boundary of the Cape Rodney-Okakari Point Marine Reserve to Port Jackson Bay, top of the Coromandel Peninsula) to all commercial and recreational rock lobster fishing, in addition to existing marine reserves, mātaitai, and proposed new HPAs provided for in the Hauraki Gulf / Tīkapa Moana Marine Protection Bill.

[13] The Hauraki Gulf / Tīkapa Moana Marine Protection Bill is currently under its second reading before parliament, and that the proposed HPA closures under this Bill are not law yet. Progress of the Bill can be found here and a copy of the Bill is available here. The proposed CRA 2 inner Hauraki Gulf closure is independent of this Bill and would be implemented under section 11 of the Act, covering the entire inner Hauraki Gulf as indicated in Figure 2 and overlapping with some of the proposed HPA closures.

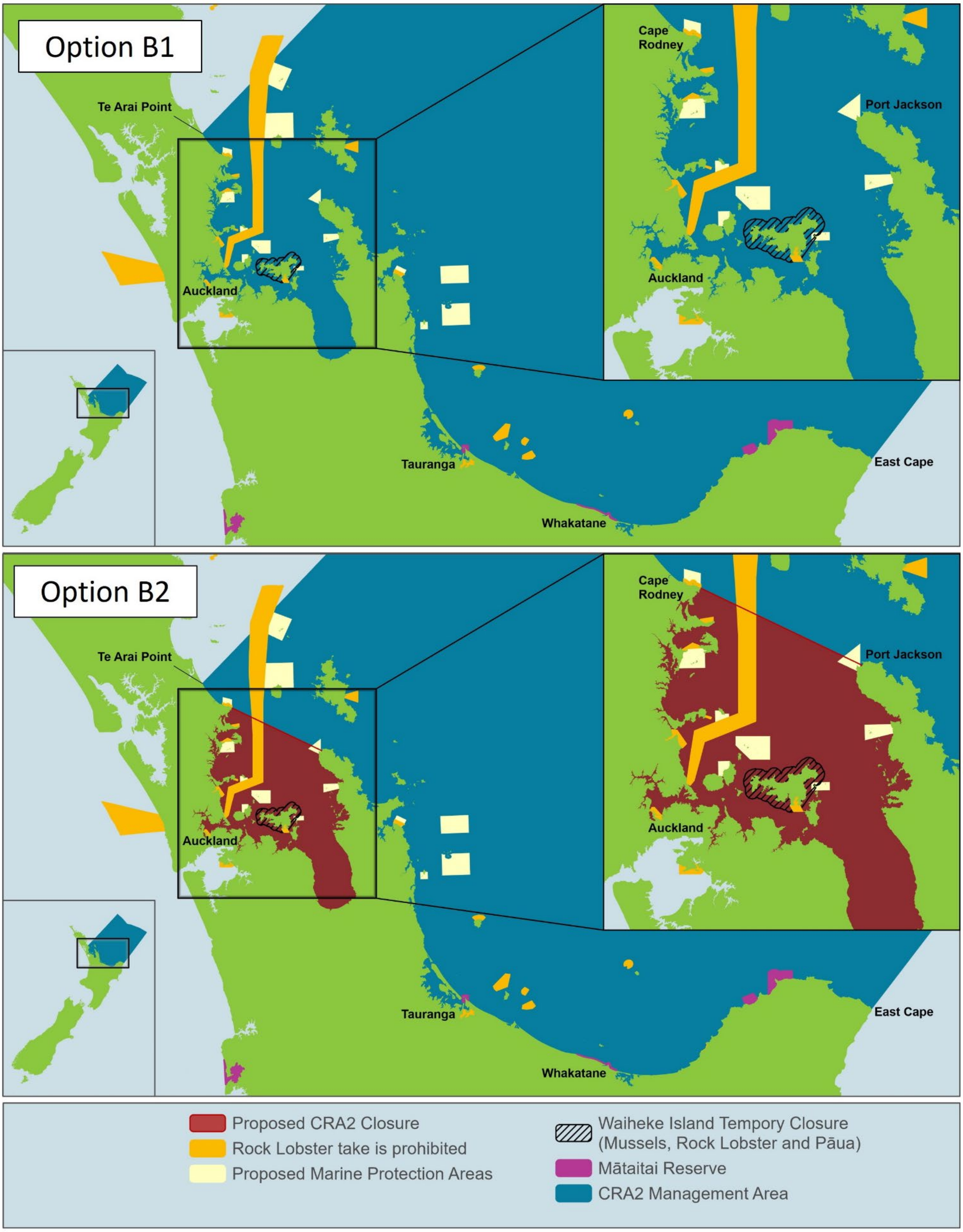

Figure 2: Existing and proposed spatial management measures for the CRA 2 QMA. The upper panel (Option B1) shows existing areas in which harvest of rock lobster is currently or proposed to be prohibited, including marine reserves, mātaitai reserves, section 186A temporary closures, submarine cable and pipeline protection areas, and High Protection Areas proposed in the Hauraki Gulf Marine / Tīkapa Moana Protection Bill. The lower panel (Option B2) includes the proposed spatial closure for all commercial and recreational rock lobster fishing within the inner Hauraki Gulf.

Management target considerations

13. FNZ has contracted modelling to understand the implications of managing at alternative targets on the population structure of CRA 2 (see Figure 7 in Part 3 '*Additional figures*'). This figure shows how the abundance of different rock lobster size classes are expected to vary between management targets, illustrating how, at higher management targets (with a larger CRA 2 biomass), large rock lobster may become more abundant.

14. Laboratory-based feeding experiments have shown that only lobster with a carapace (body) length greater than 130 mm are capable of feeding on larger kina.[14] Therefore, increasing the abundance of large rock lobsters is expected to be an effective mechanism to reduce the abundance of urchins, and therefore the prevalence urchin barrens within CRA 2.

15. There will be additional biological consequences of managing the stock at different biomass targets for the species that interact with rock lobster, as well as social, cultural, and economic consequences for the stakeholders of the CRA 2 fishery.

16. FNZ notes that urchin abundance above a certain density will result in urchin barrens, and that this density threshold will vary between locations depending on environmental conditions.[15] There is no definitive knowledge of the threshold of predator abundance required to reverse urchin barrens. This uncertainty around the biomass threshold required to prevent or reverse barrens must be considered, amongst other matters such as the maintenance of biological diversity and any adverse effects of fishing and socio-economic impacts, when developing management targets and catch settings.

17. Urchin barrens were first documented in the Hauraki Gulf in the 1960s[16] and became a dominant feature of coastal rocky reefs across north-eastern New Zealand over the following two decades. Data is not available to allow us to reliably estimate the biomass of all urchin predator species at the time when urchin barrens were first becoming established at large scales. The currently modelled time series of rock lobster biomass only extends to 1980 (Figure 3), when the lobster biomass is estimated to have been more than 3.5 times greater than the default management target (more than 3.5x B_R), and more than twice the current biomass. It is likely the rock lobster biomass was even greater during the time before urchin barrens were common and widespread. Managing CRA 2 biomass to 3.5x B_R may bring CRA 2 nearer to the abundance of large rock lobster and overall population required to meaningfully play an increased role as a predator of urchins and prevent the formation, or reduce the extent, of urchin barrens within CRA 2. However, this abundance threshold is unknown.

18. FNZ considers that it is appropriate, taking into account the species and ecological benefits listed above, to manage CRA 2 biomass to a level above B_R. Therefore, for the purpose of this consultation, FNZ has developed TAC options that align with a preliminary management target of 2x B_R (twice the default target). This preliminary biomass management target of 2x B_R allows for development of options for TAC settings from April 2025 (see Analysis of TAC options below), all of which are projected to support increasing the abundance of rock lobsters in CRA 2 and therefore supports setting a higher long term biomass management target subsequently. The 2024 rapid update assessment indicates that CRA 2 is currently above the default biomass management target and is estimated to be at approximately 1.54x B_R.

19. FNZ is also seeking feedback in this consultation from tangata whenua and stakeholders on what they would consider an appropriate longer term management target for the CRA 2 fishery. FNZ is considering longer term biomass management targets across a spectrum from B_{MSY} (1x B_R) to greater than 3x B_R. For the purposes of consultation, we have split this spectrum into three categories; 1x – 2x B_R, 2x – 3x B_R, or greater than 3x B_R. The benefits and risks of longer term biomass management targets within each category are discussed in Table 3.

20. A further consideration for setting a new longer term biomass management target is the socio-economic impact (which includes both costs and benefits), including the way and rate of achieving a higher biomass management target (i.e., what management actions and timeframes are used to move the stock to the desired biomass level). While setting a longer term biomass management target greater than B_R for CRA 2 seeks to address ecological concerns within the QMA, there are also social, cultural, and economic considerations that need to be addressed when setting a longer term biomass management target and when choosing a way and rate towards that target.

21. Moving the stock to a greater biomass management target over a shorter time frame will require a higher rate of biomass increase, and therefore likely a more significant constraint on utilisation. This constraint would impact participants in the commercial fishery (for example fishers, LFRs, and exporters) and recreational fishers. In

[14] Macdiarmid et al., 2013.
[15] Shears & Babcock 2004; Doheny et al., 2023.
[16] Dromgoole, 1964.

contrast, moving the stock to a greater biomass over a longer time frame would likely require a lower rate of biomass increase, which would likely place a lower constraint on utilisation.

22. For the TAC options proposed in this consultation, FNZ has assumed a preliminary biomass management target of 2x B_R with the best available information (the 2024 rapid update) projecting CRA 2 biomass to increase under all proposed TAC options over the next four years (depending on the selected option, CRA 2 biomass is expected to be 1.8-1.95x B_R by 2028).

23. If a higher biomass management target is chosen it will take longer to reach that biomass. There is also uncertainty around the rate at which CRA 2 biomass will increase beyond our five year projections (Figure 3) as growth over that period will be determined by future recruitment and environmental influences that cannot be accurately predicted this far out.

24. While a key objective of managing CRA 2 to a higher biomass management target is to bring the rock lobster population back to levels nearer to the biomass found in the ecosystem prior to the spread of urchin barrens, it is impossible to predict how this biomass will perform under current environmental conditions, which have changed substantially since the 1960s (due to factors including climate change and coastal development). Consequently, it is possible that managing rock lobster to a higher biomass may not result in a rock lobster biomass and population size structure that is sufficient to prevent the formation or reduce the extent of existing urchin barrens in CRA 2.

25. This uncertainty must be considered when evaluating the potential ecological, social, cultural, and economic consequences of any management decision. For this reason, taking a stepwise approach towards increasing the stock biomass could be rationalised. That is, FNZ considers there is merit in setting a moderately increased long term biomass management target initially, before looking to increase the long term biomass management target even further once the initial target has been achieved.

26. A planned stock assessment in 2025 will further inform the development of new CRA 2 management procedures that will be designed to maintain the stock biomass at or around a new long term biomass management target level.

27. FNZ welcomes your feedback on what an appropriate long term biomass management target for the CRA 2 fishery would be, and if there are benefits or risks that have not been identified.

Table 3: Benefits and risks of managing CRA 2 biomass at different longer term biomass management targets.

CRA 2 longer term biomass management target between 1 – 2x B_R	
Benefits	• Modelling shows that over the longer term, this approach would favour utilisation more than would be expected if an even higher biomass management target were selected. For example, at 1.5x B_R, modelling suggests CRA 2 could in support a TAC of 222 tonnes, 49 tonnes more than the current TAC. Depending on how much of this would be applied to the TACC, a 49-tonne TAC increase could represent an estimated $5.00 million increase to the annual landed revenue compared to the current TAC.[17] This contrasts with a 3.5x B_R biomass management target, where under the longer term CRA 2 could support a TAC of 154 tonnes, 19 tonnes less than provided for under the current TAC. Depending on how much of this would be applied to the TACC, it could represent an estimated loss in annual landed revenue of up to $1.94 million. • The 2024 rapid update assessment indicates that CRA 2 is currently above the default biomass management target and is estimated to be at approximately 1.5x B_R. Therefore, the stock would reach a biomass management target of 2x B_R sooner than a higher biomass management target. • There are anticipated economic benefits to commercial fishers (on account of managing above B_R) with increased abundance of large rock lobsters and overall biomass in CRA 2. This increased biomass is expected to lead to improved catch rates, and improved efficiency and reduced operating costs for commercial fishers. However, there is uncertainty associated with expected economic benefits due to possible changes in market demand due to the increasing size of lobsters caught in the fishery. • The abundance of large rock lobsters and overall biomass in CRA 2 (on account of managing above B_R) is expected to lead to better catch rates and experience for customary and recreational fishers (note these benefits are expected to increase at higher biomass management targets). • FNZ does not anticipate that the ecological benefits of managing to a biomass management target of 1 – 1.5x B_R will be significantly greater than those currently being experienced in CRA 2. • Modelling (see Figure 7, Part 3 '*Additional figures*') suggests that managing CRA 2 at or above a biomass management target of 1.5x B_R would result in a population with at least 2.2 times more large male rock lobster and at least 3.7 times more large female rock lobster (carapace length greater than 130 mm) relative to B_R. Rock lobster with a carapace length greater than 130 mm are considered large enough to feed on kina of all sizes and may also be effective predators of long-spined urchins.
Risks	• Modelling suggests that this approach would manage CRA 2 biomass at a level close to the level of the stock between the mid-1980s and early 1990s (Figure 3). The best available information indicates that urchin barrens were already prevalent in parts of CRA 2 by this time. There is no definitive knowledge of the threshold of predator abundance required to reverse urchin barrens.

CRA 2 longer term biomass management target between 2 – 3x B_R	
Benefits	• Modelling suggests that at 2.5x B_R, over the longer term, CRA 2 could support a TAC of 188 tonnes, 15 tonnes more than the current TAC. This would represent an opportunity for increased utilisation once the stock reaches this level. Depending on how much of this would be applied to the TACC, a 15-tonne TAC increase could represent an estimated increase in annual landed revenue of up to $1.53 million. FNZ notes that a quicker rate towards this biomass management target would likely require a higher constraint on utilisation (and therefore negative impact on both commercial and recreational fishers in the immediate term), as opposed to a slower rate which is expected to place a smaller constraint on utilisation.

[17] Calculated from the difference between the projected landing revenue (from the extra TACC allocation) using the 2024/25 CRA 2 port price ($101.97 per kilogram), and the projected landing revenue for the current (2024/25) fishing year from CRA 2 ($8.16 million). Note the annual process for determining port price is governed by the Fisheries (Cost Recovery) Rules 2001 (SR 2001/229), which are based on a surveyed price supplied voluntarily by LFRs. The port price for rock lobster is not regionally specific, even though rock lobster from some regions may receive a higher price. The quantities used to calculate landing revenue include wharf sales and exclude loss from holding pots. The future calculations assume the full TACC is landed and not exceeded. No economic flow-on effects, such as impacts on processing and retail, are quantified.

	• At this biomass management target range, the TACC could be harvested with greater efficiency than under a biomass management target between 1 – 2x B_R, due to the increased size and abundance of rock lobster in CRA 2. Increased CRA 2 biomass would be expected to lead to improved CPUE, improved efficiency and reduced operating costs for fishers. However, there is uncertainty associated with expected economic benefits due to possible changes in market demand, and the effect that changes in rock lobster size classes can have on catch. • With the current biomass estimated to be approximately 1.54x B_R, it is expected to take more time for the stock to reach this proposed range than under a biomass management target between 1 – 2x B_R. However, this period does depend on there being relatively little change in catch levels, natural mortality rates, and recruitment over time. • Modelling (see Figure 7 in Part 3 '*Additional figures*') suggests that managing CRA 2 to a biomass management target above 2.5x B_R would: (a) result in a population with at least 4.9 times more large male rock lobster and at least 11.1 times more large female rock lobster (carapace length greater than 130 mm) relative to the current biomass management target (B_R); and (b) result in a population with at least 2.3 times more male large rock lobster and at least 3.2 times more large female rock lobster relative to managing the stock at the current biomass. The expected increase in abundance of large rock lobster, in addition to an overall population increase, is expected to improve catch rates and experience for customary, commercial and recreational fishers to a greater extent than would occur with a lower biomass management target. • This approach is expected to increase the abundance of large rock lobster and the overall population available to meaningfully play an increased role as a predator of urchins and prevent the formation or reduce the extent of urchin barrens. The additional ecological benefits, such as increased survival, reproduction, and development, are expected to be greater than under a lower biomass management target between 1 – 2x B_R.
Risks	• If this option were selected, CRA 2 would be managed close to the level of biomass that modelling suggests was present within the QMA in the early-1980s (Figure 3). The best available information indicates that urchin barrens were already prevalent in parts of CRA 2 by this time. There is no definitive knowledge of the threshold of predator abundance required to reverse urchin barrens. • Modelling shows a large increase to the CRA 2 biomass target would mean a lower level of utilisation compared to what would be expected under a lower biomass management target between 1 – 2x B_R. (depending on the way and rate chosen).

CRA 2 longer term biomass management target - greater than 3x B_R	
Benefits	• Managing to a higher biomass management target (greater than 3x B_R) would be expected, over the longer term, to require a reduction in commercial catch compared to current levels and result in forgone utilisation opportunities. However, commercial harvest under this target would be conducted with the greatest efficiency, due to the increased size and abundance of rock lobster in CRA 2. FNZ notes that a quicker rate towards this biomass management target would likely require a higher constraint on utilisation (and therefore negative impact on both commercial and recreational fishers in the immediate term), as opposed to a slower rate which is expected to place a smaller constraint on utilisation. • Modelling (see Figure 7 in Part 3, '*Additional figures*') suggests that managing CRA 2 to a biomass management target above 3x B_R would: (a) result in a population with at least 6.3 times more large male rock lobster and at least 15.1 times more large female rock lobster (carapace length greater than 130 mm) relative to the current biomass management target (B_R); and (b) result in a population with at least 2.9 times more male large rock lobster and at least 5 times more large female rock lobster relative to managing the stock at the current biomass. The expected increase in abundance of large rock lobster, in addition to an overall population increase, is expected to improve catch rates and experience for customary, commercial and recreational fishers to a greater extent than what would occur with a biomass management target with a lower level of increase.

	• A large increase to the CRA 2 biomass is expected to increase the abundance of large rock lobster and the overall population required to meaningfully play an increased role as a predator of urchins and prevent the formation or reduce the extent of urchin barrens. The additional ecological benefits, such as increased survival, reproduction, and development, are expected to be greater than under a biomass management target between 1 – 3x B_R. • If a biomass management target greater than 3x B_R were adopted, CRA 2 would be managed close to the level of biomass that modelling suggests was present within the QMA in the late-1970s and early 1980s (Figure 3). The best available information suggests that the abundance of large rock lobster at this biomass management target may be nearer to the abundance of large rock lobster and overall population required to meaningfully play an increased role as a predator of urchins and prevent the formation or reduce the extent of urchin barrens. The additional ecological benefits, such as increased survival, reproduction, and development, are expected to be greater than those provided for a biomass management target lower than 3x B_R.
Risks	• With the current biomass estimated to be approximately 1.54x B_R, it is expected to take more time to reach a larger biomass management target. However, this period does depend on there being relatively little change in catch levels, natural mortality rates, and recruitment over time. • Modelling shows that, over the longer term, CRA 2 could support a TAC of 154 tonnes, 19 tonnes less than provided for under the current TAC. Depending on how much of this would be applied to the TACC, a 19-tonne TAC decrease could be applied to the TACC, which could represent an estimated loss in annual landed revenue of up to $1.94 million. • Modelling shows a large increase to the CRA 2 biomass would mean a lower level of utilisation than what would be expected with a lower CRA 2 biomass management target. This would result in some short-term economic loss for the commercial sector (although this may be partially offset by increased fishing efficiency through an expected increase in CPUE) and may necessitate a reduction in the recreational allowance and daily limit (the effect of which may be offset by the increased availability of rock lobster and an increase in the number of successful fishing events). • While this approach is estimated to bring the rock lobster population back to levels nearer to the biomass found in the ecosystem prior to the spread of urchin barrens, hindcasting of rock lobster biomass is uncertain (because there is very limited historical catch data) and it is impossible to predict how this biomass will perform under current environmental conditions, which have changed substantially since the 1960s (due to factors such as climate change and coastal development). There is no definitive knowledge of the threshold of predator abundance required to reverse urchin barrens.

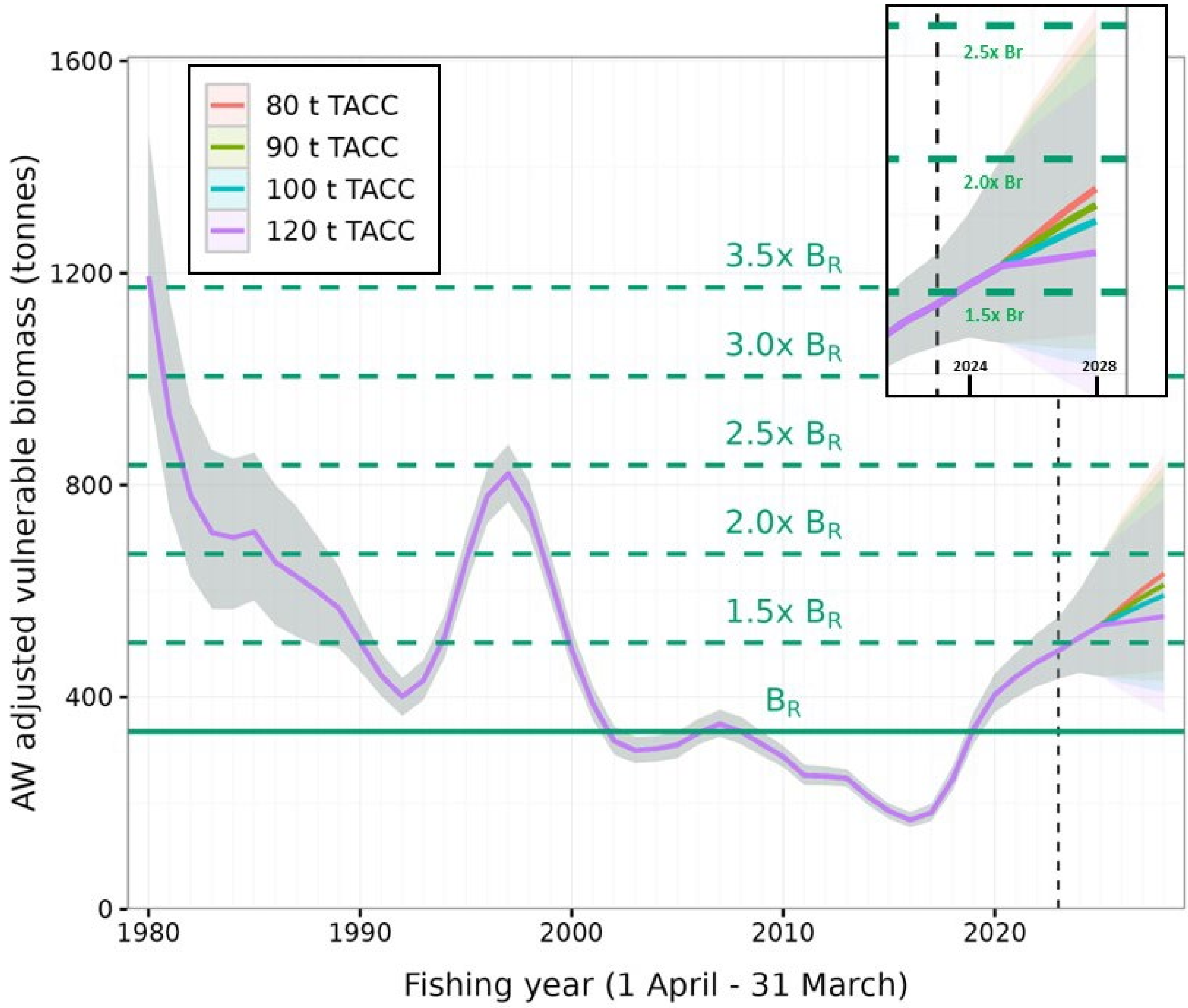

Figure 3: Posterior distribution of the 2024 rapid update model estimates of vulnerable biomass, which have been projected out to 2028. Variable shading intensity indicates the 50% and 90% credible intervals and the solid line indicates the median. The B_R management target is shown as a solid green line. The different projections are based on alternative TACC settings, with 80 tonnes (the current TACC) reflecting the current CRA 2 catch levels.

