IN THE HIGH COURT OF NEW ZEALAND
WELLINGTON REGISTRY

I TE KŌTI MATUA O AOTEAROA
TE WHANGANUI-Ā-TARA ROHE

CIV-2021-485-676

UNDER THE	Judicial Review Procedure Act 2016
IN THE MATTER OF	An application for judicial review of decisions of the Minister for Oceans and Fisheries under s 13 of the Fisheries Act 1996
BETWEEN	**THE ENVIRONMENTAL LAW INITIATIVE**
	First Applicant
AND	**CARMEN HETARAKA** on behalf of **TE URI O HIKIHIKI HAPŪ**
	Second Applicant
AND	**MINISTER FOR OCEANS AND FISHERIES**
	First Respondent
AND	**NEW ZEALAND ROCK LOBSTER INDUSTRY COUNCIL LTD**
	Second Respondent
AND	**NEW ZEALAND SPORTS FISHING COUNCIL INC**
	Intervener

AFFIDAVIT OF VINCENT CARLYLE KERR
AFFIRMED MAY 2022

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AFFIDAVIT OF VINCENT CARLYLE KERR

I, **Vincent Carlye Kerr**, science advisor, of Whangarei, solemnly and sincerely affirm:

Introduction and background

1. I am a principal of Kerr & Associates and engaged in environmental consulting with a focus on marine ecology monitoring, habitat mapping and marine protected area design and planning. I have worked as a marine technical officer for Northland Conservancy, Department of Conservation (**DOC**). I have also worked as a contractor and consultant in marine and freshwater ecology for DOC in Northland. Relevant technical reports and publications that I have authored or contributed to are identified below.

2. I am a co-founder of the Northland-based Mountains to Sea Conservation Trust, which is among New Zealand's largest marine and freshwater environmental education providers. I currently serve as a science advisor for the Trust and support a number of hapū and community conservation projects as part of the Trust's community engagement program.

3. I hold a Bachelor of Biological Science degree from the University of Oregon, USA and a National Diploma in Horticulture from the Royal Institute of Horticulture, Lincoln College. I also hold teaching qualifications at secondary and tertiary level. I am a member of the New Zealand Marine Sciences Association. I have been a keen diver and observer of the natural world since childhood.

4. Over the past twenty years, I have led numerous marine habitat mapping projects, coastal inventories, ecological descriptions and have established a number of survey and monitoring programs around Northland. I have been an active diver and marine photographer in Northland and throughout the central Pacific. My work in the Pacific has been focused on coral reef fish ecology and biodiversity surveys and exploration of remote reef systems in the Pacific.

5. Marine science investigations have been carried out within the rohe moana of Te Uri o Hikihiki, at Mimiwhangata, since the early 1970s. Mimiwhangata is located within the CRA1 quota management area. There are 34 technical reports and published research papers that specifically involve work at Mimiwhangata. Schedule 1 to this affidavit lists those investigations. My involvement with the science work at Mimiwhangata began in 1999 when I was working as a contractor for DOC. I have been involved in various capacities with all Mimiwhangata investigations and reports from 2002 onwards.

6. In addition to the science research and monitoring work summarised above, I have acted as a marine ecological advisor and expert witness in two recent Environment Court cases.[1] In the Motiti case I provided expert evidence which presented results of a large-scale Northland based GIS study of the extent of kelp forest loss due to removal of sea urchin predators from overfishing. This study is discussed below at paragraph 33. In the Northland Regional Council

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1 *Motiti Rohe Moana Trust v Bay of Plenty Regional Council* [2018] NZEnvC 67 and *Royal Forest & Bird Protection Society of New Zealand Incorporated v Northland Regional Council*, which is currently awaiting decision by the Environment Court.

case, my evidence covered the results of the decades of past research and monitoring centred on Mimiwhangata and the impacts of algal forest decline[2] and associated degraded populations of crayfish and ecological implications. Those findings are summarised in this affidavit.

7. I have read the pleadings and evidence filed in this proceeding to date. I have been asked to provide evidence describing the decline in abundance of red rock lobster and algal forest cover and increase in kina barrens within the CRA 1 quota management area, in particular:

(a) the research and monitoring at Mimiwhangata between 1973 and 2011;

(b) mātauranga and leadership from Te Uri o Hikihiki;

(c) habitat mapping showing algal forest decline and the extent of kina barren on Northland's east coast; and

(d) crayfish abundances over time based on both ecological and Mātauranga Māori evidence.

8. On the basis of my evidence in those areas, I also comment on the options before the Minister for Oceans and Fisheries (**Minister**) for his 2021/22 and 2022/23 CRA1 total allowable catch decisions (**CRA1 TAC Decisions**).

9. I have also read the expert evidence of Dr Nick Shears and Dr Andrew Jeffs. To the extent that their evidence is within my area of expertise, I confirm I agree with their opinions.

10. I have read the Code of Conduct for expert witnesses in Schedule 4 of the High Court Rules and I agree to comply with it. Where my affidavit contains matters of expert opinion evidence, I confirm the statements made are within my area of expertise.