Analysis of TAC options

28. In the absence of an agreed new biomass management target, FNZ has developed three TAC setting options that align with a preliminary biomass management target of 2x B_R (twice the default target); maintaining status quo (Option A1), a 1% increase to the TAC (Option A2) and a 9% increase to the TAC (Option A3). This preliminary target of 2x B_R allows for development of options for TAC settings from April 2025, all of which are projected to support increasing abundance of rock lobsters in CRA 2. The CRA 2 stock is projected to increase towards 2x B_R under all the proposed TAC options, but the rate at which the stock is expected to increase towards this biomass management target will depend on the TAC option adopted. The benefits and risks of each of these TAC options are discussed below.

Option A1 – retain current settings (status quo)

TAC	173	TACC	80	Customary Māori	16.5	Recreational	34	Other mortality	42.5

Benefits	Risks
• Modelling from the 2024 rapid update indicates that, under current catch levels (i.e. status quo), CRA 2 vulnerable biomass is likely to reach 1.95x B_R by 2028. • This option is expected to see a greater rate of stock biomass increase than Options A2 and A3. In turn, this option should see a rate of CPUE increase above the rate experienced under Options A2 and A3, which should result in increased harvesting efficiency and reduced operating costs to harvest the same amount of rock lobster. • There would be no change to the TAC under this option, and therefore a low likelihood of a change in fisher behaviour or additional fishing effort.	• This option proposes the highest constraint on utilisation, compared to Options A2 and A3. • Option A1 is expected to provide the greatest and quickest biomass increase. Therefore, it provides a greater likelihood than Options A2 and A3 that rock lobster biomass will remain at or increase to an as-yet unknown level that in combination with other measures (including the possible inner Hauraki Gulf spatial closure, proposed HPAs, and existing measures to facilitate urchin removals), will allow them to play their part in controlling kina populations and delivering ecosystem functions in CRA 2. However, this certainty cannot be quantified because the abundance and size distribution of rock lobster required, in combination with other predators, to mitigate urchin barren formation is unknown.

Option A2 – 1% TAC increase (12.5% TACC increase)

TAC	174.5	TACC	90	Customary Māori	16.5	Recreational	34	Other mortality	34

Benefits	Risks
• This option provides for a 1.5-tonne increase to the TAC, an 8.5-tonne decrease to other sources of fishing mortality and a 10-tonne increase to the TACC. • It is estimated that, under this option, increased landings of rock lobster could provide approximately \$1.02 million more in commercial revenue[18] than in the 2024/25 fishing year. • Modelling from the 2024 rapid update indicates that, under this option, CRA 2 vulnerable biomass will reach 1.88x B_R by 2028. • This option will allow for a greater rate of stock biomass increase than Option A3, but at a lower rate of increase than Option A1.	• Any increase to the TAC is expected to lead to increased fishing effort. As catch is not evenly distributed across CRA 2, this may lead to an aggregation of fishing effort at specific locations, that in turn could lead to localised depletion. Concerns about localised depletion have been raised by numerous stakeholders across much of CRA 2, but particularly in relation to the inner Hauraki Gulf. • This option would result in a lower rate of stock biomass increase than Option A1. • The biomass increase expected under this option is greater and within a shorter timeframe than Option A3. This provides a greater likelihood than Option A3

[18] Calculated from the difference between the projected landing revenue (from the extra TACC allocation) using the 2024/25 CRA 2 port price (\$101.97 per kilogram), and the projected landing revenue for the current (2024/25) fishing year from CRA 2 (\$8.16 million). Note the annual process for determining port price is governed by the Fisheries (Cost Recovery) Rules 2001 (SR 2001/229), which are based on a surveyed price supplied voluntarily by LFRs. The port price for rock lobster is not regionally specific, even though rock lobster from some regions may receive a higher price. The quantities used to calculate landing revenue include wharf sales and exclude loss from holding pots. The future calculations assume the full TACC is landed and not exceeded. No economic flow-on effects are quantified, such as impacts on processing and retail.

	that rock lobster biomass will remain at or increase to an as yet unknown level that in combination with other measures (including the possible inner Hauraki Gulf spatial closure, proposed HPAs, and existing measures to facilitate urchin removals), will allow them to play their part in controlling kina populations and delivering ecosystem functions in CRA 2. However, this certainty cannot be quantified because the abundance and size distribution of rock lobster required, in combination with other predators, to mitigate urchin barren formation is unknown.

<table>
<tr><th colspan="10">Option A3 – 9% TAC increase (25% TACC increase)</th></tr>
<tr><td>TAC</td><td>188.5</td><td>TACC</td><td>100</td><td>Customary Māori</td><td>16.5</td><td>Recreational</td><td>34</td><td>Other mortality</td><td>38</td></tr>
<tr><th colspan="6">Benefits</th><th colspan="4">Risks</th></tr>
<tr><td colspan="6">
• This option provides for a 15.5-tonne increase in TAC, a 4.5-tonne decrease to other sources of fishing mortality and a 20-tonne increase to the TACC.
• This option provides for the highest level of commercial utilisation, when compared with Options A1 and A2.
• This option is estimated to provide approximately $2.04 million more in commercial revenue compared to the 2024/25 fishing year.
• Modelling conducted as part of the 2024 rapid update indicates that, under this option, CRA 2 vulnerable biomass will reach 1.80x B_R by 2028.
</td><td colspan="4">
• This option is expected to result in a lower rate of stock biomass increase than Options A1 and A2, and therefore the highest level of uncertainty of the stock reaching the 2x B_R biomass management target.
• As this option provides the largest of the proposed TAC increases, it comes with the highest risk of increased fishing effort leading to localised depletion. Concerns about localised depletion have been raised by tangata whenua and numerous stakeholders, particularly in relation to the inner Hauraki Gulf.
• The predicted biomass increases under this option are expected to be less than the other options. This option provides the lowest likelihood that rock lobster biomass will increase to an as yet unknown level that in combination with other measures (including the possible inner Hauraki Gulf spatial closure, proposed HPAs, and existing measures to facilitate urchin removals), will allow them to play their part in controlling kina populations and delivering ecosystem functions in CRA 2. However, this certainty cannot be quantified because the abundance and size distribution of rock lobster required, in combination with other predators, to mitigate urchin barren formation is unknown.
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Proposed spatial closure

Rationale

29. Spatial management (which can include temporary, seasonal, and permanent closures to fishing) is used extensively in natural resource management to address sustainability and biodiversity issues, but also to optimise yields, address conflict between commercial and non-commercial fishers, protect key parts of the life cycle of harvested species, and protect key habitats.[19]

30. Within CRA 2, the inner Hauraki Gulf[20] (for the purpose of this consultation, FNZ has defined the inner Hauraki Gulf as the waters south of a straight line that extends from the southern boundary of the Cape Rodney-Okakari Point Marine Reserve to Port Jackson Bay, top of the Coromandel Peninsula; Figure 2) has been identified as an

[19] Dichmont et al., 2013.

[20] The Hauraki Gulf Marine Park Act 2000 defines the Hauraki Gulf as the coastal marine area on the east coast of Auckland region and Waikato region.

area where rock lobster abundance is low[21] and the lack of natural predators of sea urchins, including rock lobster, has contributed to a significant adverse effect on the ecosystem. Specifically, large areas of kelp forest have been replaced by extensive areas of urchin barrens. Urchin barrens have been identified in other locations across CRA 2 but are known to be particularly prevalent within the Hauraki Gulf.

31. FNZ considers the low rock lobster biomass in the inner Hauraki Gulf to be both an issue of sustainability for this part of the CRA 2 fishery (particularly for areas more easily accessed by recreational and customary fishers) and an issue of biodiversity, because of the contribution that rock lobsters make towards naturally controlling the abundance of urchins and therefore the formation of urchin barrens. Rock lobster are now frequently described by some scientists and in the media as being functionally extinct in the Hauraki Gulf,[22] with the implication that they are so scarce that they are no longer able to fulfil their ecological function as predators of urchins on coastal rocky reefs (discussed further under Part 3 '*Urchin barrens*').

32. Within the inner Hauraki Gulf, there are a number of spatial management measures either planned or already in place that protect rock lobster from harvest. These include full no-take marine reserves (at Tāwharanui, Waiheke Island, and Long Bay) and a section 186A temporary closure around Waiheke Island (Figure 2). Rock lobster potting is also prohibited within a number of submarine cable and pipeline protection areas (although there is limited rock lobster habitat within these areas). Additionally, the Hauraki Gulf / Tīkapa Moana Marine Protection Bill proposes seven new High Protection Areas (**HPA**s) within this inner Hauraki Gulf area.[23]

33. FNZ considers that the current situation in the inner Hauraki Gulf (high prevalence of urchin barrens and a low abundance of rock lobster) could warrant additional spatial measures to assist:

    (a) rebuilding the rock lobster population in the inner Hauraki Gulf to a level that allows this species to fulfil its ecosystem function as a predator of urchins within this area; and

    (b) rebuilding the rock lobster population to a level that supports a sustainable fishery in this area.

34. Consequently, FNZ is seeking feedback on a proposal to close the inner Hauraki Gulf (Figure 2) to commercial and recreational rock lobster harvest.

35. FNZ considers that the proposed spatial closure would complement any modification of the CRA 2 TAC settings, to ensure that rock lobster biomass can increase within the Hauraki Gulf to a level that allows this species to fulfil its ecosystem function as a predator of urchins.

36. This spatial closure would be implemented under section 11 of the Act, which can apply to both recreational and commercial fishers and may be put in place to ensure sustainability. A section 11 closure would not prevent customary fishing authorisations being issued by Tangata Kaitiaki.[24]

37. The best available scientific information indicates that the implementation of no-take marine protected areas is an effective means to rebuild the abundance of urchin predators (including snapper and rock lobster) and reduce urchin abundance. There are currently no examples of this type of restoration occurring outside of full no-take marine protected areas.[25]

38. To address the low abundance of rock lobster in the inner Hauraki Gulf, FNZ is proposing a rock lobster-only closure. FNZ considers this approach will complement the current network of already established and proposed no-take marine protected areas (marine reserves and HPAs) in the inner Hauraki Gulf that either already do, or could soon, protect urchin predators including rock lobster, packhorse rock lobster, and snapper within those areas.

39. At the wider Hauraki Gulf scale, existing management measures in the snapper (SNA 1) fishery have proved successful at rebuilding snapper biomass (see the snapper chapter in the May 2024 Fisheries Assessment Plenary). This trend is expected to continue over time, resulting in a snapper population structure that is increasingly capable of contributing to urchin predation throughout the Hauraki Gulf. The packhorse (PHC 1) fishery is considered likely to be at or above the biomass management target and unlikely to be overfished (see the packhorse rock lobster chapter in the November 2024 Fisheries Assessment Plenary).

40. If implemented, this proposed closure, which would only prohibit rock lobster harvest, would be the first species-specific closure of its kind in New Zealand. FNZ acknowledges it is not aware, within New Zealand, of evidence to support the effectiveness of closures to rock lobster harvest only for mitigating or reversing urchin barrens given

[21] Miller et al., 2023; Macdiarmid et al., 2013.
[22] Macdiarmid et al., 2013.
[23] New marine protections in the Hauraki Gulf/Tīkapa Moana
[24] Authorised under the Fisheries (Kaimoana Customary Fishing) Regulations 1998 or regulations 50-52 of the Fisheries (Amateur Fishing) Regulations 2013.
[25] Doheny et al., 2023.

the relative role that other urchin predators also play in addressing urchin barrens. However, it can be assumed that a closure of this type will, in many locations, result in an increase in the abundance of large rock lobster.

Existing and proposed spatial management measures (including closures) in CRA 2

41. There are no section 11 area closures currently in place for rock lobster in CRA 2.

42. There are several customary closures within CRA 2 that have been implemented under the Act including mātaitai reserves, taiāpure, and section 186A temporary closures (listed in Part 2 '*Mātaitai reserves and other customary management tools*'). FNZ recognises customary management areas are important tools for tangata whenua to manage their fisheries in a way that best fits their rohe moana.

43. There are eight marine reserves[26] within CRA 2 (listed under Part 2 '*Assessment of stock proposals against section 11 of the Act*') where harvest of all marine species is prohibited.

44. The Hauraki Gulf Marine Park[27] is, for the most part, situated within CRA 2. Within CRA 2, twelve closures are proposed as part of the Hauraki Gulf / Tīkapa Moana Marine Protection Bill[28] that will prohibit harvest of rock lobster harvest. These are:
    (a) Mokohīnau Islands High Protection Area
    (b) Te Hauturu-o-Toi / Little Barrier Island High Protection Area
    (c) Slipper Island / Whakahau High Protection Area
    (d) Cape Colville High Protection Area
    (e) Aldermen Islands / Te Ruamahua (north) High Protection Area
    (f) Aldermen Islands / Te Ruamahua (south) High Protection Area
    (g) Kawau Bay High Protection Area
    (h) Tiritiri Matangi High Protection Area
    (i) The Noises High Protection Area
    (j) Rangitoto and Motutapu High Protection Area
    (k) Pakatoa and Tarahiki / Shag Island High Protection Area
    (l) Motukawao Islands High Protection Area

Spatial characteristics of the CRA 2 fishery within the inner Hauraki Gulf

45. The best available information regarding the recreational harvest of rock lobster in CRA 2 comes from recreational boat ramp sampling and National Panel Surveys (**NPS**).[29] Recent boat ramp sampling data suggests that recreational rock lobster harvest (fish per trip) within the inner Hauraki Gulf has progressively declined since 2011/12 (see Figure 8 in Part 3 '*Additional figures*').

46. Survey data also suggests that:
    (a) The abundance of lobster in the inner Hauraki Gulf is lower than in other areas in CRA 1 and CRA 2.
    (b) The number of dive and snorkelling trips targeting reef species (including rock lobster) has declined across CRA 2 over time (see Figure 9 in Part 3 '*Additional figures*'). Notably, survey data indicated a decline in the number of reported trips in the inner Hauraki Gulf, which is the area in which over half of the recreational effort in FMA 1 takes place.

47. A review of annual commercial harvest data shows, over the last five years, that 0.5-2% of CRA 2 commercial harvest has been taken from the inner Hauraki Gulf area that is being considered for closure. Over the same timeframe and area, over 93% of CRA 2 fishing effort has taken place outside this area. The small amount of commercial fishing effort that has occurred within the inner Hauraki Gulf in recent years mostly occurs on reefs just south of the inner Hauraki Gulf boundary that has been proposed by FNZ.

The proposed closure

48. There is consensus among marine scientists that spatial closures of areas to rock lobster harvest will be an effective measure to increase the overall biomass and abundance of large rock lobster, that in turn can address urchin barrens.

49. FNZ is proposing a section 11 spatial closure within the inner Hauraki Gulf (Figure 2).

[26] Marine reserves are not fisheries management tools, but are included here as examples of area restrictions present within CRA 2.
[27] Defined in the Hauraki Gulf Marine Park Act 2000.
[28] Progress of the Bill can be found here and a copy of the Bill is available here.
[29] Maggs et al., 2024.

50. FNZ considers that the proposed closure should complement any modification of CRA 2 TAC settings to ensure that, within the Hauraki Gulf, rock lobster biomass can increase to a level at which this species can fulfil its ecological role as a predator of kina, naturally controlling the abundance of sea urchins and therefore the formation of urchin barrens.

51. FNZ acknowledges that closing the inner Hauraki Gulf will affect some commercial CRA 2 fishers. However, this is unlikely to restrain their ability to fish in other areas of CRA 2 where almost all effort and catch within the CRA 2 QMA occurs.

52. FNZ considers that the decline in recreational harvest of rock lobster from the inner Hauraki Gulf (both trips and catch) is a concerning trend, implying a reduction in the abundance of rock lobster. FNZ therefore considers that closing this area to both commercial and recreational harvesting of rock lobster is an appropriate response.

53. It is envisioned that this proposed closure would be in place until such a time that the biomass and population structure of rock lobster in the inner Hauraki Gulf has risen to a level that:
    a) allows this species to fulfil its ecosystem function as predators of urchins within this area; and
    b) can support a sustainable fishery.

54. Ecological monitoring of no-take marine protected areas within CRA 2 suggests it may take 15 or more years for ecological function to be restored in a full no-take marine reserve.[30] However, the time frame for rebuilding rock lobster biomass in a rock lobster-only closures within New Zealand is unknown, as is the impact this will have on the prevalence of urchin barrens.

55. If implemented, FNZ proposes to:
    a) undertake the monitoring required to sufficiently understand the ecological and fisheries consequences of the closure; and
    b) review the efficacy of and continued need for this proposed closure after 10 years.

56. FNZ considers that an appropriate ecological baseline for the inner Hauraki Gulf, against which future responses to management can be assessed, is provided by existing and ongoing studies, which include surveys of rock lobster and urchin distribution and population structure and the mapped distribution of urchin barrens across the inner Hauraki Gulf (see Part 3, '*Summary of urchin barren work programme to date*').

Spatial closure: Option B1 – No additional measures	
Benefits	• Commercial fishers would continue to be able to harvest rock lobster from within the inner Hauraki Gulf, which accounts for roughly 2% of CRA 2 landings over the last five years. • Recreational fishers would continue to be able to harvest rock lobster from within the inner Hauraki Gulf. However, we have heard from recreational stakeholders and tangata whenua that low abundance of rock lobster in the inner Hauraki Gulf means neither catch rates nor the recreational fishing experience currently meets expectations. Under this option, FNZ has no expectation that recreational catch rates in the inner Hauraki Gulf will improve, the exception possibly being at the margins of the new HPAs proposed by the Hauraki Gulf / Tīkapa Moana Marine Protection Bill, if enacted. • Rock lobster biomass is expected to increase within the proposed HPAs over time. Leaving the inner Hauraki Gulf open to rock lobster harvest would allow recreational and commercial fishers to utilise some portion of the HPA rock lobster biomass through spillover (the movement of fish and other marine life from a marine protected area to nearby fishing grounds). However, any aggregation of fishing effort at the boundaries of the HPAs may lead to localised depletion, which would negate this spillover benefit. • This option would not drive any displacement of fishing effort into the outer Hauraki Gulf, other parts of CRA 2 (both commercial and recreational) or into neighbouring QMAs, CRA 1 in particular (recreational only). However, FNZ has heard from recreational fishers some displacement has already occurred as fishing effort shifts from the inner Hauraki Gulf to outer Gulf islands in response to low abundance of rock lobster in the inner Gulf. • As not closing the inner Hauraki Gulf is unlikely to drive any additional displacement of fishing effort, this option is not expected to lead to increased competition or conflict between recreational and commercial fishers, or among commercial fishers.

[30] Babcock et al, 2010; Shears & Babcock, 2003; Leleu et al., 2012.

Risks	• This option is unlikely to result in an increase in the abundance of large rock lobster or overall population within the inner Hauraki Gulf, beyond changes that may occur due to the proposed HPAs. Consequently, it is unlikely that this option will result in decreased urchin abundance or grazing behaviour (outside of HPAs) and therefore it is unlikely that there will be a reduction in the prevalence of urchin barrens within the inner Hauraki Gulf. • Under this option, it is possible that the growth of rock lobster biomass within the HPAs will be diminished (both in terms of absolute biomass and rates of growth) due to the aggregation of fishing effort at the HPA boundaries. This is termed an 'edge effect,' which describes the process where individuals present within, but close to the edge of a protected area boundary are able to be harvested by those fishing outside the HPA (e.g. through attraction to bait, or normal movements of target species that would periodically take individuals beyond a marine protected area's boundaries). • Under this option it is likely that the recreational catch rates of rock lobster and the recreational fishing experience are not expected to improve. Recreational fishers based in the Auckland area who desire better access to the CRA 2 fishery will continue to need to travel beyond the inner Hauraki Gulf, with associated travel costs, resource use, and emissions. • FNZ has heard from tangata whenua that customary fishers have limited access to the rock lobster fishery both across CRA 2 and more specifically in the inner Hauraki Gulf (due to low abundance of lobster across the area) and that the current distribution and abundance of rock lobster does not meet their aspirations either as customary fishers or kaitiaki of their rohe moana. Under this option, FNZ does not anticipate the customary fishing experience will change significantly. FNZ expects that customary harvest of rock lobster will continue be limited, and that tangata whenua will continue to struggle to manaaki[31] with this taonga species. • A risk of both spatial management options presented here (Options B1 and B2) is that they do not address concerns raised by tangata whenua and stakeholders around CRA 2 sustainability and localised depletion outside of the inner Hauraki Gulf (noting that most reported urchin barrens are concentrated within the Hauraki Gulf). • The implementation of the proposed Hauraki Gulf HPAs would create some additional challenges for compliance enforcement. In that context, of the options proposed here, managing compliance of recreational fishers (particularly identifying lobster harvested in the HPAs) would be more challenging under Option B1 (no inner Hauraki Gulf closure) than under Option B2, where fishers would need to leave the inner Hauraki Gulf to legitimately harvest or possess rock lobster. • With rock lobster being described by some scientists as functionally extinct in the inner Hauraki Gulf, this option may not meet the purpose of the Act; specifically addressing the adverse effect of fishing.

Spatial closure: Option B2 – Closure of inner Hauraki Gulf to rock lobster harvest	
Benefits	• This option is more likely to lead to an increase in the abundance of large rock lobster, in addition to increasing the overall population, within the inner Hauraki Gulf. • This option is more likely to lead to rock lobster recovery within the proposed HPAs in the inner Hauraki Gulf as there will be no boundary fishing or edge effect. In turn this provides the greatest opportunity to reduce urchin barrens within HPAs due to the absence of boundary fishing edge effects for rock lobster. • Although it is uncertain whether a rock lobster closure on its own will lead to a decline in urchin barrens, the increased rock lobster biomass across the inner Hauraki Gulf that is likely to result from this closure may contribute to this biodiversity aspiration. • Rock lobster biomass is expected to increase within the HPAs and across the inner Hauraki Gulf over time. Recreational, customary Māori, and commercial fishers will be able to utilise some portion of this rock lobster biomass through spillover into the outer Hauraki Gulf. However, aggregation of fishing effort at the boundaries of the inner Hauraki Gulf may lead to localised depletion which would negate this spillover benefit. • This option is more likely to lead to an increase in the abundance of large rock lobster, in addition to an increase to the overall abundance and biomass, in what has historically been one of the most

[31] To cherish, conserve, and sustain.

	intensively fished recreational fishing areas within FMA 1. This approach will lead to much improved future experience and catch rates for recreational and customary fishers. • FNZ considers that this option would simplify compliance enforcement around recreational rock lobster harvest, as fishers who have not left the inner Hauraki Gulf should have no reason to be in possession of rock lobster. • Looking to the future management of the Hauraki Gulf, FNZ considers that once sufficient recovery has occurred, there will be an opportunity to run an engagement process to identify areas of inner Hauraki Gulf to be reopened to rock lobster harvest. Depending on the outcomes of the engagement process, harvest may be more limited in these areas than elsewhere in CRA 2 and there will be a possibility of developing bespoke management rules, for example, minimum or maximum size limits, or area-specific daily limits to support the longevity of sustainability and ecological benefits accrued during the closed period. This process could also be used to consider whether additional management measures would be appropriate elsewhere in the CRA 2 QMA.
Risks	• This option would prevent commercial fishers from accessing areas within the inner Hauraki Gulf where they currently harvest rock lobster. This includes areas at the margins of the proposed closed area (top of Coromandel and reefs from Cape Rodney to Kawau Island) which account for roughly 2% of CRA 2 landings over the last five years. • As the recreational rock lobster catch has declined and is already considered low within the inner Hauraki Gulf, the proposed closure is not expected to result in a significant loss of recreational harvest. Despite this, implementation of the proposed closed area may drive behavioural changes in recreational fishing or diving effort which could result in displacement of fishing effort to other areas. Such a change may displace effort to other areas in CRA 2 or into neighbouring QMAs (particularly CRA 1 to the north). • A risk of both spatial management options presented here (Options B1 and B2) is that neither address concerns raised by stakeholders around CRA 2 sustainability and localised depletion outside of the inner Hauraki Gulf. Option B2, closing rock lobster fishing in the inner Hauraki Gulf, has the potential to compound sustainability concerns elsewhere in CRA 2 through the displacement of fishing effort currently situated in the inner Gulf. • For the 2025 April sustainability round, TACC increases of up to 25% have been proposed. Should a TACC increase be implemented alongside the implementation of the proposed Hauraki Gulf HPAs and the closure of the inner Hauraki Gulf to rock lobster harvest, this could lead to an escalation in competition between and within fishing sectors. In turn this could increase the likelihood of localised depletion occurring, or worsening, in the areas of CRA 2 that remain open to rock lobster harvest. One way to address these concerns could be to specifically manage the rock lobster statistical area 905 (outer Hauraki Gulf) differently across both the recreational and commercial sectors. • Closing the inner Hauraki Gulf would increase costs for fishers (both recreational and commercial) who would be forced to travel further to target rock lobster. However, FNZ has heard from recreational fishers that they are already shifting fishing effort from the inner Gulf in response to low abundance of rock lobster.

Other possible CRA 2 fishery management measures

57. FNZ considers that an appropriate ecological baseline for the inner Hauraki Gulf, against which future responses to management can be assessed, is provided by existing and ongoing studies, which include surveys of rock lobster and urchin distribution and population structure, and the mapped distribution of urchin barrens across the inner Hauraki Gulf (see Part 3 '*Summary of urchin barren work programme to date*'). FNZ is not proposing further new fishery management measures (beyond those discussed above) within CRA 2 at the present time. However, FNZ is currently consulting on additional measures for CRA 1 to better manage the impact of rock lobster fishing on urchin barren formation within this QMA (see '*Proposed management measures for the Northland rock lobster fishery (CRA 1) to help mitigate urchin barrens*').

58. Notwithstanding that these two QMAs are two separate stocks at different biomass levels and with different stock dynamics, FNZ considers, given the prevalence of urchin barrens across coastal rocky reefs in north-eastern New Zealand, that there could be further opportunity to adopt other fishery management measures within CRA 2 in the future.

59. FNZ acknowledges the occurrence of kina barrens in other parts of CRA 2 beyond the inner Hauraki Gulf, that could be linked to localised rock lobster abundance. An urchin barren mapping project, funded by FNZ in 2024

(see Part 3 '*Summary of urchin barren work programme to date*'), is currently underway and is expected to provide more detailed and up to date information on the distribution of urchin barrens, in waters between 2 m and 10 m water depth, between Cape Reinga and East Cape. The outputs of this project could help inform, if necessary, appropriate fisheries management measures within CRA 2.

60. FNZ considers that the management of urchin barrens within CRA 2 to be an ongoing endeavour, and will require ongoing monitoring to inform the efficacy of any management measures adopted, and to inform the development and implementation of any further management measures deemed appropriate.

61. Further measures that could be considered for CRA 2 in the future include:

- QMA subdivision under section 25 of the Act. This could allow for more targeted management measures that accounts for the uneven distribution of urchin barrens across CRA 2 and acknowledge the differences in physical environment and fishing pressure between the inner Gulf and other parts of the QMA.
- Additional spatial closures to harvest of rock lobster.
- Additional no-take measures that would prohibit harvest of additional, or all, species.
- Seasonal closures of rock lobster harvest in CRA 2. These would be set under section 11 of the Act and could mitigate conflict between sectors using the same area (i.e., reducing overlap between sectors by separating fishing by sectors to different seasons) and discourage displacing effort to other locations.
- Setting vessel[32] and accumulation[33] limits for recreational vessels under section 11 of the Act.
- Increasing the minimum legal size and/or introducing a maximum legal size of rock lobster in CRA 2. While the intent of these measures would be to increase the abundance of large rock lobster, further modelling would be required to understand the long-term implications of altering minimum or maximum legal-size limits.
- Reviewing management measures for packhorse rock lobster, which are managed under a separate QMA (PHC 1) that covers the whole of New Zealand. Packhorse rock lobster are generalist predators and are known to consume urchins. Alongside rock lobster, packhorse rock lobster, are the only known predators of the long-spined urchin which are increasingly causing urchin barrens, especially in offshore islands of CRA 2.[34] In CRA 2, spiny and packhorse rock lobster are managed together within a combined recreational daily limit of six rock lobsters per fisher per day. Specifically, this combined recreational daily limit allows a maximum of three rock lobsters per fisher per day, and a maximum of six packhorse rock lobsters per fisher per day.

62. At the present time, more work would be required to understand the efficacy of the above measures within CRA 2, and associated risks and benefits. However, implementing and monitoring any measures adopted within CRA 1, to manage rock lobster fishing to help mitigate urchin barrens, could help inform fisheries management within CRA 2.

63. FNZ welcomes feedback on other fishery management measures, outside of what has been proposed, that could be effective at managing the impact of rock lobster fishing on localised depletion and urchin barren formation in CRA 2.

Who will be affected by the proposed changes?

64. The CRA 2 fishery extends from Te Arai Point, south of Whangarei, to East Cape at the easternmost end of the Bay of Plenty. CRA 2 is an important shared fishery with harvesting by customary, recreational, and commercial fishers. Rock lobster are culturally significant to tangata whenua who consider it to be a taonga species.

65. Commercial interests in these stocks include quota owners, vessel owner-operators and contract fishers in the catching sector, Licensed Fish Receivers (**LFRs**) and retailers and exporters. The interests of these groups are represented through organisations such as CRAMAC 2[35] and NZ RLIC.[36]

66. There are recreational interests in CRA 2. These interests are represented by a range of individuals, groups such as the New Zealand Sport Fishing Council, and various local fishing clubs and associations.

67. Tangata whenua have both commercial and customary interests in these stocks. The rohe of Hauraki/Tāmaki, Mai i Ngā Kuri a Whārei ki Tihirau and Ngā Hapu O Ngāti Porou Iwi Fisheries Forums overlap parts of the CRA 2 QMA.

[32] Limiting the number of spiny rock lobster allowed to be taken by individuals on a single vessel.
[33] Limiting the number of spiny rock lobster a person can accumulate and possess over a period of more than one day.
[34] Balemi and Shears, 2023.
[35] CRAMAC 2 is the commercial stakeholder organization operating in the CRA 2 QMA. CRAMAC 2 membership comprises of CRA 2 quota owners, processors, exporters, and fishermen.
[36] The NZ Rock Lobster Industry Council Ltd (NZ RLIC) operates as the central national agency for the commercial lobster fishing industry.

Input and participation of tangata whenua

68. FNZ has provided for input and participation of tangata whenua through engagement with the Iwi Fisheries Forums (listed above) by circulating and discussing information on the proposals. FNZ invited feedback from the Forums and offered to provide more detailed information upon request.

69. To date no specific feedback has been received from Hauraki/Tāmaki Iwi. A summary of feedback from Mai i ngā Kuri a Whārei ki Tihirau and Nga Hapu O Ngāti Porou is provided in Table 4. FNZ will engage further with the Iwi Fisheries Forums during consultation. FNZ also welcomes any input from tangata whenua outside of this planned engagement.

Table 4: Iwi Fisheries Forum feedback to date.

Mai i ngā Kuri a Whārei ki Tihirau	This Forum provided feedback in August 2024. The Forum expressed ongoing concern for the abundance of rock lobster in their customary fisheries, with some members expressing a view that there should not be a TAC increase until an abundance increase has been observed. There was collective consensus that the stock should be managed to a higher biomass level than it currently is so rock lobster can fulfil its role as a predator of kina.
Nga Hapu O Ngāti Porou	This Forum provided feedback in October 2024. The Forum also expressed ongoing concern for the abundance of rock lobster in their customary fisheries, with some members expressing a view that there should not be a TAC increase at this time. There was collective consensus that the stock should be managed to a higher biomass level than it currently is.

Fishery characteristics and settings

Table 5: Fishery characteristics and settings for CRA 2.

Commercial (TACC)
70. The current TACC is 80 tonnes.
71. Almost all CRA 2 commercial harvest is from potting.
72. Commercial interests in these stocks include a number of quota owners (10% of all CRA 2 shares are Settlement quota), owner/operators and contract fishers in the catching sector, and LFRs. The commercial fishing interests of these groups are represented through organisations such as Te Ohu Kaimoana, CRAMAC 2 and NZ RLIC.
73. Based on the last three fishing years, in CRA 2 there have been on average 46 quota owners, and 16 permit holders landing rock lobster catch to eight LFRs. Over the last ten years the number of quota owners in CRA 2 has steadily declined from 51, down to 43 at the start of the 2024/25 fishing year.
74. The 2023/24 fishing year saw six LFRs receiving rock lobster from CRA 2 after a fairly consistent average of ten LFRs receiving CRA 2 rock lobster over the previous nine years.
75. Over the last three fishing years, there were between 16 and 18 vessels landing rock lobster from CRA 2, compared with 29 to 40 vessels operating in the previous three decades.
76. Over the last five years the CRA 2 average annual port price[37] revenue has been $6.77 million, while over the same period the estimated average free-on-board[38] export revenue attributable to CRA 2 was $10.17 million.

[37] Includes wharf sales and excludes loss from holding pots and value derived outside of the catching sector, such as in processing and retail.

[38] Free-on-board is the value of export goods, including raw material, processing, packaging, storage, and transportation up to the point where the goods are about to leave the country as exports. FOB does not include storage, export transport or insurance cost to get the goods to the export market. Export prices are not provided as regionally specific for the origin of rock lobster, even though rock lobster from some regions may receive a higher export price. Estimated stock specific export free-on-board revenue assumes that export revenue is proportional to quantity landed.

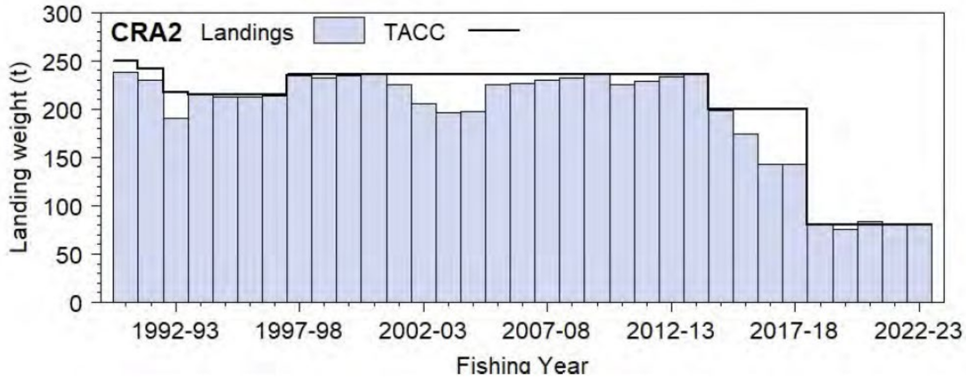

Figure 4: Historical landings and TACC for CRA 2.

Customary Māori
77. The current customary allowance is 16.5 tonnes. 78. CRA 2 customary catch is provided for by the Fisheries (Kaimoana Customary Fishing) Regulations 1998, and regulations 50-52 of the Fisheries (Amateur Fishing) Regulations 2013 (**Amateur Regulations**). 79. In the last five years, a total of 9,765 unspecified units[39] of rock lobster were reported as authorised for customary harvest from CRA 2, averaging 1989 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. 80. For the 2022 CRA 2 stock assessment customary catch was modelled at five tonnes, which was split 10%/90% between seasons, with 90% assumed taken in the spring/summer and the balance in the autumn/winter. 81. FNZ acknowledges that there is uncertainty in the available information that can inform the customary allowance for CRA 2. Therefore, FNZ considers that based on available information, maintaining this allowance at 16.5 tonnes is appropriate and no change is proposed. 82. FNZ welcomes feedback on this allowance.
Recreational
83. The current allowance for recreational fishing in CRA 2 is 34 tonnes. 84. The majority of recreational harvest is hand gathering via diving, with a smaller amount harvested by potting. 85. The 2022/23 National Panel Survey (**NPS**) of Marine Recreational Fishers (Heinemann & Gray, 2024) estimated an annual recreational take of 9.99 tonnes (±3.10 tonnes). This estimate, combined with estimates of Amateur Charter Vessel harvest (0.91 tonnes), and recreational take under section 111 of the Act (recreational harvest taken by commercial fishers) (1.20 tonnes), provides a total estimated recreational catch of 12.10 tonnes. 86. It is considered that the current allowance is appropriate and therefore FNZ is not proposing a change. FNZ welcomes feedback on this allowance.
Other sources of mortality caused by fishing
87. The current allowance for other sources of mortality caused by fishing is 42.5 tonnes. 88. Other sources of mortality caused by fishing in CRA 2 include illegal catch, handling mortality caused by the return of under-sized lobsters, berried female lobsters, and high-grading, as well as predation on lobsters by octopus and other predators within pots. 89. The 2022 CRA 2 stock assessment modelled illegal catch as 20% of the total commercial catch summed over the period 1979–1989, followed by 10% of the summed commercial catch from 1990 to 2021. This assessment modelled illegal catch at 27.4 tonnes. 90. The 2024 rapid update assessment estimated the handling mortality median value to be 1.48 tonnes, while non-size-limited mortality (illegal + customary) was modelled at 25.65 tonnes. 91. For the purpose of this consultation, based on the recent stock assessment and rapid update, FNZ has assumed current other mortality caused by fishing to be 30 tonnes.

[39] Customary harvest of rock lobster is usually reported as kilograms or number of individuals. However, in some cases (such as in CRA 2) the unit used is not specified.

92. For Option A1 (*status quo*) FNZ has proposed not to modify this allowance. For Options A2 and A3, the proposed increase (from 30 tonnes) is scaled as the same increase to the TACC under these options (12.5% for Option A2 and 25% for Option A3).

93. FNZ welcomes feedback on this allowance.

Additional supporting information and legal context

94. In Parts 2 and 3 below there is additional information to support the above analysis and proposed options. Part 2 outlines our initial assessment of the proposed changes against provisions of the Fisheries Act 1996. Part 3 provides information about the status of the stock, additional figures, and more detailed science and management information which informed our analysis in Parts 1 and 2.

95. In Part 2, the proposals have been assessed against sections 9, 10, 11, and 13 of the Act. There is also information on mātaitai reserves and other customary management tools which are relevant to the Minister's decision making under section 21(4).

96. For information on how the proposed changes meet the requirements of sections 5 (Application of international obligations and Treaty of Waitangi (Fisheries Claims) Settlement Act 1992), and 8 (Purpose) of the Act, as well as detail on the statutory considerations relevant to TAC decisions, see the Legal Appendix on our consultation webpage.

How to have your say

97. We welcome your views on these proposals. Please provide detailed information and sources to support your views where possible.
    - Do you support using a higher biomass management target for long-term management of the CRA 2 stock? Why?
    - What do you think of the long-term biomass management targets discussed? Do you support a particular biomass management target?
    - Do you support the 2x B_R preliminary management target? Why?
    - Which option do you support for revising the TAC and allowances? Why?
    - Do you support the proposed spatial closure? Why?
    - Do you support the boundaries that FNZ has suggested for the proposed inner Hauraki Gulf closure? Why?
    - If you do not support any of the options listed, what alternative(s) should be considered? Why?
    - Do you think any additional measures should be considered?
    - 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?
    - What are your aspirations for the CRA 2 fishery? Do you think there is another way to realise this outside of this discussion document?
    - Do you have any concerns about potential impacts of the proposed options on the aquatic environment?
    - Is there any relevant literature or research you are aware of that you think should have been referred to in this paper?
    - Do you have any further information to share on the location of urchin barrens in CRA 2?
    - Are there other fishery management measures that you feel could be appropriate in CRA 2? Why?

98. FNZ invites you to make a submission on the proposals set out in this discussion document. Consultation closes at **5pm on 29 January 2025**.

99. Please see the FNZ sustainability consultation webpage 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.

Part 2: Initial assessment against relevant legal provisions

Overview

100. The tables below outline FNZ's initial assessment of the proposed changes against sections 9, 10, 11, and 13 of the Act. Information to support this assessment can be found in Part 3 '*Supporting information*'. Information on kaitiakitanga and mātaitai reserves and other customary management tools has also been provided – this is relevant to the Minister's decision making under sections 12(1)(b) and 21(4).

101. For information on how the proposed changes meet the requirements of sections 5 (Application of international obligations and Treaty of Waitangi (Fisheries Claims) Settlement Act 1992), and 8 (Purpose) of the Act, as well as detail on the statutory considerations relevant to TAC decisions, see the Legal Appendix on our consultation webpage.

Initial assessment of the proposals against section 13 of the Act

102. Table 6 below outlines FNZ's initial assessment of the proposed options for CRA 2 against section 13(2)(c) of the Act. This assessment has been informed by the best available information on the status of the stock (summarised in Part 1 under '*Rationale* for *review*' and detailed in Part 3 under '*Stock status*') and the information discussed in '*Information on biology, interdependence, and environmental factors*' in Part 3.

Table 6: Initial assessment of the proposed changes under section 13(2)(c) of the Act.

Section 13(2)(c)	103. The biomass of CRA 2 can be reliably estimated in relation to *MSY* using the 2022 stock assessment and 2024 rapid update assessment, which showed both vulnerable and spawning stock biomass to be high relative to the biomass management target. Both vulnerable and spawning stock biomass are projected to increase over time. Uncertainties associated with the stock assessment are discussed under '*Information principles: section 10 of the Act*'. 104. While the biomass of the stock is estimated to be above the *MSY*, there is a desire among many stakeholders to manage biomass to an even higher level above the *MSY*. As noted above, FNZ also considers that biomass should be moved to a higher level; toward 2x B_R at a minimum, to help rock lobster better fulfil their ecosystem role as a predator of urchins. 105. FNZ is consulting on three TAC options, all of which intend to move the stock toward a higher level above the *MSY*. A change to the TAC (per any of these options) would be made under section 13(2)(c) of the Act. A TAC set by the Minister under this section of the Act must enable the level of any stock whose current level is above that which can produce the maximum sustainable yield 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 the maximum sustainable yield, while having regard to the interdependence of stocks. 106. FNZ's initial view is that the three proposed TAC options would all be consistent with the objective of enabling the stock to move to a level above that which can produce the *MSY*. This is reinforced by the forward projections from the stock assessment model, which project that biomass will continue increasing under all three options. 107. The way and rate at which the stock will increase towards a higher level will depend on the TAC setting. Under Option A1 (status quo) the stock is likely to reach a higher biomass level more quickly (projected to reach 1.95x B_R by 2028) than if the TAC were increased under Option A2 (projected to reach 1.88x B_R by 2028) or Option A3 (projected to reach 1.80x B_R by 2028). Way and rate considerations are discussed further below within this table.
Harvest Strategy Standard	108. Two alternative measures of biomass for the CRA 2 stock have been provided by the 2022 assessment model and subsequent updates, spawning stock biomass (**SSB**) and vulnerable biomass. These two alternative measures of biomass for the stock are required because: a) The Harvest Strategy Standard for New Zealand Fisheries (**HSS**) specifies that the default biomass management target is 40% B_0, the soft limit 20% B_0, and the hard limit is 10% B_0, and specifies that these should be determined relative to the SSB of the unfished level; and

b) The maximum sustainable yield for CRA 2 can only be calculated from the vulnerable biomass component of the stock, which is the component that provides yield from the fishery.

109. Because these two measures of biomass are not directly comparable, the current stock status cannot be directly assessed relative to both the soft and hard limits and the B_{MSY} (B_R) target level on the same plot, and they are shown below independently of each other in Figure 5.

110. FNZ has undertaken research to determine B_{MSY} for rock lobster with B_{MSY} reference levels 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 maximum sustainable yield, while meeting the risk constraints in the HSS. B_{MSY} reference levels represent a default biomass management target.

111. Because of the points covered above, the biomass management target (B_R) for CRA 2 is a B_{MSY} proxy (rather than being 40% SB_0). The 2024 rapid update assessment estimates CRA 2 vulnerable biomass to be at 154% B_R and spawning biomass to be at 38% of SB_0, (well above the soft and hard limits). Spawning and vulnerable are both expected to increase under all the proposed TAC options remaining above B_R and hard and soft limits. With respect to the suggested preliminary biomass management target of 2x B_R (200% B_{MSY}), all TAC options proposed are expected to lead to the stock eventually increasing in biomass towards this biomass management target, albeit at different rates of biomass increase for each option. The TAC increases proposed under Options A2 and A3 will reduce the rate of biomass increase, as opposed to maintaining the current TAC (see Figure 3).

Section 13(2)(c)

Interdependence of stocks

112. Evidence suggests predation upon rock lobsters by octopus, rig, blue cod, grouper, southern dogfish, seals, and other rock lobsters. These species have relatively broad diets, and it is unlikely that any of them are dependent on rock lobster as a food source.

113. Rock lobsters are ecologically important predators in New Zealand's rocky reef ecosystems, where they can exert top-down regulation of prey populations. Rock lobsters are known to prefer bivalves but they do eat a wide variety of foods such as crabs, starfish, seaweeds, small fish, and sea urchins (being the few predators known to eat larger urchins). At least on the northeast coast of New Zealand (but possibly at other locations), predation on urchins by rock lobster can play a significant role in determining the prevalence and distribution of urchin barrens (discussed under Part 3 '*Urchin barrens*').

114. It is important to note that kelp and other macroalgal species are indirectly affected by fishing for rock lobster (as well as harvest of other species that feed on sea urchins). Removal of rock lobster (and other urchin predators) reduces predation on sea urchins, which graze on macroalgae (including kelp) and some benthic invertebrates, though the density of rock lobster abundance required that will result in the formation of urchin barrens is unknown (also noting there are other reef-based predators that predate on urchins). Under reduced predation, urchins can increase in abundance and over-graze kelp, resulting in reef habitat devoid of macroalgae. These areas are known as urchin barrens.

115. There is uncertainty about the biomass of rock lobster that would need to be left unharvested in CRA 2 to enable rock lobster to fulfil their ecological function as a predator of sea urchins.

116. There is some uncertainty regarding how much TAC changes for CRA 2 would impact rock lobster size and age distribution, and what size and age distribution of rock lobster would be required to mitigate and remedy existing urchin barrens and avoid the formation of new urchin barrens.

117. In the immediate term, FNZ proposes to manage CRA 2 stock biomass to 2x B_R, with the proposed TAC options expected to increase the stock's biomass towards this biomass management target at different rates. TAC options that propose either no or minimal increase to catch allowances are expected to lead to a greater rate of biomass increase compared to TAC options that allow a greater increase to catch allowances.

118. FNZ considers that a suite of management controls, including approaches to (a) reduce urchin biomass at particular sites and (b) increase the abundance of a range of kina predators such as snapper, will be required to address the issue of urchin barrens. FNZ

	considers that the proposed closure, if implemented, will complement any modification of CRA 2 TAC settings to ensure that, within the inner Hauraki Gulf, rock lobster biomass can increase to a level where this species is able to fulfil its ecological role as a predator of kina, naturally controlling the abundance of urchins and therefore the formation of urchin barrens.
Section 13(2)(c) Way and rate that will result in stock moving above a level that can produce MSY	119. Approaches to the way in which, and rate at which, a stock is moved above the biomass management target include, but are not limited to, different rates of reduction to TACs and TACCs (e.g., immediate or gradual/phased), gear modifications/restrictions (i.e., to increase selectivity), and closed areas (e.g., spawning or nursery grounds). 120. All TAC options proposed are expected to lead to the stock eventually increasing in biomass to 2x B_R, albeit each option at a different way and rate. The TAC increases proposed under Options A2 and A3 will increase the amount of time it will take for the stock to reach 2x B_R (a longer way and rate), as opposed to maintaining the current TAC (see Figure 3). 121. The proposed spatial closure, if implemented, may also lead to a shorter way and rate at which the stock reaches 2x B_R by closing harvest within the inner Hauraki Gulf, where rock lobster that are not fished contribute to the overall biomass of CRA 2. However, this cannot be quantified at the present time.
Section 13(3) Factors to have regard to in considering the way and rate the stock is moved towards or above B_{MSY} (B_R)	122. In considering the way and rate at which a stock is moved towards or above a level that can produce the maximum sustainable yield, the Minister must have regard to the social, cultural, and economic factors they consider relevant. 123. Maintaining the CRA 2 TAC, while a faster rate to 2x B_R, will provide for no further opportunity for commercial utilisation of the fishery. However, benefits associated with attaining a higher stock biomass management target are anticipated to be realised more quickly: • Improved CPUE, improved efficiency, and reduced operating costs for commercial fishers. • Better catch rates and experience for customary and recreational fishers. • Ecological benefits associated with a higher abundance of rock lobster, that in turn may have wider social, cultural, and economic implications associated with better ecosystem health. 124. While a longer rate to 2x B_R, increasing the CRA 2 TAC as proposed under Options A2 and A3 will provide further opportunity for commercial utilisation of the fishery. The benefits associated with a higher stock biomass management target are still anticipated to be realised, albeit more slowly than maintaining the current TAC. 125. Potential increases to export earnings associated with a TAC increase (Options A2 and A3) are discussed under Part 1 '*TAC Options*'. 126. Commercial stakeholders potentially affected by a TAC change (quota owners, fishers, and LFRs) are discussed under Part 1 '*Fishery characteristics and settings*'.

Kaitiakitanga

127. Information provided by Iwi Fisheries Forums, and iwi views on the management of fisheries resources and fish stocks, as set out in Iwi Fisheries Plans, are among the ways that tangata whenua can exercise kaitiakitanga in respect of fish stocks.

128. As noted above under *'Input and participation of tangata whenua'*, three Iwi Fisheries Forums represent iwi with interests in CRA 2.

129. Mai i ngā Kuri a Whārei ki Tihirau, has a fisheries plan which lists rock lobster, kina, and kelp as taonga species. The plan also sets out objectives for management of fish stocks. Objectives relevant to this review include:
a) Management Objective 1: Iwi fisheries management activities support the growth and wellbeing of our people.
b) Management Objective 2: Iwi are actively engaged with others to increase their fisheries potential within environmental limits.
c) Management Objective 3: The fisheries environment is healthy and supports a sustainable fishery.
d) Management Objective 4: Tino rangatiratanga is advanced to ensure that iwi driven goals are achieved.

130. FNZ considers that the proposed management measures presented in this paper generally contribute towards these objectives, as they aim to support sustainability of the fishery and the surrounding ecosystem. However, as noted in Table 6 above, some members of the Mai i ngā Kuri a Whārei ki Tihirau Forum have expressed opposition to increasing the TAC of CRA 2 until an abundance increase has been observed. This suggests that of the TAC options proposed, the forum members consider Option A1 (the status quo) would best meet their Fisheries Plan objectives.

131. FNZ is seeking further input from tangata whenua on how the proposed measures for CRA 2 may or may not provide for kaitiakitanga as exercised by tangata whenua, and how tangata whenua consider the proposed measures may affect their rights and interests in this stock.

132. Currently within the Nga Hapu O Ngāti Porou Iwi Fisheries Forum there are 11 draft hapū plans that are in the final stages of completion and are expected to be signed off by the relevant hapū management unit soon. The Nga Hapu O Ngāti Porou Iwi Fisheries Forum is also currently preparing a forum fisheries management plan.

133. Customary tools under the Fisheries (Kaimoana Customary Fishing) Regulations 1998 and the Act enable tangata whenua to autonomously manage important customary fishing grounds in ways that best fit local customary practices in the form of mātaitai reserves, taiāpure, and temporary closures.

134. Where a hapū or iwi manage their customary fishing activities under the Fisheries (Kaimoana Customary Fishing) Regulations 1998 they are able to determine their own customary practices, which can include the exercise of kaitiakitanga to remove urchins to rebalance the ecosystem of their customary fishing grounds.

135. In addition, recent approval of a traditional non-commercial fishing use under regulation 52(1) of the Amateur Fishing Regulations enables the taking, disposal, culling, or translocation of kina from traditional fishing grounds to manage the population of kina to maintain the balance of the ecosystem.

Mātaitai reserves and other customary management tools

136. Section 21(4) of the Act requires that, when allowing for Māori customary non-commercial interests, the Minister must take into account any mātaitai reserve in CRA 2 that is declared by notice in the Gazette under regulations made for the purpose under section 186, and any area closure or any fishing method restriction or prohibition imposed under section 186A or 186B.

137. The mātaitai reserves, area closures, fishing method restrictions, and prohibitions that apply in CRA 2 are listed in Table 7 below.

138. It is not anticipated that the proposed TAC changes for CRA 2 would negatively impact the availability of these species in these areas, given their increasing abundance and the distribution of commercial fishing effort outside of these areas.

139. There could be some potentially positive effects in these areas in the distant future if the proposed spatial closure is implemented. Furthermore, a higher biomass management target could potentially have positive effects in these areas through a higher CRA 2 biomass, meaning greater abundance of rock lobster and greater abundance of large rock lobsters.

140. For more information on how mātaitai reserves and other customary management tools are relevant for TAC decisions, see heading 2.7 in the Legal Appendix (*Matters to be taken into account in setting or varying any total allowable commercial catch – section 21 of the Act*).

Table 7: Mātaitai reserves and other customary management tools that apply to CRA 2.

Customary area	Management type
Te Maunga o Mauao Te Rae o Kohi Raukokore Te Kopa o Rongokānapa	**Mātaitai reserve** Commercial fishing is not permitted within mātaitai reserves unless regulations state otherwise (Te Kopa o Rongokānapa allows some limited commercial catch).
Maketu	**Taiāpure** All types of fishing are permitted within a taiāpure. The management committee can recommend regulations to manage commercial, recreational, and customary fishing.
Waiheke Island	**Temporary closures** Section 186A temporary closures are used to restrict or prohibit fishing of any species of fish, aquatic life, or seaweed or the use of any fishing method. Waiheke Island – closed to mussel, rock lobster, and pāua harvest. Other temporary closures that are present within the CRA 2 QMA but do not apply to CRA 2: • Umupuia Beach – closed to cockle harvest only. • Te Mata and Waipatukahu – closed to pipi, cockle, mussel, and oyster harvest.

Initial assessment of the proposals against section 9 of the Act

141. Table 8 below outlines FNZ's assessment of the proposed options for CRA 2 against the environmental principles in section 9 of the Act which the Minister must take into account when considering the CRA 2 TAC. This assessment has been informed by our knowledge of the current environmental impact of this fishery, which is discussed under *'Information on environmental impacts'* within Part 3.

Table 8: Initial assessment of the proposed changes under section 9 of the Act.

<table>
<tr><td>Associated or dependent species should be maintained above a level that ensures their long-term viability - Section 9 (a) of the Act</td><td>
142. Potting is the primary method for rock lobster harvest in CRA 2. Pots are considered to be set too deep for seabirds to enter; there have been no recorded seabird interactions within the CRA 2 fishery over the last decade.
143. Potting fisheries can interact with marine mammals by entangling species such as humpback whales and orcas. However, these events are rare. Within the CRA 2 fishery there has been one mammal interaction reported with pot or trapping gear over the last decade.
144. Incidental fish and invertebrate catch in CRA 2 is predominantly packhorse rock lobster and snapper (landed), and octopus and red moki (mostly released alive).
145. FNZ is proposing:
• TAC options ranging from status quo to a 9% increase (see Part 1 'TAC options'). While there is a higher probability of increased fishing effort under any TAC increase, as noted above, the CRA 2 potting fishery rarely interacts with seabirds, mammals, or any species of conservation concern. Given this, FNZ considers it unlikely that any of the proposed TAC options would threaten the long-term viability of any associated or dependent species.
• Setting a preliminary biomass management target of 2x B_R, a higher biomass management target than at present. Therefore, in the longer term, there is a reduced probability of attributable interactions and/or any threat to the long-term viability of any associated or dependent species.
• A spatial closure of the inner Hauraki Gulf (see Part 1 'Proposed spatial closure'). Closure of the inner Hauraki Gulf is expected to lead to the elimination of rock lobster harvest within this area, and in turn significantly reduce the probability of attributable interactions and/or any threat to the long-term viability of any associated or dependent species within this area. However, this could lead to a redistribution and aggregation of effort in other locations within CRA 2, notably on the boundary of the proposed spatial closure, which could significantly increase the likelihood of
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</table>

	attributable interactions and/or any threat to the long-term viability of any associated or dependent species. Not proceeding with the proposed closure means this probability will not reduce and may increase if there is an increase to the TAC. • Furthermore, if the proposed spatial closure proceeds, it would be expected that some associated species within the inner Hauraki Gulf might indirectly benefit as the ecosystem changes that is expected to favour enhanced biodiversity.
Biological diversity of the aquatic environment should be maintained - Section 9(b) of the Act	146. Potting is the main method of targeting rock lobster commercially. Previous studies have shown that potting is likely to have very little direct effect on non-target species.[40] However, one study that reviewed the impact of crustacean potting on benthic assemblages noted that while these potted areas were characterised by species indicative of a healthy reef system, it did note there was a potential concern of potting damage on long-lived, slow growing taxa.[41] Any change of fishing effort as a result of the proposed TAC options is considered unlikely (in most cases) to have a direct impact on the biological diversity of the aquatic environment, caution may be required when considering benthic environments that could be sensitive to potting damage. 147. Fishing for rock lobster can indirectly impact biological diversity of the aquatic environment because of the relationship between abundance and size distribution of rock lobster and the abundance of kina, which graze on kelp (discussed further in Part 3 *'Urchin barrens'*). The abundance and size distribution implications under each option are discussed under Part 1 *'Analysis of proposed options'*. 148. FNZ is proposing: • TAC options ranging from status quo to a 9% increase (see Part 1 *'TAC options'*). A greater TAC increase would provide for more utilisation of the fishery, that in turn would likely constrain rock lobster abundance, which in turn would reduce the likelihood that rock lobster can fulfil their ecological role. This would likely result in a lower amount of biological diversity than what would be expected if a smaller/no TAC increase were implemented. • Setting a preliminary biomass management target of 2x B_R, a higher biomass management target than at present. Therefore, in the longer term, there is a higher probability of increasing rock lobster abundance, which in turn increases the likelihood that rock lobster can fulfil their ecological role. This would likely result in higher biological diversity within CRA 2 than what would be expected if the stock were managed to a lower biomass level. • A spatial closure of the inner Hauraki Gulf (see Part 1 *'Proposed spatial closure'*). Closure of the inner Hauraki Gulf is expected to lead to the elimination of rock lobster harvest within this area, and in turn is expected to lead to an increase in biomass and the abundance of large rock lobster. In the long term, this is expected to lead to an increase in rock lobster abundance and in turn increase their ecological role within in the inner Hauraki Gulf, which increases the likelihood of an increase in biological diversity. However, this could also lead to a redistribution and aggregation of effort in other locations within CRA 2, notably on the boundary of the proposed spatial closure, which could significantly increase the harvest of rock lobster in those areas, the reduction of their ecological role, and in turn leading to a reduction in biodiversity.
Habitat of particular significance for fisheries management should be protected - Section 9(c) of the Act	149. The main methods for taking rock lobster are potting and hand-gathering. Both methods are considered to have low levels of benthic impact. 150. FNZ has identified eight potential habitats of particular significance for fisheries management in the CRA 2 QMA (see Part 3 *'Potential habitats of particular significance for fisheries management'*). All but one do not overlap with areas where rock lobster fishing occurs, and none include kelp as a key species, meaning it is unlikely that the options for CRA 2 proposed here would result in a risk of adverse effects for any of these habitats. Potting for rock lobster in one potential habitat of particular significance, Craddock Channel, is spatially localised, and the biogenic habitat of dog cockles and horse mussels is considered likely to be resilient to cray potting.

[40] Coleman et al., 2013; Stephenson et al., 2017.
[41] Gall et al., 2020.

	151. The proposal to close the inner Hauraki Gulf to all rock lobster fishing would include closing access to three potential habitats of particular significance to fisheries management (Whangateau Harbour, Kawau Bay, and Ponui Island) for the purpose of rock lobster fishing. As there is no known fishing for CRA 2 over the potential habitats of particular significance for fisheries management, and the methods for taking rock lobster have low levels of benthic impact, the closure is unlikely to have a direct effect on the potential habitat of particular significance for fisheries management in CRA 2. 152. While FNZ does not currently have evidence available to support the identification of specific (spatially-defined) areas of kelp-dominated habitat as potential habitat of particular significance for fisheries management, we recognise the likely importance of kelp-dominated habitat in supporting settlement, recruitment, and productivity of a number of species, including rock lobster. The options proposed here have potential to support kelp recovery in the long term.

Initial assessment of the proposals against section 11 of the Act

Table 9: Initial assessment of the proposed changes under section 11 of the Act.

The Minister must take into account:	
Effects of fishing on any stock and the aquatic environment – section 11(1)(a)	153. "*Effect*" is defined widely in the Act.[42] The direct effects of fishing for rock lobster need to be considered, as well as the indirect effects of this fishing on other species and the surrounding ecosystem. 154. There is information about the direct effects of fishing on the CRA 2 stock throughout this paper, particularly within Part 1 under '*TAC options*' and *'Fishery characteristics and settings'*, and in Part 3 under *'Stock status'.* 155. The direct effects of fishing for other stocks caught in the CRA 2 fishery are summarised above in Table 8, and further detailed below in Part 3 under '*Information on environmental impacts'.* 156. Indirect effects of fishing for other species, for example, potential impacts of fishing for rock lobster's food chain, are summarised above under the '*interdependence of stocks'* part of Table 6, and in Table 8. Further background analysis about potential indirect effects is provided in Part 3 under '*Urchin barrens'* and *'Information on biology, interdependence, and environmental factors'.* 157. The magnitude of the effects of fishing on the CRA 2 stock, other associated stocks and species, and the wider environment, will vary depending on the TAC for CRA 2, the biomass management target for the fishery, and the implementation of any area closures. Greater effects are likely to occur under higher TAC settings, and the Minister must consider this in his decisions on these measures. The Minister must also consider that the proposed closure in the inner Hauraki Gulf would remove effects of rock lobster fishing on the stock and environment within that area. However, as noted above, this could potentially also result in increased effects of fishing in the remaining areas of CRA 2 due to displacement of effort.
Existing controls that apply to the stock or area – section 11(1)(b)	158. A range of existing management controls apply to CRA 2. These are listed below and apply to both recreational and commercial fishers unless noted otherwise. (a) **Gear restrictions**: the use of spears for taking rock lobsters is prohibited. Recreational fishers are also prohibited from using spring loaded loops or lassos, or from using set or baited nets for taking rock lobster. (b) **Number of pots (recreational only)**: there is a maximum number of pots that may be used, set, or possessed in New Zealand fisheries waters on any day for recreational purposes. Recreational fishers are restricted to three pots. Two or more recreational fishers on a vessel are restricted to a combined total of six pots.

[42] Section 2(1) of the Act defines "effect" to mean the direct or indirect effect of fishing, and includes any positive, adverse, temporary, permanent, past, present, or future effect. It also includes any cumulative effect, regardless of the scale, intensity, duration, or frequency of the effect, and includes potential effects.

	(c) Escape apertures: a fisher must not set, use, or possess on a vessel a rock lobster pot, unless the pot has at least two rectangular apertures (other than the mouth of the pot) through which undersize rock lobsters are able to escape. (d) Must be measurable: rock lobster must be possessed in a state that can be measured. (e) Size restrictions**:** rock lobsters have a minimum legal size of 60 mm tail width for females and 54 mm tail width for males. (f) Prohibited states**:** it is illegal to take or possess rock lobsters carrying external eggs (in berry), or rock lobsters in the soft-shell stage (post moulting). (g) **Telson clipping (recreational only)**: A person who takes any rock lobster from CRA 2 must, on taking the rock lobster, cut one-third of the telson off the tail fan. (h) **Area closures**: There are several mātaitai reserves, taiāpure, and section 186A closures area closures within CRA 2 (see Part 2 '*Mātaitai reserves and other customary management tools*'). Two marine protected areas, within Tauranga Habour and the Motiti Islands, in CRA 2 prevent commercial and recreational fishing (not including urchin harvest or Māori non-commercial customary fishing rights). Both recreational and commercial fishing are subject to restrictions and prohibitions within the Hauraki Gulf, Kawau Island, Whangaparaoa Peninsula, Great Barrier Island Cable Protection Zones. There are also eight marine reserves protected under the Marine Reserves Act (1971), in which all types of fishing are prohibited; Cape Rodney - Okakari Point, Tāwharanui, Long Bay – Okura, Motu Manawa-Pollen Island, Te Matuku, Whanganui A Hei (Cathedral Cove), Tuhua (Mayor Island), and Te Paepae o Aotea (Volkner Rocks). Marine reserves are not fisheries management tools but are included here as examples of area restrictions that apply to CRA 2. (i) Daily limits (recreational only): no person may take or possess more than three rock lobsters within the combined daily limit of six rock lobsters (rock lobster and packhorse combined).
The natural variability of the stock – section 11(1)(c)	159. Rock lobster stocks generally have a high level of natural variability. Populations can fluctuate rapidly in response to changes in the environment, which can affect the recruitment, abundance, and availability of rock lobsters. This variability is taken into account in the stock assessments used to inform the development of TAC options. 160. Environmental factors that are thought to influence the productivity of rock lobster populations include water temperature, ocean currents, shelter availability, and food availability.[43] Rock lobster grow at different rates around New Zealand, and female lobster mature at different sizes.[44] 161. Given the number of environmental variables that can influence the productivity (notably recruitment) of rock lobster, any modification of the TAC should be approached with caution. 162. The natural variability of CRA 2 in respect to climate change is discussed in Part 3 '*Environmental conditions affecting the stock*'.
Hauraki Gulf Marine Park Act - section 11(2)(c)	163. Section 11(2)(c) of the Fisheries Act 1996 requires the Minister to have regard to sections 7 and 8 of the Hauraki Gulf Marine Park Act 2000 when varying the TAC relating to stocks with boundaries intersecting with the Park. 164. Section 7 recognises the national significance of the Hauraki Gulf and section 8 sets out objectives for management of the Hauraki Gulf Marine Park. 165. The boundaries of the Hauraki Gulf Marine Park also intersect with CRA 2. 166. The proposals discussed in this consultation paper aim to promote sustainable use of the CRA 2 resource. In respect to the proposed spatial closure, that seeks to rebuild rock lobster abundance within the inner Hauraki Gulf, there are expected to be some negative implications for social, economic, and recreational well-being in the short term, but this would improve in the long-term, along with improved cultural wellbeing.

[43] Linnane et al., 2010.
[44] Annala, 1983.

	167. FNZ considers that the proposals discussed in this consultation paper are consistent with the objectives of the Hauraki Gulf Marine Park Act.
Fisheries plans, and conservation and fisheries services – section 11(2A)	**The Hauraki Gulf Fisheries Plan** The Revitalising the Gulf: Government action on the Sea Change Plan strategy (**Revitalising the Gulf**) is relevant to the future management of the portion of CRA 2 that lies within the Hauraki Gulf Marine Park. A key fisheries output from Revitalising the Gulf is the area specific fisheries plan approved under section 11A of the Act. The Hauraki Gulf Fisheries Plan has three desired outcomes: • Healthy, functioning aquatic ecosystems that support sustainable fisheries; • Fisheries resources are at levels which meet the needs of Treaty partners and stakeholders; and, • Inclusive and integrated regional participation in the governance of fisheries. 168. There are also new marine protection proposals for the Hauraki Gulf Marine Park which would overlap CRA 2 (discussed under Part 1 '*Proposed spatial closure*'). 169. FNZ considers that the proposed changes to the CRA 2 catch limits would be consistent with the desired outcomes, management objectives and actions in the Hauraki Gulf Fisheries Plan. 170. The Hauraki Gulf Fisheries Plan proposes specific management measures to support the sustainability[45] and improved future management of kina within the Hauraki Gulf Marine Park.[46] One of these management measures is to facilitate the co-development of a management plan for restoring healthy kelp forests, which will consider the causes and address the environmental impacts of kina barrens and include management considerations for predator species such as snapper and rock lobster. **Fisheries and conservation services:** 171. Fisheries services of relevance to the options in this paper include the research used to monitor stock abundance, such as contracted projects for stock monitoring and stock assessment, tag deployment and recapture. Fisheries services include the tools used to enforce compliance with management controls in the fishery. Furthermore, the FNZ contracted research project[47] is another relevant service (discussed in Part 3 under '*Supporting information'* and *'Summary of urchin barren work programme to date)*'. 172. FNZ has initiated observer coverage within CRA 2 for the 2024/25 financial year, which will help verify fisher-reported data. However, prior to this there has been no observer or on-board camera coverage of CRA 2. Fisheries Compliance regularly monitors the CRA 2 area to ensure that management controls are being adhered to.
The Minister must have regard to:	
Relevant statements, plans, strategies, provisions, and documents - section 11(2)	**Regional plans:** 173. There are two regional councils (Waikato Regional Council and Bay of Plenty Regional Council) and two unitary authorities (Auckland Council and Gisborne District Council) that have coastlines within the boundaries of CRA 2. Each of these authorities have policy statements and plans to manage the coastal and freshwater environments, including terrestrial and coastal linkages, ecosystems, and habitats. 174. FNZ has reviewed these documents and the provisions that might be considered relevant can be found here. 175. FNZ considers the proposed measures and options for CRA 2 to be consistent with these provisions, which are of a general nature and focus mostly on maintaining the natural character and diversity of the marine environment. There are no provisions specific to rock lobster.

[45] Management Objective 2.2: 'Address localised depletion of fisheries resources within the Hauraki Gulf'.
[46] Management Objective 1.3: 'Mitigate the direct and indirect impacts of fishing on the marine food chain'.
[47] ZBD2023-03: Summarising and updating knowledge on the distribution of kina barrens in key regions of New Zealand.

Non-mandatory relevant considerations	
Other plans and strategies	Te Mana o te Taiao (Aotearoa New Zealand Biodiversity Strategy) 176. FNZ considers that the sustainability measures proposed for CRA 2 are generally consistent with relevant objectives of Te Mana o te Taiao – the Aotearoa New Zealand Biodiversity Strategy. This includes Objective 10, which is to ensure that ecosystems are protected, restored, resilient and connected from mountain tops to ocean depths; and Objective 12, which is to manage natural resources sustainably. The Revitalising the Gulf: Government action on the Sea Change Plan strategy (Revitalising the Gulf) 177. This plan is relevant to the future management of the portion of CRA 2 that lies within the Hauraki Gulf Marine Park. A key fisheries output from this strategy is the area specific fisheries plan approved under section 11A of the Act; The Hauraki Gulf Fisheries Plan.

Information principles: section 10 of the Act

178. The best available information relevant to CRA 2 is presented throughout this paper, and uncertainties in the information have been highlighted where relevant. Table 10 below provides an additional summary of the best available information and key areas of uncertainty, unreliability, or inadequacy in that information.

Table 10: Best available information and key areas of uncertainty for CRA 2.

Best available information	Key areas of uncertainty, unreliability, or inadequacy
Stock status of CRA 2: The best available information on the status of CRA 2 (in relation to *MSY*) comes from a full scientific stock assessment using standardised CPUE. The most recent full stock assessment was conducted in 2022, based on data up to the 2021 April fishing year. Subsequent updates to the stock assessment have been undertaken annually, with the most recent rapid assessment update undertaken in 2024. The results of these assessments are described in detail within the November 2024 Fisheries Assessment Plenary and have been summarised throughout this paper where relevant (in particular, in Part 3 under *'Stock Status'*).	The majority of the data used in the stock assessment, and subsequent rapid updates, to assess stock status relies on fishery-dependent data (data collected by commercial fishers). Fishery-dependent data can be biased by changes in fishing efficiency, and does not cover areas not commercial fished (such as the majority of the inner Hauraki Gulf). There are limited fishery independent assessments available from CRA 2 that FNZ is aware of, Hanns et al (2022), that is discussed in this table below, and Nessia et al (2024), that is discussed under Part 3 '*Supporting information, Stock status*'. Noted uncertainties at the time of the last stock assessment summarised in the November 2024 Plenary Report are outlined as the following: • Estimates of recreational catch are uncertain and the estimates of illegal catch are unreliable. • Tag-based growth may not represent growth of underlying population. The stock assessment, and subsequent rapid updates, estimates the abundance of rock lobster in the whole of the CRA 2, and is limited in their ability to assess rock lobster abundance at finer spatial scales (localised) within CRA 2.
Customary, recreational, and illegal fishing estimates: The best available information on CRA 2 customary, recreational, and illegal fishing is presented in Part 1 under '*Fishery characteristics and settings*'. Recreational catch information relies heavily on the results of the 2022/23 NPS, additional information is provided by boat ramp sampling (creel surveys).	The NPS provides some spatial information but does not provide detailed spatial data on the distribution of recreational fishing across the CRA 2 QMA. The NPS panel tends to have low participation in specialised fisheries like rock lobster which can result in lower precision for harvest estimates. Uncertainty from boat ramp sampling has been incorporated with uncertainty in the annual harvest estimates from the NPS 2024 publication for CRA 2. FNZ has contracted additional recreational surveys for CRA 2 for 2024/25 which will provide an annual estimate of recreational harvest. Additional surveys through to at least 2028/29 are being considered. There is uncertainty in the magnitude and distribution of customary, recreational, and illegal fishing occurring in each rock lobster statistical area of CRA 2.

Best available information	Key areas of uncertainty, unreliability, or inadequacy
	The information on authorised customary harvest in CRA 2 is considered incomplete.
Location and extent of urchin barrens: *Estimating the extent of urchin barrens and kelp forest loss in northeastern Aotearoa, New Zealand* (Kerr et al., 2024). New Zealand Aquatic Environment and Biodiversity Chapter 13 '*Trophic and ecosystem-level effects*', and Doheny et al. (2023).	Kerr et al. (2024) estimated the percentage of shallow rocky reef habitat that comprises urchin barrens at seven sites between Maitai Bay at the Northland Peninsula to Tāwharanui Peninsula in the Hauraki Gulf, then extrapolated this information to estimate the extent of urchin barrens across the region (30% urchin barren coverage) based on the extent of rocky reef habitat. Other information on the location and extent of urchin barrens in CRA 2 is cited in Doheny et al. (2023). Particular areas of uncertainty in defining the percent cover of barrens for a given location relate to the depth cut off for shallow reefs, which can be different depending on the study. Note these studies do not consider urchin barrens that may occur within CRA 2 that are outside the Hauraki Gulf. Urchin barrens are known to occur across the whole of CRA 2 but are particularly concentrated within the Hauraki Gulf. FNZ has contracted a research project to estimate the extent of urchin barrens between 2 m and 10 m water depth from Cape Reinga to East Cape using satellite imagery. The results are expected to provide a spatially comprehensive and current map of urchin barren distribution for the entire area (initial results are expected in December 2024 with final results expected in May 2025).
The effect of fishing on urchin barren formation and the efficacy of marine reserves in reversing barrens and restoring kelp forest habitat: New Zealand Aquatic Environment and Biodiversity Chapter 13 '*Trophic and ecosystem-level effects*', and Doheny et al. (2023).	Key information knowledge gaps pertaining to the relationship between rock lobster, other predators, and urchin barrens, as well as the management required to mitigate urchin barrens are outlined in pages 66-73 and 78 of Doheny et al. (2023). Information gaps most relevant to this discussion document include: a. The overall CRA 2 biomass threshold and abundance of large rock lobsters (as one of the few key urchin predators) required to enable them to meaningfully contribute as rocky reef predators, including helping mitigate urchin barren formation. b. The relative importance of rock lobster to other urchin predators in reducing or reversing barren formation, e.g., how packhorse rock lobster contribute to urchin predation across urchin size classes in comparison to rock lobster. c. The extent to which the trophic effects of fishing interact with changing sea temperatures, ocean acidification, eutrophication, sedimentation, and invasive species needs to be further explored. This includes the future impact that climate change and marine heat waves will have on rock lobsters, and urchin and macroalgae abundance and distribution. d. The design of closures required to support ecosystem recovery.
Fishery-independent studies of CRA 2 Hanns, B J; Haggitt, T; Shears, NT (2022) Marine protected areas provide unfished reference information to empirically assess fishery status. Biological Conservation.	Potting surveys inside and outside Cape Rodney and Tāwharanui marine reserves, in 2018 and 2019, were used to assess the value of using lightly fished populations inside marine reserves to assess stock status empirically. The surveys also generated length frequency distributions for populations in the marine reserves. The dive surveys after 2019 did not show large increases in abundance relative to previous surveys (contrary to the 2022 CRA 2 stock assessment). This study was followed by the Nessia et al. (2024) study (discussed under Part 3 '*Supporting information*' and '*Stock status*').
Observer coverage	FNZ has initiated observer coverage within CRA 2 for the 2024/25 financial year, which will help verify fisher reported data. However, prior to this

Best available information	Key areas of uncertainty, unreliability, or inadequacy
	there has been no observer coverage in CRA 2. FNZ has, for the most part made some assumptions about fishing and environmental interactions based on fisher-reported data that has not been independently verified (such as an on-board FNZ observer), such as fishing effort, catch information or protect species interactions.
Environmental impacts	Best available information has been assessed to identify potential habitat of particular significance for fisheries management. Given their distribution in relation to rock lobster fishing and their ecological characteristics, FNZ does not consider direct or indirect effects of the options proposed are likely.

Stock status

179. For the purpose of stock assessment and management, rock lobsters are assumed to constitute separate fish stocks within each rock lobster QMA. However, there is likely to be some degree of relationship and/or exchange between fish stocks in these QMAs, either as a result of migration, larval dispersal, or both.

180. Rock lobster differs from many other fish stocks managed under the QMS in that a large portion of the total and spawning biomass is not legally harvestable and is not therefore considered to be vulnerable to fishing. This is because rock lobster that are in berry (a female lobster carrying fertilized eggs under her tail) or lobsters in a soft-shell state (post-moulting) are not allowed to be harvested. Consequently, the vulnerable biomass refers to that portion of a stock's biomass that is available to fisheries, i.e., legally harvestable adult rock lobsters (that are also often referred to as the exploitable biomass). For rock lobsters this is limited to male and female fish above the MLS at the beginning of the autumn-winter season, excluding berried females. SSB refers to sexually mature females only. This includes females that are sexually mature but smaller than the minimum legal size who are not vulnerable to the fishery (i.e., cannot be landed legally).

181. CRA 2 vulnerable biomass has been through two recent declines. The first, in the late-1990s and early 2000s following a period of increased abundance, and then a second period of decline from about 2007 through to 2018 (Figure 5). In response to low biomass levels, resulting from the more recent decline, in 2015/2016 the CRA 2 industry voluntarily shelved 25 tonnes of the 200-tonne TACC, even though the operation of the management procedures did not require a TACC reduction. The amount of shelving was increased to 49 tonnes for 2016/17 and 2017/18.

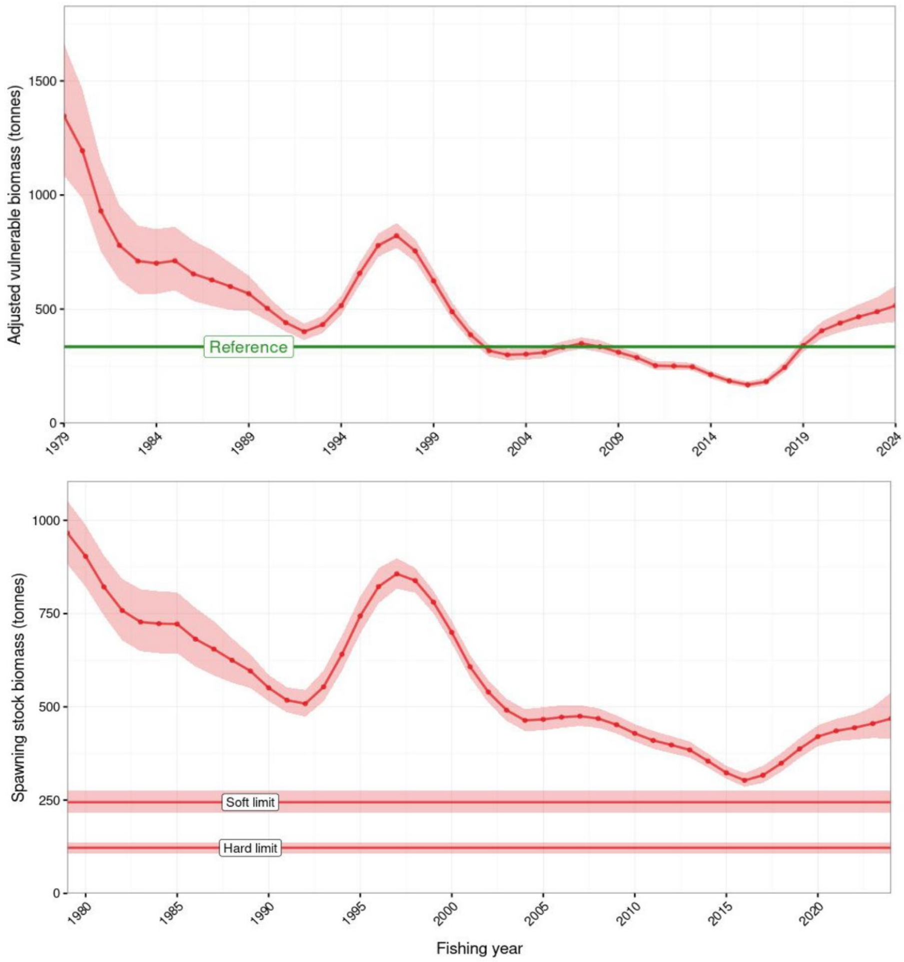

Figure 5: Posterior distribution of the 2024 rapid update model estimates of vulnerable biomass (upper panel) and female *SSB* (lower panel) estimates, which have been projected out to 2028. Variable shading intensity indicates the 50% and 90% credible intervals and the solid line indicates the median. The B_R interim target is shown as a solid green line and the distributions of the soft (20% SB_0) and hard (10% SB_0) limits are also shown.

182. A full stock assessment was conducted in 2017 in which CRA 2 vulnerable biomass was estimated to be at about half of the management target (B_R) and the spawning biomass (SB_0)[48] was assessed as being close to the soft limit (20% SB_0; Figure 5).[49] At that point the TAC was reduced for 2018/19 from 416.5 tonnes to 173.1 tonnes. This reduced TAC comprised an 80-tonne TACC, 34 tonnes for recreational catch, 16.5 tonnes for customary harvest, and 42.5 tonnes for 'other fishing mortality' (Table 1). The number of commercial vessels operating in CRA 2 dropped to below 20 after this drop in TACC, compared with 29 to 40 vessels operating in the previous three decades. There were 16 commercial vessels participating in the CRA 2 fishery in 2022/23.[50] The recreational daily limit was also reduced from six to three lobsters in 2020.

183. Following cuts to the TAC and recreational daily limit, a full quantitative stock assessment was conducted in 2022. The assessment used a Bayesian length-based model that was informed by commercial CPUE, length-frequency, sex-ratio, and tag release/recapture data. The assessment showed that showed that CRA 2 biomass had increased significantly since 2020 in response to the decrease in exploitation rate. Vulnerable biomass was estimated to be 68% above B_R and spawning biomass was 40% SSB_0 (effectively doubling since the 2017 assessment). Vulnerable biomass and spawning stock biomass were also projected to continue to increase, at least over the five years model projection period.

184. Rapid updates of the CRA 2 assessment, which do not aim to replace full stock assessments but complement them by providing inference about stock status in the interim years between full assessments, were then conducted in 2023 and 2024. The updates used the 2022 base case model, settings, and assumptions, but incorporated CPUE, tagging, length-frequency and sex ratio data reported for the 2022/23 and 2023/24 fishing years. The rapid updates confirmed the findings of the 2022 assessment, although the most recent estimates of where the CRA 2 stock sits relative to unfished spawning and unfished vulnerable biomass are a little lower, and projections of growth slightly slower than in the 2022 and 2023 models. The 2024 update suggests that CRA 2 vulnerable biomass is currently at 154% of B_R and is projected to increase towards 200% of B_R in 2028 (under current harvest settings). Over the same projection period spawning biomass is also expected to increase to 41% of SB_0.

185. A full quantitative stock assessment is planned for CRA 2 in 2025 which will provide a fully revised estimate of stock biomass and recruitment. It is intended that this new assessment model, alongside the new biomass management target, which is being consulted on here, will inform the setting of a TAC appropriate to the new biomass management target and the development of new management procedures for CRA 2. The management procedures will be designed to iteratively manage the stock biomass at or around a biomass management target level that is yet to be set.

Comparison of fishery-independent survey data with the CRA 2 stock assessment

186. While the assessments described above indicate the CRA 2 stock is well above the current biomass management target and that biomass has grown significantly since TAC was reduced in 2018, research papers published by Hanns et al. 2022 and Nessia et al. (2024) challenge some of the assessment's findings.

187. The Nessia et al. (2024) study (which builds on the earlier work of Hanns et al. (2022)) compares rock lobster populations on shallow reefs (less than 20 m depth) in three marine reserves with six fished locations across the Hauraki Gulf rock lobster statistical areas 905 and 906 (Figure 6) to provide a fisheries-independent assessment of this important fishery and the degree of recovery following the 2018 TAC reductions. They found that total, vulnerable, and spawning stock biomass were 12-43 times greater within marine reserves compared to fished locations. Using marine reserve populations as proxy estimates of unfished biomass they estimated that rock lobster populations on shallow reefs in the Hauraki Gulf are at less than 10% of unfished levels. This study contrasts with the fisheries-dependent stock assessment (and associated rapid updates) that estimates rock lobster biomass across the whole of CRA 2 at about 41% of unfished spawning biomass. Based on monitoring of lobster populations inside and outside of three marine reserves, little evidence was found that rock lobster populations in the Hauraki Gulf had recovered since large commercial catch reductions in 2018.

188. The authors also challenge the stock assessment's interpretation of increasing CPUE (which informs the index of abundance). They cite literature suggesting that CPUE may not always reflect actual abundance due to the influence of exogenous factors on catch rates, such as target species biology, environmental conditions, fishing gear type and configuration, and fisher behaviour. In the case of CRA 2, they suggest that the increase in CPUE that occurred immediately followed the 2018 TAC reduction might be due to fishers focussing on high productivity areas to harvest the smaller catch limit, rather than being a sign of increased rock lobster abundance and biomass.

[48] SB_0, also known as virgin spawning biomass (also referred to in this paper as unfished biomass), is the theoretical carrying capacity of the spawning biomass of a fish stock. In some cases, it refers to the average spawning biomass of the stock in the years before fishing started. More generally, it is the average over recent years of the biomass that theoretically would have occurred if the stock had never been fished.

[49] The soft limit is a biomass limit, below which the requirement for a formal, time-constrained rebuilding plan is triggered.

[50] Starr (2024).

189. FNZ acknowledges there is merit in using fisheries-independent data to compare with fisheries-dependent data, which can provide input in the development and revision of a stock assessment model and there are numerous examples of this approach. However, FNZ notes the following differences in the two data types to assess rock lobster abundance:

- The 2022 CRA 2 stock assessment model (which informs the 2024 rapid assessment update) is based solely on single species (rock lobster) fishery dynamics, and does not account for all other human-induced effects on the marine ecosystem. The stock assessment model uses an ongoing time series of rock lobster catch and effort within the whole of CRA 2, whereas the Nessia et al. (2024) study reviews rock lobster abundance at specific sites within the Hauraki Gulf at specific points in time.
- The Nessia et al. (2024) estimate of stock status relative to SSB is not directly comparable to the 2022 CRA 2 stock assessment model's estimate of abundance. The study assumes that the biomass of rock lobster outside of the marine reserve would revert to a biomass level observed within marine reserves if all forms of rock lobster harvest ceased, regardless of any other fishing or human induced stressors that this environment may have experienced since these marine reserves, were first established.
- While the impacts of fishing for rock lobster would have contributed to the current state of the marine environment and ecosystem outside of marine reserves, the higher density of rock lobster within marine reserves, compared to outside marine reserves (notably sub-legal lobster that are not directly impacted by commercial and recreational fisheries, see Figure 4 of Nessia et al. 2024), cannot be attributed solely to fishing effort targeting this species. The higher abundance of rock lobster observed inside marine reserves will in part be due to rock lobster's preference for a biological environment that has developed in the absence of fishing for all species (and other human activities), which in turn attracts rock lobster and causes aggregations of localised high rock lobster abundance.

190. FNZ considers that while the Nessia et al. (2024) study can provide possible insights in the rock lobster abundance and population dynamics within the Hauraki Gulf itself, given the reasons mentioned and limited comparable other fishery independent studies, caution should be exercised when extrapolating the Nessia et al. (2024) study to make inferences on rock lobster abundance outside of the areas surveyed, the wider CRA 2 fishery; especially when making direct comparisons to the 2022 CRA 2 stock assessment. Therefore, FNZ considers that at this stage, the 2024 rapid assessment update (that is underpinned by the 2022 CRA 2 stock assessment) constitutes the best information on the state of rock lobster populations within CRA 2.

191. However, FNZ are in discussions with the University of Auckland to explore how more direct quantitative analytical comparisons can be made between the data presented by Nessia et al. (2024) and the data used to inform the current stock assessment for CRA 2. This may lead to aspects of the data and/or results from the surveys undertaken by Nessia et al. being incorporated in future CRA 2 stock assessments.

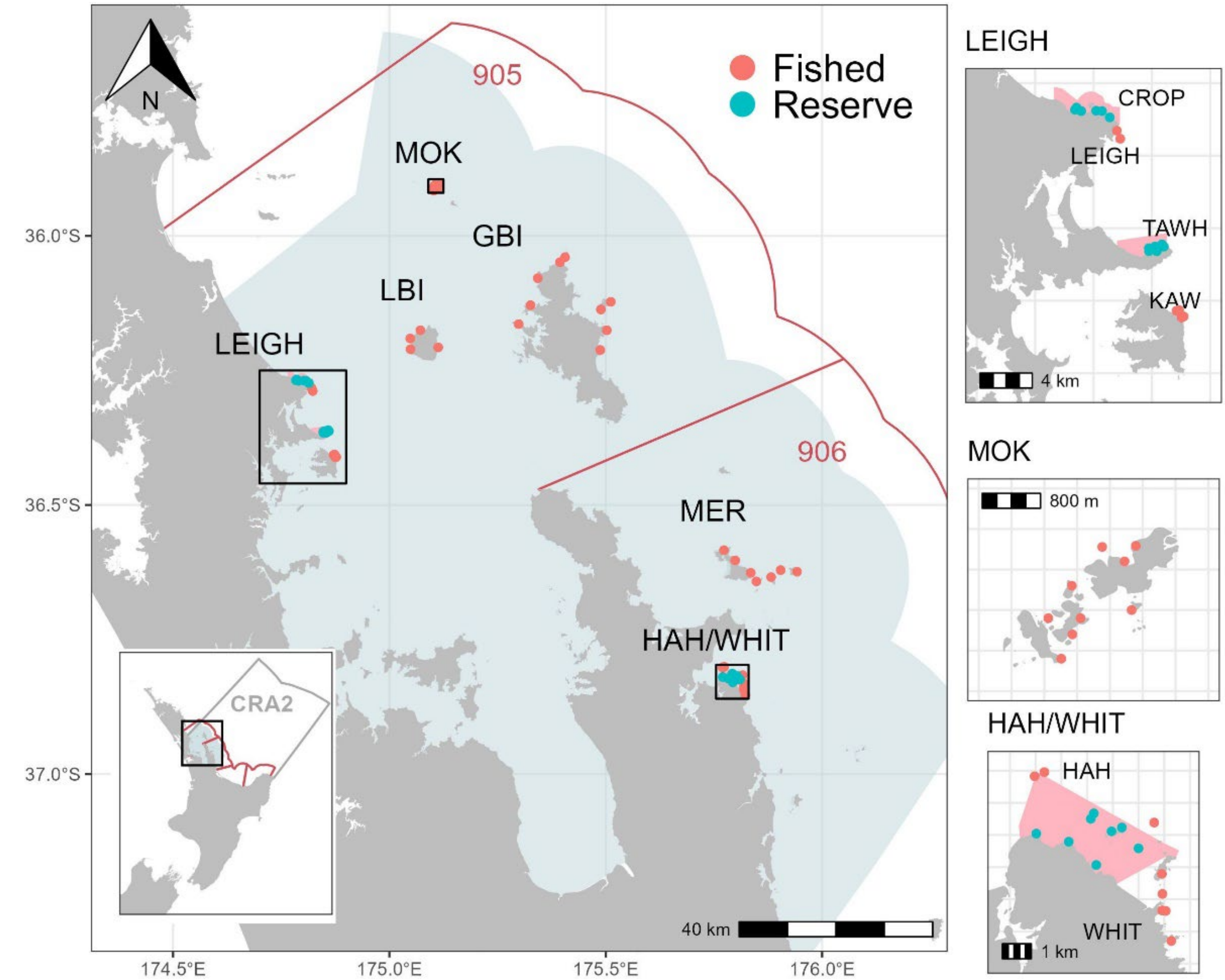

Figure 6: Sites and locations across the Hauraki Gulf Marine Park (light blue shaded area) and rock lobster statistical areas 905 and 906 (boundaries depicted by red lines) surveyed by Nessia et al. (2024). No-take marine reserves (shown as pink shaded areas) include CROP (Cape Rodney-Okakari Point Marine Reserve), TAWH (Tāwharanui Marine Reserve), and HAH (Te Whanganui-o-Hei/Cathedral Cove Marine Reserve). Fished locations include MOK (The Mokohinau Islands), GBI (Aotea/Great Barrier Island), LBI (Hauturu/Little Barrier Island), LEIGH (coastal Leigh), KAW (Kawau Island), MER (Mercury Islands), WHIT (Whitianga, sites adjacent to HAH). Figure taken from Nessia et al. 2024.

Additional figures

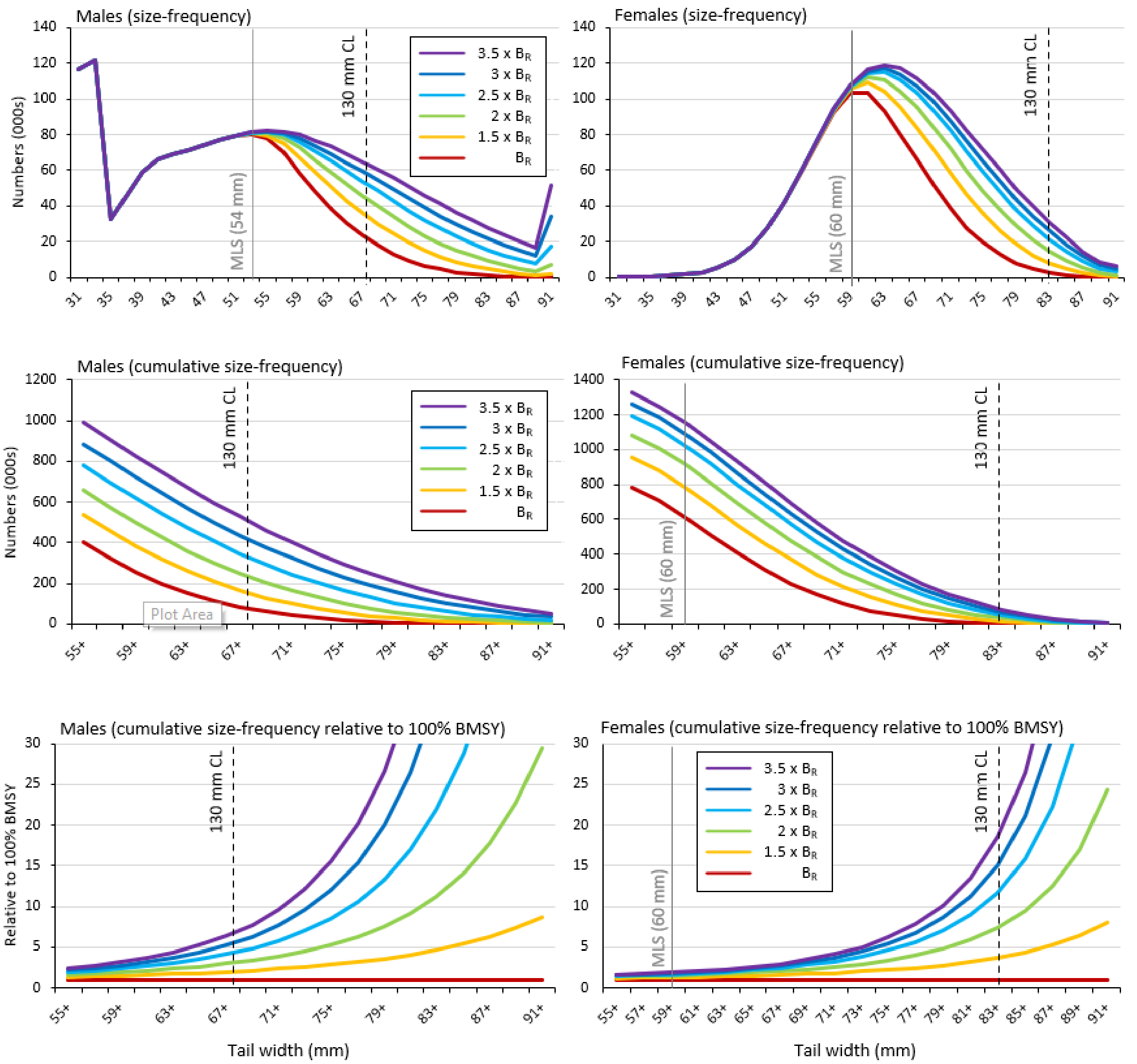

Figure 7: Predicted numbers of male (left) and female (right) rock lobster in CRA 2 under different biomass management targets. The 1.5x B_R data provides an indication of the current CRA 2 population structure that is estimated to be at 1.54 B_R. The minimum legal-size limits for males (54 mm tail width) and for females (60 mm) are indicated by grey vertical lines. Tail widths that equate to 130 mm carapace length (CL)[51] for each sex are indicated by dashed vertical lines, which is the size at which rock lobster are considered capable of eating any size urchin. The upper panels show frequency of large (≥130 mm CL) rock lobster. The middle panels show cumulative frequency of large rock lobster, and the lower panels indicate cumulative abundance of different size classes that are larger than each size class, relative to B_R which is the current interim biomass management target.

[51] Lobster carapace length is measured from the back of the eye socket to the end of the carapace, parallel to the midline.

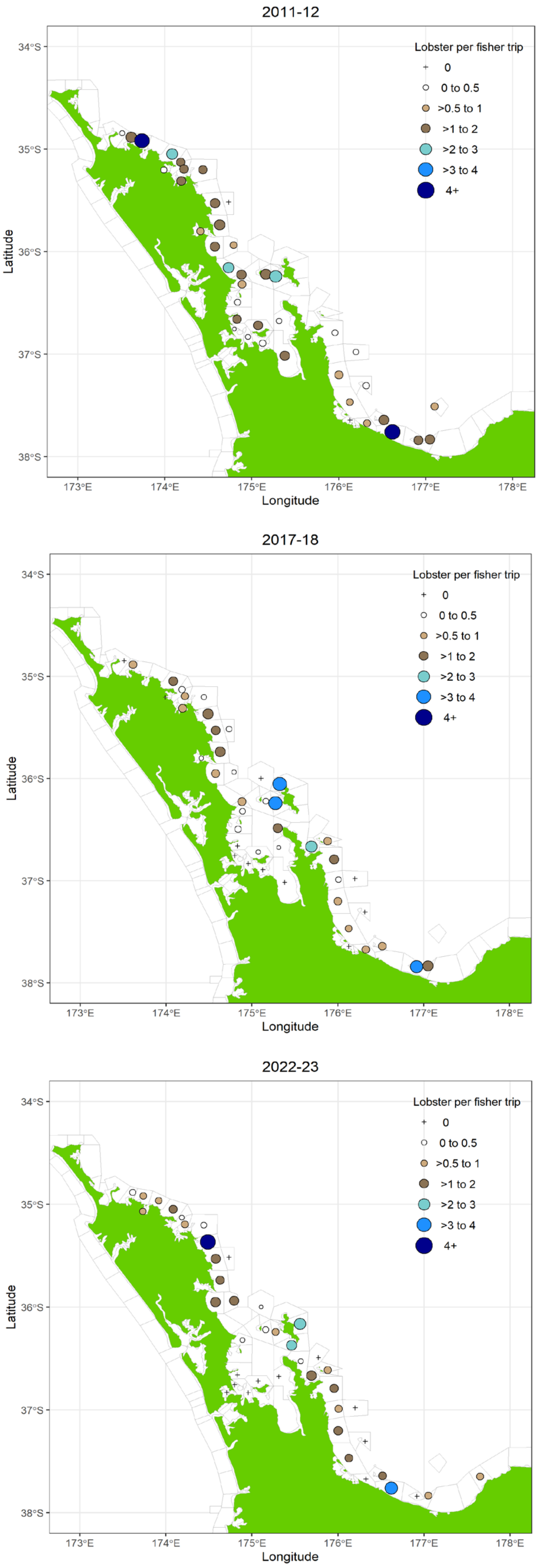

Figure 8: Average number of individual rock lobsters caught per recreational dive/snorkel fishing trip. Data taken from additional boat ramp sampling conducted in conjunction with the NPS during survey years. This provides an indication of the relative abundance in those areas where targeting of rock lobster took place, showing the abundance of lobster in the inner Hauraki Gulf appears lower than in other areas in CRA 1 and CRA 2, and increasingly so over the time series.

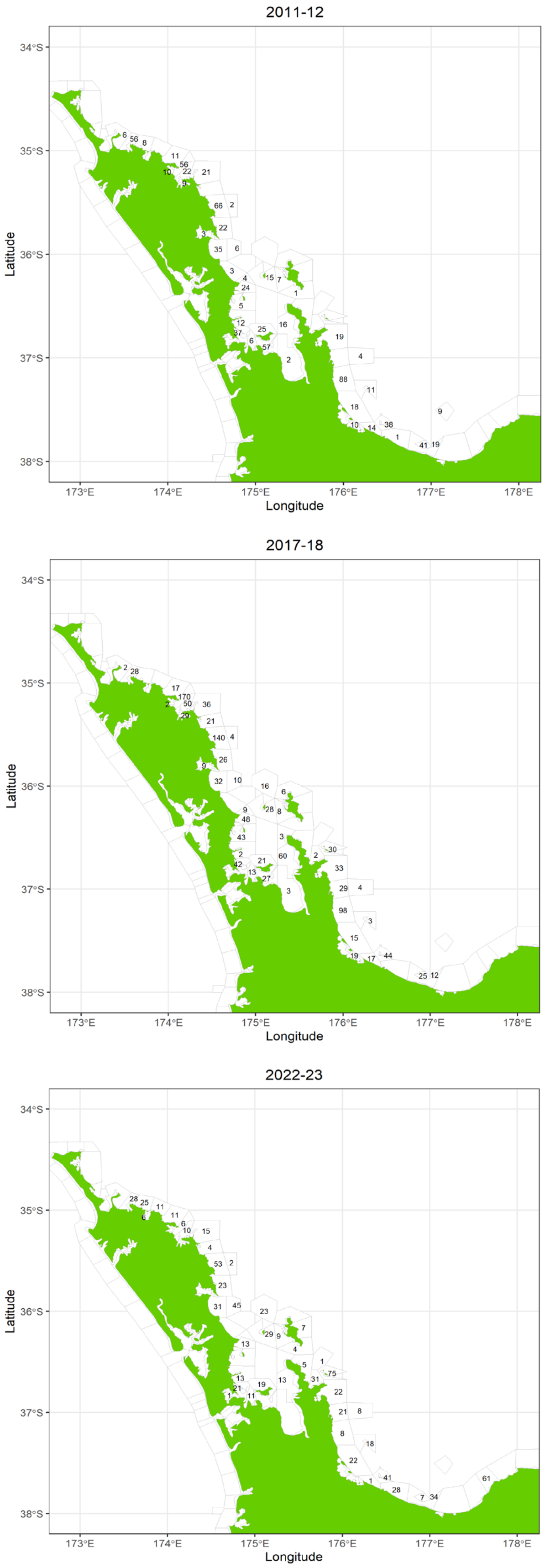

Figure 9: Number of trips reported by interviewed divers/snorkelers targeting reef species (including rock lobster, packhorse rock lobster and kina). Data taken from additional boat ramp sampling conducted in conjunction with the NPS during survey years. The figures denote the number of trips where fishers reported diving/snorkelling for reef species, from which rock lobster catch rates estimates have been calculated (Figure 8).

Urchin barrens

192. Urchin barrens are sea urchin dominated areas of rocky reef that would normally support healthy kelp forest but have little or no kelp due to overgrazing by sea urchins.[52]

193. Rock lobsters are ecologically important predators in New Zealand's rocky reef ecosystems. The best available information indicates that predators, including rock lobsters, when present at sufficient abundance and size structure can have a significant role in mitigating sea urchin barrens,[53] which are less biologically diverse environments than the kelp forest habitats they replace.

194. *Evechinus chloroticus* (**kina**) is the dominant barren-forming urchin species in New Zealand, although the subtropical urchin *Centrostephanus rodgersii* (**long-spined urchin**) has recently been reported as increasing in parts of northern New Zealand, forming extensive urchin barrens on offshore Islands including in the Poor Knights Marine Reserve.[54] FNZ recognises that barrens caused by the long-spined urchin are an increasing issue and rock lobster and packhorse rock lobster (*Sagmariasus verreauxi*) are potentially the only predators that can consume the largest long-spined urchins in New Zealand.[55] While this paper is specific to the rock lobster CRA 2 fishery, and therefore does not consider catch settings for packhorse rock lobster (see Part 1 '*Overview, Other possible CRA 2 management measures*'), FNZ is currently seeking feedback in the CRA 1 QMA on the recreational daily limit for packhorse rock lobster.

195. Urchin barrens are not ubiquitous across rocky reefs and tend to be restricted to different depth zones determined by environmental conditions. On moderately exposed coasts, the shallow reef (0–3 m water depth) tends to be occupied by brown macroalgae,[56] intermediate depths (3–8 m water depth) are where urchin barrens normally occur (especially those caused by kina), and deeper reefs (>8 m water depth) are dominated by kelp forests (*Ecklonia radiata*).[57] Grazing of macroalgae and other invertebrates by *C. rodgersii,* the long-spined urchin, tends to result in barrens forming at greater depths, commonly below 10-12 m. On more exposed reefs, barrens form on deeper sections of reef (12–20 m), while in more sheltered conditions barrens are restricted to shallower depths.[58] Urchin barrens tend to not form in very sheltered areas that experience high sediment loads, or areas with freshwater inputs or excessive wave action.

196. Multiple factors can cause kelp decline (including sedimentation, disease, and marine heatwaves). However, in northeastern New Zealand, fishing of top reef predators is considered to be a key factor behind the proliferation of kina, resulting in extensive kelp loss and the formation and expansion of urchin barrens.[59] Our understanding of this relationship is based on observations of the concurrent recovery of kelp and of urchin predators (including snapper, *Chrysophrys auratus,* and rock lobster) inside marine reserves in north-eastern New Zealand,[60] and the positive effect of protection from fishing on the abundance of kelp and predators inside seven marine reserves from the Three Kings Islands to the Bay of Plenty.[61]

197. The loss of kelp forests in coastal ecosystems negatively impacts fisheries productivity, biodiversity, and ocean carbon sequestration. Urchin barrens support a far lower level of biodiversity relative to kelp forests due to the loss of ecosystem services that macroalgae provides. These include providing complex three-dimensional habitat that fish and shellfish feed and shelter in and the provision of organic matter that contributes to productivity both on rocky reefs where kelp grows, and in non-reef habitats to which algal detritus is transported.[62] Furthermore, the loss of kelp forests and associated biodiversity may make these reefs less resilient to the impacts of climate change,[63] which would likely impact the productivity of marine ecosystems on the north-east coast (FMA 1) of New Zealand.

198. Once established, urchin barrens are stable and persistent. Studies have shown that urchin abundance must be reduced to very low levels (<1 m^2) for urchin barrens to revert to a kelp or macroalgae dominated habitat.[64]

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[52] Doheny et al., 2023.
[53] FNZ's working definition, for the purpose of identifying those areas that are of concern, is "sea urchin dominated areas of rocky reef that would normally support healthy kelp forest but have little or no kelp due to overgrazing by sea urchins" (taken from Doheny et al, 2023).
[54] Sweatman, 2021.
[55] Balemi & Shears, 2023.
[56] Fucalean algae which belongs to the order *Fucales* and are commonly found in marine environments.
[57] Choat & Schiel, 1982; Shears & Babcock, 2004.
[58] Shears et al., 2004.
[59] 2024 Aquatic Environment Biodiversity Report, Chapter 13: Trophic and Ecosystem Level Effects – in review (and references within).
[60] Babcock et al., 1999; Shears & Babcock, 2003; and Leleu et al., 2012
[61] Edgar et al., 2017.
[62] Udy et al., 2019.
[63] Bernhardt & Leslie, 2013; Duffy et al., 2016.
[64] Filbee-Dexter & Scheibling 2014; Ling et al., 2015; Shears & Babcock, 2003.

199. While urchin barrens are known to be common across the coastal reefs of much of north-east New Zealand, there is no comprehensive record or map of their distribution to support tangata whenua and stakeholder engagement or inform management decision-making. An urchin barren mapping project, funded by FNZ in 2024 (see Part 3 '*Summary of urchin barren work programme to date*'), is currently underway and is expected to provide more detailed and up to date information on the distribution of urchin barrens, in waters between 2 m and 10 m water depth, between Cape Reinga and East Cape. The spatial dataset will act as a baseline to monitor future change or recovery and facilitate the management of fishing effects on urchin barrens. This may provide valuable information to help guide urchin barren management within CRA 2. The initial results from this project are expected in December 2024 with presentation of final results expected in May 2025.

200. A literature review, conducted as part of this mapping project, has identified and collated records of urchin barren coverage across north-eastern New Zealand (including CRA 2). This includes studies conducted in the northern part of CRA 2 that are published in either peer reviewed scientific journals or in university graduate student theses (Table 11; Figure 10). FNZ notes that the studies of urchin barren coverage included in this compilation, have been conducted at different spatial scales, with each representing a snapshot at specific points in time. This review also does not include any information about the distribution of urchin barrens on reefs south of Te Whanganui-o-Hei/Cathedral Cove Marine Reserve (Hahei) in southern Hauraki Gulf. Consequently, caution should be exercised when inferring current urchin coverage across the whole of CRA 2.

Table 11: Recent studies of urchin barren coverage within northern portion of CRA 2.

Location	Year studied	Estimated proportion of reef covered by urchin barrens	Publication
Mokohinau Islands	2019	Barren coverage 4% of shallow reef in 1978 and 26% of shallow reef in 2019.	Lawrence, K. (2019). Mapping long-term changes in reef ecosystems using satellite imagery. University of Auckland Thesis.
Te Hauturu-o-Toi/Little Barrier	2019	Urchin barrens covered 32.72% of reef.	Dartnall, L. (2022). The extent of kina barrens over time at Hauturu-o-Toi and the Noises Islands. Univeristy of Auckland Thesis.
Cape Rodney to Okakari Point Marine Reserve	2019	Urchin barrens covered 2% of shallow reef.	Lawrence, K. (2019). Mapping long-term changes in reef ecosystems using satellite imagery. University of Auckland Thesis
	2006	Urchin barrens covered 44.7 hectares in 1977, 4.5 hectares in 2006.	Leleu, K., Remy-Zephir, B., Grace, R., & Costello, M. J. (2012). Mapping habitats in a marine reserve showed how a 30-year trophic cascade altered ecosystem structure. Biological Conservation, 155, 193-201.
Tawharanui	2006	Tāwharanui (38% barren coverage on shallow reefs at fished sites and 2% barren coverage on shallow reefs at marine reserve sites) and Leigh (39% barren coverage on shallow reefs at fished sites and 1% barren coverage on shallow reefs at marine reserve sites)	Kerr, V. C., Grace, R. V., & Shears, N. T. (2024). Estimating the extent of urchin barrens and kelp forest loss in northeastern Aotearoa, New Zealand. New Zealand Journal of Marine and Freshwater Research, 1–22.
Noises Islands	2019	Urchin barrens covered 49.5% of reef.	Dartnall, L. (2022). The extent of kina barrens over time at Hauturu-o-Toi and the Noises Islands. University of Auckland Thesis.
Long Bay	2020	No urchin barrens observed at fished or reserve sites.	Kulins, S. (2021). Investigating the ecological effects of Long Bay-Okura Marine Reserve. University of Auckland Thesis.
Te Whanganui-o-Hei/Cathedral Cove Marine Reserve (Hahei)	2014	20% coverage of reef outside of the reserve. 5% coverage of reef inside the reserve.*	Kibele, J., & Shears, N. (2017). Mapping rocky reef habitats on the eastern Coromandel Peninsula with multispectral satellite imagery (No. 12557259). Hamilton, New Zealand: Waikato Regional Council.
	2015	Urchin barren coverage not quantified, observed at some sites. Appears *Carpophyllum flexuosum* replacing barrens.	Haggitt, T. (2017). Te Whanganui a Hei Marine Reserve Habitat Mapping, Report prepared by eCoast for Department of Conservation.
Waiheke	2016	Urchin barren coverage not quantified, observed at some sites.	Haggitt, T. (2016) Ecological survey of Waiheke Island north-west coastline, report prepared by eCoast for Auckland Council and Hauraki Gulf Conservation Trust.

* Urchin barren coverage was combined with turfing algae coverage for analysis.

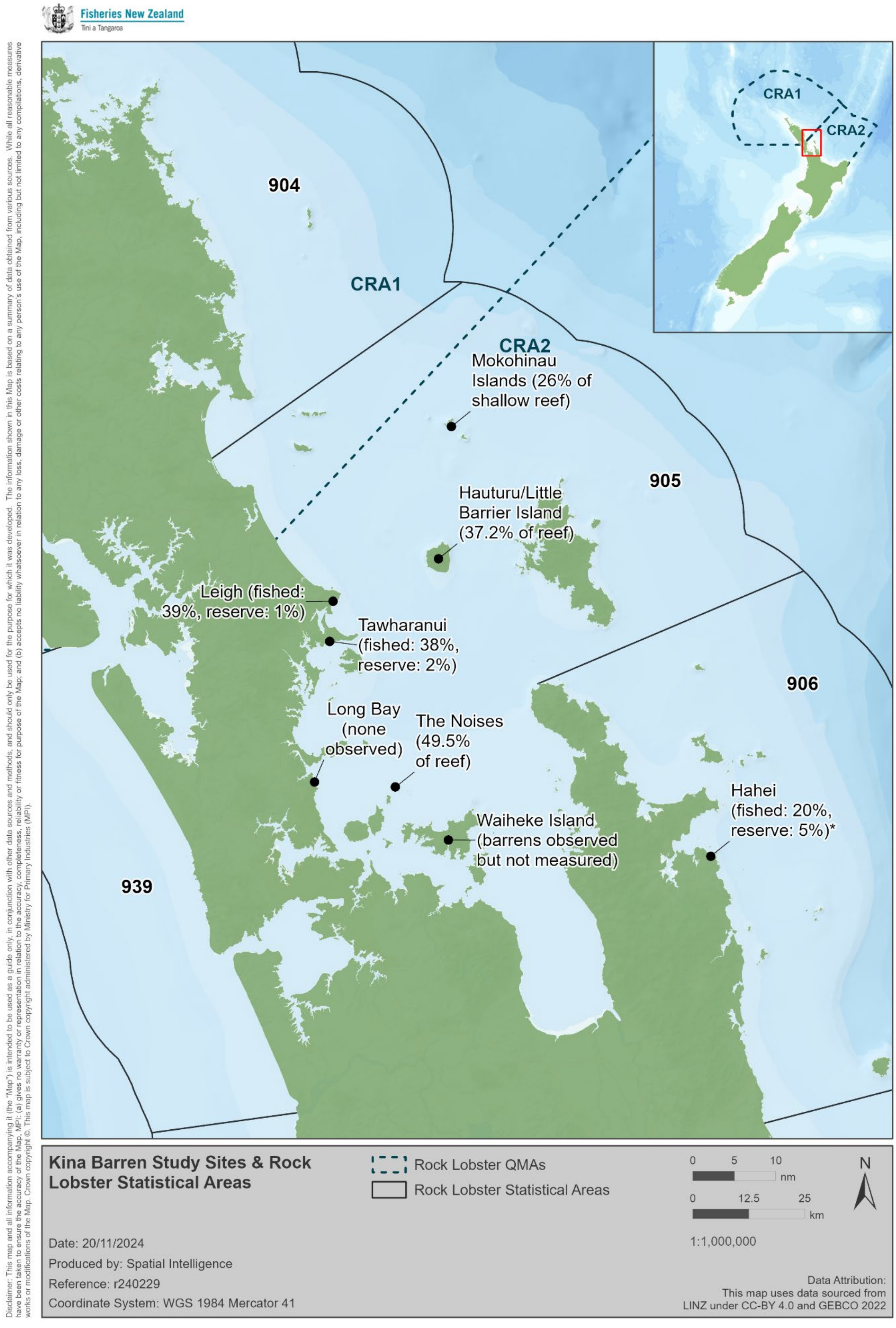

Figure 10: Map of coastal reef locations within the northern portion of CRA 2 where known urchin barrens occur, that have been compiled by an FNZ literature review (see Table 11).

201. FNZ has already implemented a range of management measures to facilitate urchin removals, including increasing the recreational daily limit for kina in SUR 1A and SUR 1B,[65] and authorising a new special permit purpose and a new traditional non-commercial fishing use to provide for the culling, translocation, and removal of urchins (see '*Summary of urchin barren work programme to date'* below).

202. Removing urchins is a management action that can accelerate kelp forest restoration at local scales, but it does not address underlying ecosystem imbalances which contribute to the formation of urchin barrens. Evidence from marine reserves in northeastern New Zealand has shown that increased abundance of large urchin predators (including rock lobster and snapper) can assist in reversing urchin barrens and support the re-establishment of kelp forest habitat. Studies have shown that recovery of kelp forest habitat within no-take reserves can take decades.[66] However, it is thought this could occur more quickly if combined with urchin removals. A recent study in the Hauraki Gulf that involved removing ~403,000 individual kina and 166 long-spined urchins from just 7.1 hectares of shallow reef, led to the recovery of a kelp forest within two years of the removal taking place. However, it should also be noted that this exercise was incredibly labour intensive and that the ecological benefits are likely to be temporary as urchin abundance had begun to increase 2 years post removal.[67]

203. In addition to consuming sea urchins, the presence of rock lobster and snapper can influence sea urchin grazing behaviour. A study in northern New Zealand found that inside marine reserves in the presence of predators such as rock lobster and snapper, sea urchins are more likely to exhibit cryptic behaviour, where they remain in cracks and crevices and consume already detached pieces of drifting algae (instead of roaming openly across the reef, actively seeking out algae to consume).[68]

204. The relative importance of rock lobster as a predator of kina compared to other species, such as snapper, has not been quantified. Urchin predation by fish such as snapper has been linked directly to the predator mouth size (i.e., how wide snapper can open their mouths), with larger fish capable of consumer larger urchins. Urchin predation by rock lobster is less size dependant because rock lobster can use their claws to pry large urchins from rocks and open them via the urchins' unprotected mouthparts. However, laboratory-based feeding experiments have shown that only lobster with a carapace length greater than 130 mm are capable of feeding on large kina (> 90 mm test diameter).[69] In CRA 2, 130 mm carapace length equates to 83 mm tail width (**TW**) for females and 68 mm TW for males (Figure 7, see Part 3 '*Additional figures*').[70]

205. It is likely that the best way to ensuring rock lobster are able fulfil their ecological role as a key predator of kina is to maintain an appropriate overall abundance of large rock lobster. While there is currently little information to identify what constitutes an 'appropriate overall abundance' of rock lobster to reduce or reverse the spread of urchin barrens, it is likely to be higher than the number of large lobster currently present in urchin barren dominated habitats.

206. Rock lobster has been described as being functionally extinct in the Hauraki Gulf, meaning they are no longer large or abundant enough to play an ecological role in controlling kina densities in the area.[71]

207. FNZ acknowledges that fisheries management responses to address urchin barrens should consider measures to raise the abundance of additional urchin predators apart from rock lobster (including snapper and packhorse rock lobster).

208. The loss of ecosystem services and biodiversity associated with the replacement of kelp forest with urchin barren can be viewed as an adverse effect on the aquatic environment. Given evidence that fishing of urchin predators contributes to urchin barren formation, managing fishing under the Act must include consideration of this effect by avoiding,[72] remedying, or mitigating urchin barrens.[73]

209. Guidance on whether remedying of this adverse effect is required over mitigation or avoidance is not provided in the Act and has not been provided by the Courts. While 'avoiding' is not a reasonable management response to the existing urchin barrens as they have already formed, the Minister's has discretion as to whether mitigating or remedying existing urchin barrens is required. FNZ has identified mitigation[74] of existing urchin barrens and avoiding the formation of new urchin barrens as an appropriate short-term measure.

[65] The recreational daily limit is a combined limit for kina (*Evechinus chloroticus*) and the long-spined urchin (*Centrostephanus rodgersii*)

[66] Babcock et al., 2010; Shears & Babcock, 2003; and Leleu et al., 2012.

[67] Miller et al., 2023.

[68] Spyksma et al., 2017.

[69] Andrew & MacDiarmid, 1991.

[70] Webber et al., (2024).

[71] Macdiarmid et al., 2013.

[72] Avoid' is not defined in the Act, however the Courts have considered similar provision contained in section 5(2)(c) of the Resource Management Act 1991 and defined 'avoiding' as 'not allowing' or 'preventing the occurrence of'. Definitions of 'remedy' and 'mitigate' were not provided by the Courts.

[73] Section 8(2)(b), Fisheries Act 1996.

[74] To mitigate urchin barrens, there is likely a continuum of different management outcomes which range from the restoration of urchin barrens on a large spatial scale to some measure of reduction in the extent of urchin barrens in parts of the region or reducing the expansion of urchin barrens.

Summary of urchin barren work programme to date

210. It is important to note that potential sustainability measures for rock lobster are not intended as the sole measure to address urchin barrens. FNZ acknowledges a comprehensive set of measures is required to respond to the causes and effects of urchin barrens, these measures aim to:

(a) Reduce the number of urchins found in barrens to allow kelp to regrow, and

(b) Increase the abundance and efficacy of urchin predators (including but not limited to rock lobster) to provide for more predation of urchins.

211. In addressing the effects of urchin barrens, a number of measures have been approved to facilitate removal of urchins (kina and *Centrostephanus rodgersii*) from areas of concern. These include:

(a) An increase to the recreational daily limit for kina (combined *Evechinus chloroticus* and *Centrostephanus rodgersii*) in Fishery Management Area 1 from 50 kina per fisher per day to 150 kina per fisher per day.[75]

(b) Approval of a traditional non-commercial fishing use under regulation 52(1) of the Amateur Fishing Regulations to allow the taking, disposal, culling, or translocation of kina from traditional fishing grounds to manage the population of kina to maintain the balance of the ecosystem as a traditional non-commercial fishing use.

(c) Approval of a new special permit purpose to enable the removal of sea urchins for the management or prevention of urchin barrens.[76]

212. Additionally, measures to increase rock lobster abundance in the CRA 2 region have already been implemented and include:

(a) Although not a response to the issue of kina barrens, in 2018 the TAC for CRA 2 was reduced from 416.5 tonnes to 173 tonnes, including a 60% reduction in the TACC; from 200 tonnes to 80 tonnes. This cut was made in response to address critically low levels of abundance in the fishery, and was projected to double the abundance within four to eight years. In 2020 the recreational daily limit was reduced from six to three rock lobsters per fisher per day to help ensure that recreational catch did not exceed the 34-tonne annual recreational allowance.

(b) In August 2024, the Minister approved a two-year fishing closure at Waiheke Island to help increase the abundance of rock lobster.[77]

213. FNZ has also sought input and participation from tangata whenua and undertaken pre-engagement with stakeholders on a range of measures both specific to rock lobster and wider measures. This included;

(a) In July and August 2023, held a series of management workshops with the National Rock Lobster Management Group and the joint applicants on the 2022 CRA 1 Judicial Review (ELI, Forest & Bird, and Te Uri o Hikihiki Hapū). The workshops were to discuss the management tools identified in paragraph 168 above for the purpose of facilitating input from tangata whenua and stakeholders regarding the costs and benefits of these proposed tools and to identify additional tools they may propose for consideration.

(b) A hui in May 2024 hosted by the Minister to engage with the local community in Northland to discuss initiatives and management tools to reduce the spread and extent of kina barrens.

(c) FNZ attended Iwi Fisheries Forums in Northland on multiple occasions to provide information on research undertaken and progress with the wider kina barren work programme and to gain input on rock lobster management measures.

214. FNZ has contracted a range of research and facilitated workshops to assist in identifying knowledge gaps regarding the causes and distribution of kina barrens[78] and has now begun research to begin filling these gaps. Relevant research and work include:

(a) In 2023, FNZ funded a literature review to better understand the current state of knowledge informing the trophic cascade hypothesis and fishing pressure in relation to sea urchin barren habitat on coastal rocky reef systems within New Zealand.[79]

[75] Review of the recreational daily kina limit in fishery management area 1 (the east coast of the upper North Island)
[76] Enabling the removal of sea urchins for the management or prevention of urchin barrens
[77] Temporary fishery closures in the Hauraki Gulf | NZ Government (mpi.govt.nz)
[78] Doheny et al., 2023.
[79] Available at: AEBR 324 Fishery-induced trophic cascades and sea urchin barrens in New Zealand: a review and discussion for management (mpi.govt.nz)

(b) During 2023 and 2024, FNZ participated in a Sustainable Seas National Science Challenge case study to develop a decision-making tool for evaluating management approaches to kina barrens.

(c) In March 2023, FNZ facilitated a national kina barren science workshop to prioritise science needs to address sea urchin barrens in fisheries management decisions.[80]

(d) In 2024, FNZ contracted research project ZBD2023-03: Summarising and updating knowledge on the distribution of kina barrens in key regions of New Zealand. This project is expected to collate existing data on the spatial and temporal extent of sea urchin barrens in New Zealand (mapping project), identify information gaps, and collect additional data for the upper North Island (Cape Reinga to East Cape) to inform management and monitor future change. This could inform further fishery management measures in future (see Part 1 '*Other possible CRA 2 fishery management measures*').

Information on biology, interdependence, and environmental factors

215. This information supports FNZ's initial assessment of the proposals against section 13 of the Act in 'Part 2: Assessment against *relevant legal provisions*'. Information in this section was derived from the CRA 2 chapter of the November 2024 Fisheries Assessment Plenary and the Aquatic Environment and Biodiversity Annual Review (**AEBAR**), except where cited otherwise.

Interdependence of stocks

87. Information on the role rock lobster play in the prevalence and distribution of sea urchin barrens is discussed above in Part 3 '*Urchin barrens*'.

Biological characteristics

Distribution and movement

216. Rock lobsters are mainly found on reef habitat and sometimes on sandy seafloor down to 200 m water depth.

217. Macroalgae (kelp) increases structural complexity and provides habitat and food for prey species of rock lobster. Kelp is also consumed directly by rock lobster.[81]

218. Adult rock lobsters are generally considered to have a small home range once settled (i.e., less than 5 km). However, they also exhibit patterns of movement at various life stages. This includes movement into shallow water seasonally for moulting and mating, and females move to the edges of reefs to spawn their eggs. Some migrations consist of large numbers of rock lobsters moving together.

Growth, maturity, and reproduction

219. Although rock lobsters have not been aged, they are thought to be relatively long-lived. Individuals in Australia are considered to live at least 20 years.[82] Size at maturity varies between rock lobster stocks with 50% of CRA 2 females being potentially egg bearing in the mid 53 mm tail width class.

220. Female rock lobsters produce eggs once a year and can produce between 40,000 to 600,000 eggs in a single reproductive event, with larger females producing more eggs than smaller females.[83] Eggs incubate for 3 to 4 months on the underside of the female's tail, held in place by small hairs.[84]

221. Mating occurs in autumn, with the eggs hatching in spring. Larval development can last 12 to 24 months and occurs far offshore.[85] Because of the long larval life of rock lobsters, the origins of larvae are difficult to determine. 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.

222. A study which modelled the locations that rock lobster hatch and settle around New Zealand estimated that most rock lobster which hatch in CRA 2 become entrained in the East Cape and Wairarapa Eddies and settle

[80] See section 8 in AEBR 324 Fishery-induced trophic cascades and sea urchin barrens in New Zealand: a review and discussion for management (mpi.govt.nz)
[81] MacDiarmid et al., 2013.
[82] Linnane et al., 2021.
[83] Green & Gardener, 2009.
[84] Kelly et al., 1999.
[85] Bradford et al., 2014; Chiswell & Booth, 2008.

downstream in CRA 3 and 4. However, rock lobster that settle in CRA 2 appear to originate from North Cape to Kaikoura (including CRA 1 , CRA 2, CRA 3, and CRA 4).[86]

223. After the larval phase, puerulus settle on coastal rocky reef and less frequently on complex seaweeds and bryozoans. Rocky reef in shallow water less than 20 m deep[87] is critical settlement habitat for rock lobsters and provides the conditions and substrates key for kelp habitat in New Zealand.[88] Pueruli of rock lobsters use chemical cues associated with coastal waters to help locate settlement habitats.[89]

224. The time lag from puerulus settlement to recruitment in the CRA 2 stock assessment models (at 32–34 mm TW) was estimated to be shorter than the two to three years for CRA 3, depending on locality, based on an analysis of juvenile growth information from Gisborne Wharf and Stewart Island.[90]

225. Evidence from Australia suggests that kelp habitat is important for rock lobster settlement, and that declines in kelp habitat could negatively affect rock lobster productivity.[91] For example, in Tasmania juvenile rock lobster showed increased recruitment and survival in kelp compared to long-spined urchin barren habitat[92] and larger reefs with kelp appear critical to the recruitment of rock lobsters.[93]

226. In New Zealand, pueruli have been observed to detect and respond to both underwater sounds (acoustic cues) and substrate or chemical cues from different habitats, with seaweed and rock substrates increasing settlement and speeding up moulting.[94] Underwater sounds can provide orientation cues for pelagic crustacean larvae, expedite settlement and initiate settlement behaviour.[95]

227. Juvenile rock lobster are more vulnerable to predation in kina barrens compared to kelp habitats during the day and potentially during dusk/dawn, but not during the night when they are typically active.[96] Kelp habitats also provide more of the preferred invertebrate prey for juvenile lobsters,[97] potentially increasing nutrition and growth, further research is required to confirm this relationship.

228. Recent analysis indicates a potential relationship between sea surface temperature and rock lobster recruitment, where relatively warm years were associated with poorer recruitment in northern regions.[98]

Predator-prey interactions

229. Rock lobsters are ecologically important predators in New Zealand's rocky reef ecosystems, where they can exert top-down regulation of prey populations.[99] They consume a broad range of prey, including molluscs, crustaceans, annelid worms, macroalgae, echinoderms, sponges, bryozoans, fish, foraminifera, and brachiopods.[100] They strongly prefer soft-sediment bivalves over rocky reef prey and make nocturnal foraging movements away from the reef.[101] Their feeding rates vary seasonally in relation to moulting and reproductive cycles.

230. Rock lobsters can also consume kina. While rock lobsters prefer soft-sediment bivalves over urchins and consumption of sea urchins varies seasonally with moulting stage they are one of the few predators that can eat large sea urchins.[102] Laboratory experiments found that predation on large sea urchins is limited to large rock lobsters.[103]

231. Evidence from Australia suggests that rock lobsters of all sizes (including small lobsters: 65-109 mm carapace length) consume the long-spined sea urchin *Centrostephanus rodgersii* Although the size of long-spined urchins consumed by lobsters was not investigated by this study, they were found to be less prominent in the diet of lobsters sampled from the established urchin barren site suggesting that long-spined urchins in barrens may exceed the size suitable for rock lobster predation.[104]

[86] Chiswell & Booth, 2008.
[87] Puerulus settlement takes place mainly in depths less than 20 m, but not uniformly over time or between regions. Settlement indices measured on collectors can fluctuate widely from year to year.
[88] Booth et al., 1991.
[89] Hinojosa et al., 2018.
[90] Roberts & Webber, 2022.
[91] Hinojosa et al., 2015; Hinojosa et al., 2018; Shelamoff et al., 2022.
[92] Hinojosa et al., 2015.
[93] Shelamoff et al., 2022.
[94] Stanley et al., 2015.
[95] Stanley et al., 2012.
[96] Hesse et al., 2016.
[97] Taylor, 1998.
[98] Roberts & Webber, 2024 – in review
[99] Pinkerton et al., 2008.
[100] MacDiarmid et al., 2013.
[101] Flood, 2021.
[102] Flood, 2021; Andrew & MacDiarmid, 1991.
[103] Andrew & MacDiarmid, 1991.
[104] Smith et al, 2023.

232. In addition to consuming sea urchins, the presence of rock lobster and snapper can influence urchins indirectly. A study by Spyksma et al. (2017) in northern New Zealand found that increased presence of predators such as rock lobster and snapper inside marine reserves increases cryptic behaviour (hiding in crevices) by sea urchins.

233. The ecological role rock lobster plays in sea urchin abundance, and hence the occurrence of sea urchin barrens, is discussed further under headings 'Spatial Closures' and 'Assessment of proposals against section 9 of the Act'.

234. Predation on rock lobsters is known from a variety of fish species. Published scientific observations suggest octopus, rig, blue cod, grouper, southern dogfish, seals, and other rock lobsters are predators of rock lobsters.[105]

Environmental conditions affecting the stock

235. FNZ's assessment of the proposed options for CRA 2 against the environmental principles in section 9 of the Act which the Minister must take into account when considering the CRA 2 TAC are discussed under Part 2 '*Initial assessment against relevant legal provisions, Assessment of the proposals against section 9 of the Act*'.

236. Rock lobster spend an extended time in the planktonic larval phase, swimming and drifting in the ocean for up to 24 months. Therefore, 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 planktonic developmental phase of rock lobster, that settle to the sea floor varies among areas and from year to year.

237. 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.

238. Evidence from Australia suggests that kelp habitat may be critical to the settlement success of rock lobster (*Jasus edwardsii*) pueruli, providing important settlement cues, food, and refuge.[106] The same relationship has yet to be observed in New Zealand[107] and further research is needed to test this. However, given the similarity between ecosystems in Tasmania and New Zealand these potential relationships are important to consider for the management of rock lobster. Kelp does support both food sources and shelter for later life stages of rock lobster in New Zealand,[108] suggesting the health of coastal kelp forests is likely tightly linked to the health of the rock lobster population.

239. Information on variability in rock lobster growth, size at maturity, available abundance, mortality, and recruitment is incorporated into the stock assessments that inform rock lobster management.

Climate change

240. The ocean around New Zealand is, in some regions, warming at a rate well in excess of the global average.[109] While the extent to how this will impact the wider ecosystem is unknown, it can be expected that there will be an impact on rock lobster, including their spatial variability.

241. Recent assessment indicates a potentially negative relationship between sea surface temperature and rock lobster recruitment in northern New Zealand.[110] This work is preliminary and requires further investigation, however this could be a significant development. Organisms such as rock lobsters are particularly susceptible to ocean acidification because it lessens their ability to lay down calcified body structures during each moult.[111] Changes to ocean circulation patterns also have the potential to affect the recruitment of the rock lobster, given the extended larval stage. Extended periods of extremely warm ocean temperatures known as marine heatwaves are increasing in intensity and frequency across the globe with trends predicted to accelerate under future climate change. New Zealand experienced several extended periods of marine heatwaves in recent years,[112] causing a range of impacts including temporary southern migrations of warm-water fish and loss of ecologically important seaweeds.[113] Marine heatwaves may have direct effects on rock lobster through temperature stress affecting their physiological condition[114] or indirect effects through impacts on associated habitats e.g., kelp forests.

[105] MacDiarmid et al., 2013.
[106] Hinojosa et al., 2015; Hinojosa et al., 2018; Shelamoff et al., 2022.
[107] Stanley et al., 2015; Hesse et al., 2015.
[108] MacDiarmid & Kelly, 2013.
[109] Sutton & Bowen, 2019.
[110] Roberts & Webber, 2024 – in review
[111] Bell et al., 2023; Hepburn et al., 2011.
[112] Salinger et al., 2019; Bell et al., 2023.
[113] Thomsen et al., 2019; Salinger et al., 2020; Thomsen et al., 2021.
[114] Oellermann et al., 2020.

Information on environmental impacts

242. This information supports FNZ's assessment of the proposals against section 9 of the Act in Part 2 '*Initial assessment against relevant legal provisions*'.

Protected species

Seabirds

243. Management of seabird interactions with New Zealand's commercial fisheries is guided by the National Plan of Action – Seabirds 2020 (**NPOA-Seabirds**). The NPOA-Seabirds sets out the New Zealand government's commitment to reducing fishing-related captures and associated mortality of seabirds. The vision of the NPOA-Seabirds is that New Zealanders work towards zero fishing-related seabird mortalities.

244. Management actions and research under the NPOA-Seabirds are guided and prioritised based on the seabird risk assessment that breaks down the risks to seabird population by fishery groups. The most recent seabird risk assessment was published in 2023.

245. There have been no reported interactions with seabirds in CRA 2 fishery in the last 10 years. This is likely due to the primary fishing method being potting, with pots usually set too deep for seabirds to enter.

Mammals

246. In New Zealand waters, marine mammal entanglements with pot fishing gear have been documented since 1980. A recent study on cetacean interactions with potting fisheries (Pierre et al., 2022) found that from 1980 to the present, 1-2 entanglement events of cetaceans per year were reported on average. However more recently, from 2010-2020, an average of 4-5 entanglement events per year have been recorded.

247. Nationally, the most recorded entanglements over time have involved humpback whales, followed by orca. Within the CRA 2 fishery there has been one mammal interaction reported with pot or trapping gear over the last 10 years.

248. Methods to reduce impacts on cetaceans from interactions and entanglements with pot and trap fishing gear include modified fishing practices, spatial/temporal management, and active untangling of entrapped cetaceans. Actively untangling is the main documented response to addressing entanglements in New Zealand to date.

249. Guidance for commercial pot fishers has been distributed by NZ RLIC. This guidance includes proactive approaches to reduce the risk of cetacean entanglements with fishing gear, providing information on whale identification, best practice approaches to mitigation, and reporting requirements.

Fish and invertebrate bycatch

250. When rock lobster was targeted in CRA 2 from the 2018/19 to 2023/24 fishing years, the most frequently reported incidental species caught in the CRA 2 target fishery were packhorse rock lobster (PHC 1), octopus, red moki and snapper (SNA 1 and SNA 2). Packhorse rock lobster and snapper are landed as bycatch while octopus and red moki are mostly considered to have been released alive.

251. PHC 1 overlaps with CRA 2. The 2020 stock assessment considered to the stock to be Likely to be at or above the target and Unlikely to be overfished.

252. SNA 1 overlaps CRA 2 while SNA 2 very slightly overlaps with CRA 2 at the far east of the Bay of Plenty (from Cape Runaway to East Cape); both are managed under the QMS. Under the National Inshore Finfish Fisheries Plan SNA 1 is a Group 1 stock[115] and SNA 2 is a Group 2 stock.[116]

253. SNA 1 consists of two sub stocks:
    a. SNA 1 East Northland, with the 2023 stock assessment considered the stock to be About as Likely as Not (40–60%) to be at or above the target and About as Likely as Not (40–60%) to be overfished.
    b. SNA 1 Hauraki Gulf/Bay of Plenty, with the 2023 stock assessment considered the stock to be Very Likely to be at or above the target and Very Likely to be overfished.

254. SNA 2 consists of two sub stocks with SNA 2 North the only sub stock overlapping with CRA 2. The 2022 stock assessment was unable to determine the stock status in relation to its target, so stock status unknown.

[115] A Group 1 stock's status is determined using fully quantitative stock assessments to provide high levels of information, certainty of stock status and assurance of the stock's sustainability.

[116] A group 2 stock is usually monitored with partial quantitative stock assessments, which are mostly based on trends in relative abundance. Future population (biomass) projections are not provided for.

Biological diversity of the environment

255. Potting is the main method of targeting rock lobster commercially and is assumed to have very little direct effect on non-target species. FNZ is not aware of any information that exists regarding the benthic effects of potting in New Zealand.

256. A study on the effects of lobster pots on the benthic environment was completed in a report on the South Australian rock lobster fisheries.[117] This fishery is likely to be the most comparable to New Zealand because the lobster species is the same (*Jasus edwardsii*) and many of the same species are present, although pots and how they are fished may differ. The report concluded that the amount of algae removed by pots (due to entanglement) probably has no ecological significance.

257. Species within an ecosystem interact through a number of mechanisms including feeding or predation commonly referred to as trophic links within an overall 'food web.' Changes to the abundance, size structure, and functional type[118] of a species can affect both its predators and prey through trophic interactions.[119] Changes in the abundance of one species may go on to affect other species that are neither its predators nor its prey. Changes within an ecosystem are therefore linked and can impact multiple trophic levels, affecting biodiversity and ecosystem resilience.

258. As outlined in the [2023 Aquatic Environment and Biodiversity Report No. 324], kelp provides a wide and diverse range of services, including:

    (a) Providing energy and organic matter to rocky reef ecosystems as well as adjacent intertidal and deepwater ecosystems;
    (b) Providing complex three dimensional structures which support high levels of biodiversity through both shelter and food subsidies; and
    (c) Cultural ecosystem services through harvestable food and materials as well as recreational and tourism opportunities.

259. It is important to note that kelp is indirectly affected by fishing for predators (see '*Urchin barrens*' above). The removal of predators, including rock lobster, can reduce predatory control of the abundance of kina, which graze on kelp. The magnitude of this relationship depends on many factors that vary regionally. Biotic factors include (but are not limited to) fishing pressure, population dynamics of predators, prey and kelp and ecosystem resilience. Abiotic factors in include temperature, turbidity and chemistry (among others)). An over-abundance of kina and the over grazing of kelp systems can result in kina barrens. Kelp forests are an important habitat and food source for many rocky reef dwelling species. Therefore, in making a decision, the Minister must give consideration to the indirect impacts of rock lobster fishing on species that directly rely on kelp.

260. Kelp habitats are likely to be important for a range of harvested and non-harvested species, and any reduction in such habitats is therefore likely to be adverse to rock lobster and other species that rely on kelp for shelter or food.

261. Fishing-induced trophic cascades, kelp grazers (e.g., butterfish), and other impacts on the ecosystem due to fishing, sedimentation, and climate change can have long term impacts on kelp abundance and distribution. In turn, this could potentially negatively impact the suitability of rocky reef habitat for juvenile and adult rock lobsters as a refuge for settlement, as well as the availability of their prey species.

Potential habitats of particular significance for fisheries management

262. Using the best available information, FNZ have identified eight potential habitats of particular significance for fisheries management in CRA 2. A description of those areas and their sensitivities, why they are considered particularly significant, and the current measures in place that restrict fishing in those areas can be found in Table 12.

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[117] Casement & Svane, 1999.

[118] 'Functional type' refers to the collection of life history and ecological characteristics of an organism, including whether it is an herbivore, carnivore or omnivore, its feeding behaviour (including size of prey) location in the water column/benthos, and mobility.

[119] Rosas-Luis et al., 2017.

Table 12: Potential habitats of particular significance for fisheries management within the CRA 2 QMA.

<table>
<tr><th>Habitat of particular significance</th><th>Attributes of habitat</th><th>Reasons for particular significance</th><th>Risks/Threats</th><th>Existing protection measures</th><th>Evidence</th></tr>
<tr><td>Cape Runaway</td><td>Moki spawning grounds around both sides of Cape Runaway and south to roughly 37° 37.2'S 177° 56.8'E (Mātauranga) and east/south to Mahia (Fisheries New Zealand, 2024).
We have no data describing a specific association between habitat and spawning; however, moki only spawn in this area, usually in August-September.</td><td>Spawning (Moki)</td><td rowspan="5">Potential CRA 2 fishing impacts:
• Impact of potting on benthos considered to be low (see Part 2 ‘Assessment of the proposals against section 9 of the Act’).
• Hand gathering of rock lobster considered very unlikely to impact benthic habitats.
• Interruption of prey relationship (see Part 3 ‘Urchins’).

Non-fishing impacts:
• Vessels anchoring over sensitive benthic habitat.
• Sedimentation from land-based practices.
• Eutrophication from land-based practices and finfish farming.
• Nutrient enrichment and chemical pollutants from land-based practices.
• Nutrient enrichment from aquaculture.
• Additional aquaculture facilities over seagrass.</td><td>• Trawling and Danish seining prohibited.
• Any fishing with nets is banned for cultural reasons in a small, inshore area from Cape Runaway to the south.
• The potential habitat of particular significance for fisheries management appears to lie somewhat within mātaitai (but this requires confirmation).</td><td>Mātauranga noted in Fisheries New Zealand, 2024
Jones et al., 2016</td></tr>
<tr><td>Colville Channel</td><td>Blue cod - mixed biogenic reef: horse mussels, dog cockles (Jones et al., 2016; M Morrison, pers. comm.; C Duffy, pers. comm.) Over 30 m water depth, structure supports benthic foraging of juveniles.
Scallops – shell hash with fine filamentous material e.g. algae, tube worms (M Morrison, pers. comm.).
Snapper – water column (Zeldis and Francis, 1998)</td><td>Nursery (Blue cod)
Spawning (Snapper)
Shellfish bed (Scallops)</td><td>• Inshore PSH MHS trawl net prohibited.
• Pair trawling and pair Danish seining prohibited.</td><td>Zeldis and Francis, 1998
Jones et al., 2016
M Morrison, pers. comm.
C Duffy, pers. comm.</td></tr>
<tr><td>Craddock Channel</td><td>Blue cod - mixed biogenic reef: horse mussels, dog cockles (M Morrison, pers. comm., C Duffy, pers. comm.) Over 30 m water depth, structure supports benthic foraging of juveniles.
Area to east of channel known for snapper spawning (Zeldis and Francis 1998; Jones et al., 2016).</td><td>Nursery (Blue cod)
Spawning (Snapper)</td><td>• Inshore PSH MHS trawl net prohibited.
• Pair trawling and pair Danish seining prohibited.</td><td>Zeldis and Francis, 1998
Jones et al., 2016
C Duffy, pers. comm.
M Morrison, pers. comm.</td></tr>
<tr><td>Fitzroy Harbour, Great Barrier Island</td><td>Mud, burrows, low density horse mussels provides structure, feeding opportunities (zooplankton) and refuge from predation (M Morrison pers. comm.; Morrison et al., 2019; Morrison, 2021)</td><td>Nursery (Snapper)</td><td>• Inshore PSH MHS trawl net prohibited.
• Trawling and Danish seining prohibited.
• Pair trawling and pair Danish seining prohibited.</td><td>Morrison et al., 2019
Morrison 2021
M Morrison, pers. comm.
C Duffy, pers. comm.</td></tr>
<tr><td>Kawau Bay</td><td>Muddy seafloor habitats with large burrow complexes and/or horse mussel beds with associated epifauna. Seasonal presence of juvenile snapper (Francis, 1995, Morrison et al., 2019; M.Morrison, pers. comm.)
Continuity with spawning habitats in coastal waters (Zeldis and Francis, 1998) adjacent to</td><td>Nursery (Snapper)</td><td>• Trawling, pair trawling, and pair Danish seining prohibited.
• Submarine Cable and Pipeline Protection - small area in south of bay.
• Pair trawling and pair Danish seining prohibited.</td><td>Francis 1995
Zeldis and Francis, 1998
Morrison et al., 2019.
M Morrison, pers. comm.
C Duffy, pers. comm.</td></tr>
</table>

Habitat of particular significance	Attributes of habitat	Reasons for particular significance	Risks/Threats	Existing protection measures	Evidence
	harbours, estuaries, and coastal embayments, known to be important nurseries.				
Ponui Island	Mud, burrows, and horse mussels (M Morrison, pers. comm.). Spawning habitats in coastal waters adjacent to harbours, estuaries, and coastal embayments, known to be important nurseries (Morrison et al., 2019).	Nursery (Snapper)		• Danish seine prohibited. • Pair trawling and pair Danish seining prohibited.	Morrison et al., 2019. M Morrison, pers. comm. Clinton Duffy, pers. comm.
Waimate Embayment	Mud, burrows, and horse mussels (M. Morrison pers. comm.). Spawning habitats in coastal waters adjacent to harbours, estuaries, and coastal embayments, known to be important nurseries (Zeldis 1993; Zeldis and Francis 1998; Morrison et al., 2019)	Spawning (Snapper) Nursery (Snapper)		• Danish seine prohibited. • Pair trawling and pair Danish seining prohibited.	Zeldis 1993. Zeldis and Francis 1998 Morrison et al., 2019. M. Morrison, pers. comm. C. Duffy, pers. comm.
Whangateau Harbour	Sheltered, clear waters, strong tidal mixing (M Morrison pers. comm.). Connectivity to other habitats important to other life cycle stages - ontogenetic shift from *Hormosira* (Neptune's necklace) covered intertidal reefs to *Carpophyllum* kelp forests inside harbour entrance then out to coastal reefs (Morrison, 1990). Parore changes habitat over first year of life: 2-3 months on the *Hormosira* reefs, then movement to estuarine *Carpophyllum* forests. Connectivity to other habitats important for later life cycle stages (in Whangateau steep reefs with brown kelp inside harbour entrance, shallow subtidal reefs at harbour entrance with some algal cover). Juvenile kahawai, grey mullet, sand and yellow belly flounder, spotties, trevally, snapper (Morrison et al., 2014).	Nursery (Parore)		• Inshore PSH MHS trawl net prohibited. • Pair trawling and pair Danish seining prohibited. • Danish seine nets, trawl nets, box or teiche nets, trammel nets, purse seine nets, or lampara nets in rivers, streams, lakes, lagoons, or estuaries.	Morrison, 1990. Morrison et al., 2009. Morrison et al., 2014. M Morrison, pers. comm.

References

Andrew, N. L., & MacDiarmid, A. B. (1991). Interrelations between sea urchins and spiny lobsters in northeastern New Zealand. Marine Ecology Progress Series, 211-222.

Annala, J. (1983) New Zealand rock lobsters: biology and fishery. Fisheries Research Division Occasional Publication No. 42. New Zealand Ministry of Agriculture and Fisheries, Wellington. 36 p.

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.

Babcock, R. C., N. T. Shears, A. C. Alcala, N. S. Barrett, G. J. Edgar, K. D. Lafferty, T. R. McClanahan, and G. R. Russ. (2010). "Decadal Trends in Marine Reserves Reveal Differential Rates of Change in Direct and Indirect Effects." Proceedings of the National Academy of Sciences of the United States of America 107: 18256–61.

Balemi, C.A. and Shears, N.T. (2023). Emergence of the subtropical sea urchin *Centrostephanus rodgersii* as a threat to kelp forest ecosystems in northern New Zealand. Frontiers in Marine Science, 10, p.1224067.

Bell, J. J., Davy, S. K., Jones, T., Taylor, M. W., & Webster, N. S. (2013). Could some coral reefs become sponge reefs as our climate changes?. Global change biology, 19(9), 2613-2624.

Bell, J. J., Smith, R. O., Micaroni, V., Strano, F., Balemi, C. A., Caiger, P. E., Shears, N. T. (2023). Marine heat waves drive bleaching and necrosis of temperate sponges. Current Biology, 33(1), 158-163.

Bernhardt, J. R., Leslie, H. M. (2013) Resilience to Climate Change in Coastal Marine Ecosystems. Annual Review of Marine Science 5, 371–92.

Booth, J. D., Carruthers, A. D., Bolt, C. D., & Stewart, R. A. (1991). Measuring depth of settlement in the red rock lobster, Jasus edwardsii. New Zealand Journal of Marine and Freshwater Research, 25(2), 123-132.

Bradford, R. W., Griffin, D., & Bruce, B. D. (2014). Estimating the duration of the pelagic phyllosoma phase of the southern rock lobster, Jasus edwardsii (Hutton). Marine and Freshwater Research, 66(3), 213-219.

Casement, D; Svane, I (1999) Direct Effects of Rock Lobster Pots on Temperate Shallow Rocky Reefs in South Australia: a study report to the South Australian Rock Lobster Industry. South Australian Research & Development Institute. 24 p.

Chiswell, S. M., & Booth, J. D. (2008). Sources and sinks of larval settlement in Jasus edwardsii around New Zealand: where do larvae come from and where do they go?. Marine Ecology Progress Series, 354, 201-217.

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 and ecology, 60(2-3), 129-162.

Coleman, R.A., Hoskin, M.G., Von Carlshausen, E. and Davis, C.M. (2013). Using a no-take zone to assess the impacts of fishing: Sessile epifauna appear insensitive to environmental disturbances from commercial potting. Journal of Experimental Marine Biology and Ecology, 440, pp.100-107.

Dartnall, L. (2022). The extent of kina barrens over time at Hauturu-o-Toi and the Noises Islands. Univeristy of Auckland Thesis.

Dichmont, C.M., Ellis, N., Bustamante, R. H., Deng, R., Tickell, S., Pascual, R., Lozano-Montes, H., Griffiths, S. (2013). Evaluating marine spatial closures with conflicting fisheries and conservation objectives. Journal of Applied Ecology. 50. 10.1111/1365-2664.12110.

Doheny, B., Davis J.P., Miller, B. (2023). Fishery-Induced Trophic Cascades and Sea Urchin Barrens in New Zealand: A Review and Discussion for Management. New Zealand Aquatic Environment and Biodiversity Report No. 4425. 126 p.

Duffy, J.E., Lefcheck, J.S., Stuart-Smith, R.S., Navarrete, S.A., & Edgar, G.J. (2016). Biodiversity enhances reef fish biomass and resistance to climate change. Proceedings of the National Academy of Sciences. doi:10.1073/pnas.1524465113.

Dromgoole F. (1964). The depredation of Ecklonia radiata beds by the sea urchin Evechinus chloroticus. Tane. 10:120–122.

Edgar, G. J., Stuart-Smith, R. D., Thomson, R. J., & Freeman, D. J. (2017). Consistent multi-level trophic effects of marine reserve protection across northern New Zealand. PLoS One, 12(5), e0177216.

Filbee-Dexter, K., & Scheibling, R. (2014). Sea urchin barrens as alternative stable states of collapsed kelp ecosystems. Marine Ecology Progress Series, 495, 1–25.

Fisheries New Zealand (2011) Operational Guidelines for New Zealand's Harvest Strategy Standard. Accessible at: https://www.mpi.govt.nz/dmsdocument/19706-OPERATIONAL-GUIDELINES-FOR-NEW-ZEALANDS-HARVEST-STRATEGY-STANDARD

Fisheries New Zealand (2022) Aquatic Environment and Biodiversity Annual Review 2021. Compiled by the Aquatic Environment Team, Fisheries Science and Information, Fisheries New Zealand, Wellington New Zealand. 779 p.

Fisheries New Zealand (2024). Fisheries Assessment Plenary, November 2024: stock assessments and stock status. Compiled by the Fisheries Science Team, Fisheries New Zealand, Wellington, New Zealand. Accessible at: https://www.mpi.govt.nz/dmsdocument/66321#page=324.

Flood, A. S. 2021. PhD: Gut Instincts: Feeding behaviour of the rock lobster, Jasus edwardsii. The University of Auckland, Auckland, New Zealand.

Francis, M. P. (1995). Spatial and seasonal variation in the abundance of juvenile snapper (Pagrus auratus) in the north-western Hauraki Gulf. New Zealand Journal of Marine and Freshwater Research, 29(4), 565-579.

Gall, S.C., Rodwell, L.D., Clark, S., Robbins, T., Attrill, M.J., Holmes, L.A. and Sheehan, E.V. (2020). The impact of potting for crustaceans on temperate rocky reef habitats: Implications for management. Marine Environmental Research, 162, p.105134.

Green, B. S., Gardner, C. (2009). Surviving a sea-change: survival of southern rock lobster (Jasus edwardsii) translocated to a site of fast growth. ICES Journal of Marine Science, 66(4), 656-664.

Haggitt, T. (2016) Ecological survey of Waiheke Island north-west coastline, report prepared by eCoast for Auckland Council and Hauraki Gulf Conservation Trust.

Haggitt, T. (2017). Te Whanganui a Hei Marine Reserve Habitat Mapping, Report prepared by eCoast for Department of Conservation.

Hanns, B.J., Haggitt, T., and Shears, N.T., 2022. Marine protected areas provide unfished reference information to empirically assess fishery status. Biological Conservation, 276, p.109775.

Heinemann A; Gray, A (2024) National Panel Survey of Recreational Marine Fishers 2022-23. New Zealand Fisheries Assessment Report 2024/51. 116 p.

Hepburn, C. D., Pritchard, D. W., Cornwall, C. E., McLeod, R. J., Beardall, J., Raven, J. A., & Hurd, C.L. (2011). Diversity of carbon use strategies in a kelp forest community: implications for a high CO2 ocean. Global Change Biology, 17(7), 2488-2497.

Hesse, J., Stanley, J. A., & Jeffs, A. G. (2015). Lobster in a bottle: a novel technique for observing the predation of juvenile spiny lobster (Jasus edwardsii). Marine and Freshwater Research, 67(11), 1625-1633.

Hesse, J., Stanley, J. A., & Jeffs, A. G. (2016). Relative predation risk in two types of habitat for juvenile Australasian spiny lobsters, Jasus edwardsii. Marine Biology Research, 12(9), 895-906.

Hinojosa, I. A., Gardner, C., Green, B. S., & Jeffs, A. (2018). Coastal chemical cues for settlement of the southern rock lobster, Jasus edwardsii. Bulletin of Marine Science, 94(3), 619-633.

Hinojosa, I. A., Green, B. S., Gardner, C., & Jeffs, A. (2015). Settlement and early survival of southern rock lobster, Jasus edwardsii, under climate-driven decline of kelp habitats. ICES Journal of Marine Science, 72(suppl_1), i59-i68.

Jones, E.G., Morrison, M.A., Davey, N., Hartill, B.W., and Sutton, C. (2016). Biogenic habitats on New Zealand's continental shelf. Part I: Local ecological knowledge. New Zealand Aquatic Environment and Biodiversity Report No. 174. Ministry for Primary Industries, Wellington. 99 pp.

Kelly, S., MacDiarmid, A. B., & Babcock, R. C. (1999). Characteristics of spiny lobster, Jasus edwardsii, aggregations in exposed reef and sandy areas. Marine and Freshwater Research, 50(5), 409-416.

Kerr, V. C., Grace, R. V., & Shears, N. T. (2024). Estimating the extent of urchin barrens and kelp forest loss in northeastern Aotearoa, New Zealand. New Zealand Journal of Marine and Freshwater Research, 1-22.

Kibele, J., & Shears, N. (2017). Mapping rocky reef habitats on the eastern Coromandel Peninsula with multispectral satellite imagery (No. 12557259). Hamilton, New Zealand: Waikato Regional Council.

Kulins, S. (2021). Investigating the ecological effects of Long Bay-Okura Marine Reserve. University of Auckland Thesis.

Lawrence, K. (2019). Mapping long-term changes in reef ecosystems using satellite imagery. University of Auckland Thesis.

Leleu, K., Remy-Zephir, B., Grace, R., & Costello, M. J. (2012). Mapping habitats in a marine reserve showed how a 30-year trophic cascade altered ecosystem structure. Biological Conservation, 155, 193-201.

Ling, S. D., Scheibling, R. E., Rassweiler, A., Johnson, C. R., Shears, N., Connell, S. D., Salomon, A. K., Norderhaug, K. M., Pérez-Matus, A., Hernández, J. C., Clemente, S., Blamey, L. K., Hereu, B., Ballesteros, E., Sala, E., Garrabou, J., Cebrian, E., Zabala, M., Fujita, D., & Johnson, L. E. (2015). Global regime shift dynamics of catastrophic sea urchin overgrazing. Philosophical Transactions of the Royal Society B: Biological Sciences, 370 (1659), 20130269.

Linnane, A., Gardner, C., Hobday, D., Punt, A., McGarvey, R., Feenstra, J., & Green, B. (2010). Evidence of large-scale spatial declines in recruitment patterns of southern rock lobster Jasus edwardsii, across south-eastern Australia. Fisheries Research, 105(3), 163-171.

Linnane, A; McGarvey, R; Gardner, C; Hartmann, K; De Lestang, S (2021) Southern rock lobster (2021). Fisheries Research and Development Corporation, Canberra. 6 p. URL: https://fish.gov.au/2020-Reports/southern_rock_lobster.

MacDiarmid, A. B., Freeman, D., & Kelly, S. (2013). Rock lobster biology and ecology: Contributions to understanding through the Leigh Marine Laboratory 1962–2012. New Zealand Journal of Marine and Freshwater Research, 47(3), 313–333.

Maggs, J.Q.; Evans, O.E.; Taylor, R.; Armiger, H; Marsh, C; Hartill B.W. (2024). Monitoring of recreational harvest of red rock lobster Jasus edwardsii in CRA 2. New Zealand Fisheries Assessment Report 2024/52. 41 p.

Miller, K. I., Balemi, C.A., Bell, D.R., Blain, C.O., Caiger, P.E., Hanns, B.J., Kulins, S.E., Peleg, O., Spyksma, A.J.P., Shears, N.T. (2023). Large-scale one-off sea urchin removal promotes rapid kelp recovery in urchin barrens. Restoration Ecology, 32: e14060. https://doi.org/10.1111/rec.14060

Morrison, M. (1990). Ontogenetic shifts in the ecology of the parore, Girella tricuspidata. Unpublished MSc Thesis, University of Auckland. 66 p.

Morrison, M.A. (2021). Hauraki Gulf Marine Park habitat restoration potential. New Zealand Aquatic Environment and Biodiversity Report No. 265. Ministry for Primary Industries, Wellington. 136 pp.

Morrison, M.A., Jones, E.G., Parsons, D.P., and Grant, C.M. (2014). Habitats and areas of particular significance for coastal finfish fisheries management in New Zealand: A review of concepts and life history knowledge, and suggestions for future research. New Zealand Aquatic Environment and Biodiversity Report No. 125. Ministry for Primary Industries, Wellington. 205 pp.

Morrison, M.A., Lowe, M.L., Parsons, D.M., Usmar, N.R., and McLeod, I.M. (2009). A review of land-based effects on coastal fisheries and supporting biodiversity in New Zealand. New Zealand Aquatic Environment and Biodiversity Report No. 37. Ministry of Fisheries, Wellington. 100 pp.

Morrison, M. A., McKenzie, J., & Bian, R. (2019). Pre-recruit (0+) snapper (Chrysophrys auratus) beam trawl and beach seine surveys of East Northland and the Hauraki Gulf (SNA 1). New Zealand Fisheries Assessment Report, 72, 50.

Nessia HR, Hanns BJ, Haggitt TR and Shears NT (2024) Using marine protected areas to assess the status and recovery of the spiny lobster Jasus edwardsii fishery in the Hauraki Gulf, Aotearoa New Zealand. Frontiers in Marine Science.

Oellermann, M., Hickey, A. J., Fitzgibbon, Q. P., & Smith, G. (2020). Thermal sensitivity links to cellular cardiac decline in three spiny lobsters. Scientific reports, 10(1), 202.

Pinkerton, M., C. Lundquist, C. Duffy, and D. Freeman. 2008. Trophic modelling of a New Zealand rocky reef ecosystem using simultaneous adjustment of diet, biomass and energetic parameters. Journal of Experimental Marine Biology and Ecology 367:189-203.

Roberts, J; Webber, D N (2022) Growth of juvenile red rock lobster (Jasus edwardsii) in New Zealand and implications for stock assessment. New Zealand Fisheries Assessment Report 2022/45. 59p.

Rosas-Luis, R., Navarro, J., Loor-Andrade, P., & Forero, M. G. (2017). Feeding ecology and trophic relationships of pelagic sharks and billfishes coexisting in the central eastern Pacific Ocean. Marine Ecology Progress Series, 573, 191-201.

Salinger, M. J., Renwick, J., Behrens, E., Mullan, A. B., Diamond, H. J., Sirguey, P., Sutton, P. J. (2019). The unprecedented coupled ocean-atmosphere summer heatwave in the New Zealand region 2017/18: drivers, mechanisms and impacts. Environmental Research Letters, 14(4), 044023.

Salinger, M. J., Diamond, H. J., Behrens, E., Fernandez, D., Fitzharris, B. B., Herold, N., Trought, M. C. (2020). Unparalleled coupled ocean-atmosphere summer heatwaves in the New Zealand region: drivers, mechanisms and impacts. Climatic Change, 162, 485-506.

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. (2004). Community composition and structure of shallow subtidal reefs in northeastern New Zealand. Science for Conservation, 245, 65 p.

Shears, N. T., Babcock, R. C., Duffy, C. A. J., & Walker, J. W. (2004). Validation of qualitative habitat descriptors commonly used to classify subtidal reef assemblages in north-eastern New Zealand. New Zealand Journal of Marine and Freshwater Research, 38(4), 743-752.

Shelamoff, V., Layton, C., Tatsumi, M., Cameron, M. J., Wright, J. T., & Johnson, C. R. (2022). Restored kelp facilitates lobster recruitment but not other mid-trophic macroinvertebrates. Aquatic Conservation: Marine and Freshwater Ecosystems, 32(7), 1115-1125.

Smith, J. E., Keane, J., Oellermann, M., Mundy, C., & Gardner, C. (2023). Lobster predation on barren-forming sea urchins is more prevalent in habitats where small urchins are common: a multi-method diet analysis. Marine and Freshwater Research, 74(18), 1493-1505.

Spyksma, A. J., Taylor, R. B., & Shears, N. T. (2017). Predation cues rather than resource availability promote cryptic behaviour in a habitat-forming sea urchin. Oecologia, 183, 821-829.

Stanley, J.A., Hesse, J., Hinojosa, I.A. et al., (2015) Inducers of settlement and moulting in post-larval spiny lobster. Oecologia 178, 685–697.

Stanley, J. A., Radford, C. A., & Jeffs, A. G. (2012). Location, location, location: finding a suitable home among the noise. Proceedings of the Royal Society B: Biological Sciences, 279(1742), 3622-3631.

Starr, P.J. (2024). Rock lobster catch and effort data: 1979–80 to 2022–23. New Zealand Fisheries Assessment Report 2024/10. 146 p.

Stephenson, F., Mill, A.C., Scott, C.L., Polunin, N.V. and Fitzsimmons, C. (2017). Experimental potting impacts on common UK reef habitats in areas of high and low fishing pressure. ICES Journal of Marine Science, 74(6), pp.1648-1659.

Sutton, P. J., & Bowen, M. (2019). Ocean temperature change around New Zealand over the last 36 years. New Zealand Journal of Marine and Freshwater Research, 53(3), 305-326.

Sweatman, J. A. (2021). The population history and demography of the long-spined sea urchin (Centrostephanus rodgersii) in Aotearoa New Zealand: a thesis presented in partial fulfilment of the requirements for the degree of Master of Science in Biological Sciences at Massey University, Albany, New Zealand (Doctoral dissertation, Massey University).

Taylor, L. (1998). From Theory to Practice: Maine's New Approach to Lobster Management. Maine Department of Marine Resources.

Thomsen, M. S., Mondardini, L., Alestra, T., Gerrity, S., Tait, L., South, P. M., Schiel, D. R. (2019). Local extinction of bull kelp (Durvillaea spp.) due to a marine heatwave. Frontiers in Marine Science, 6, 84.

Thomsen, M. S., Mondardini, L., Thoral, F., Gerber, D., Montie, S., South, P. M., Schiel, D. R. (2021). Cascading impacts of earthquakes and extreme heatwaves have destroyed populations of an iconic marine foundation species. Diversity and Distributions, 27(12), 2369-2383.

Udy, J., Wing, S., O'Connell-Milne, S., Kolodzey, S., McMullin, R., Durante, L., & Frew, R. (2019). Organic matter derived from kelp supports a large proportion of biomass in temperate rocky reef fish communities: Implications for ecosystem-based management. Aquatic Conservation: Marine and Freshwater Ecosystems, 29(9), 1503-1519.

Webber, D.N.; Roberts, J.O.; Starr, P.J.; Rudd, M.B.; Pons, M. (2024). Data for the 2023 stock assessment of red rock lobsters (Jasus edwardsii) in CRA 6. New Zealand Fisheries Assessment Report 2024/19. 73 p.

Wynne-Jones, J; Gray, A; Heinemann, A; Hill, L; Walton, L (2019) National Panel Survey of Marine Recreational Fishers 2017–2018. New Zealand Fisheries Assessment Report 2019/24. 104 p.

Zeldis, J.R. (1993). Application of egg surveys for spawning-stock biomass estimation of snapper, orange roughy, and hoki in New Zealand. Bulletin of Marine Science 53(2) 864-890.

Zeldis, J.R. and Francis, R.I.C.C. 1998. A daily egg production method estimate of snapper biomass in Hauraki Gulf, New Zealand. ICES Journal of Marine Science, 55: 522-534.