Research and monitoring at Mimiwhangata between 1973-2011

11. Mimiwhangata ranks amongst the most significant sites in New Zealand from a science perspective. Of particular significance is the long-term nature of the data sets for fish and crayfish stocks, which stretch back into the 1980s. Detailed habitat mapping studies have been carried out in 1973, 1981 and 2005. These have allowed for analysis of historic aerial imagery dating back to 1950.

12. Those habitat maps have been completed with varying coverage of Mimiwhangata. These studies involve analysis of aerial imagery, various forms of sonar data and ground truthing surveys using remotely operated or drop

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[2] In this affidavit I refer to both algal forest and *Ecklonia radiata* forest. Algal forest is a general term that varies in species composition depending on the geographical context. In Northland, *Ecklonia radiata* is the predominant species of kelp found in algal forests. While other kelp species are present in different depth zones and wave energy situations, *Ecklonia radiata* is the dominant species, especially in the most productive zone of algal forest. For that reason, algal forest within Northland is often named after the *Ecklonia radiata* as the dominant species.

cameras, sediment sampling, and in some cases scuba dives. Figure 1 below shows the spatial relationship between the two fine-scale mapping studies (1973 and 2005) and additionally the 1981 Paparahi Point (**Pa Point**) map. All of these methods and the mapping processes unveil a lot of information about the characteristics of the areas involved. The maps have shown themselves to be a valuable tool for planning and designing marine protected areas, assessing ecological significance, describing marine communities and identifying spatial areas of habitats to be used as proxies for ecological communities.

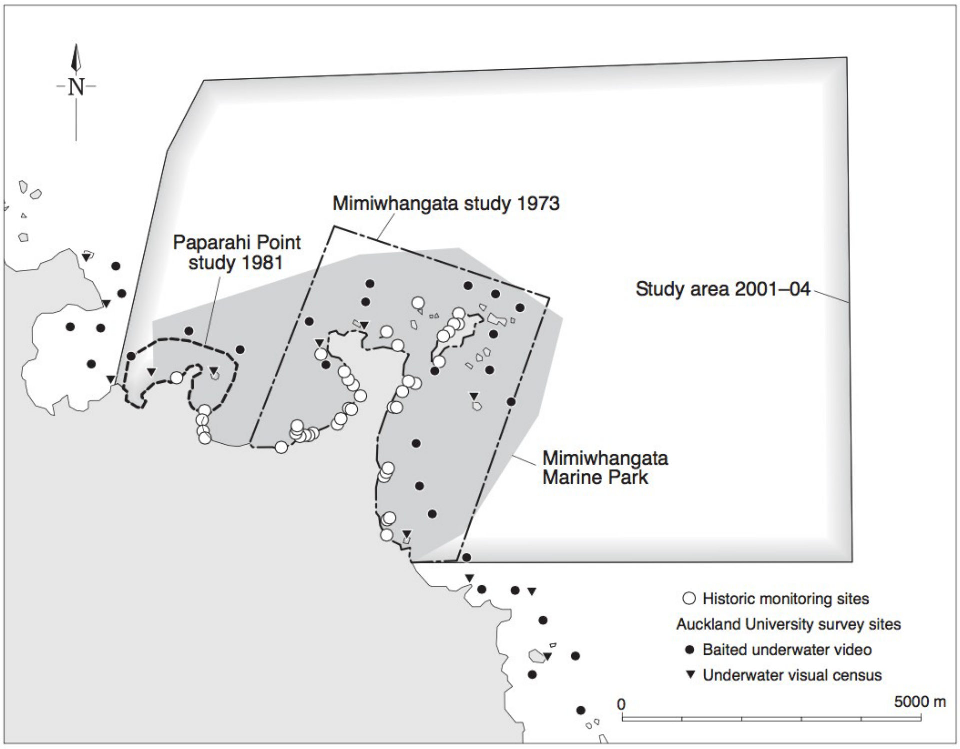

***Figure 1** Survey sites at Mimiwhangata established in 1976 by Dr Grace and the three areas where habitat mapping was completed in 1973, 1981 and 2005.*

13. The crayfish research projects at Mimiwhangata also included areas adjacent to the North and South of the current Marine Park. These areas represent sampling of the coast between Whananaki and Helena Bay. Mimiwhangata's long time-series of diving-based permanent fixed transects were paired with a study of the former Tāwharanui Marine Park, which was a no-take reserve until recently, when it became a marine reserve. In addition to my involvement in those projects, I have been diving on the Northland coast since the early 1980s and have been observing crayfish abundance and ecology of crayfish along with habitat mapping projects up and down the coast. In my experience, the results in and around Mimiwhangata are indicative of what I have observed all along Northland's east coast. I also interact regularly with other divers and coastal hapū groups that I work with. Their observations also reflect this description of red rock lobster being at very low levels of abundance with large individuals typically no longer seen.

14. The results of the habitat mapping studies showed that there has been significant loss of the shallow algal forest since the 1970s, coinciding with increased fishing pressure in this area and significant decreases of stock levels

(crayfish and snapper) reported in fisheries planning documents. Associated studies in other Northland sites support the understanding of the mechanisms at play with the algal forest loss. The pattern is similar and shows widespread loss and indications that the change in state from healthy *Ecklonia radiata* kelp forest to kina barren is quite stable once large kina barrens emerge. The studies also provide us with an understanding of the process of recovery within full no-take reserves, as we have clear examples of kelp forest being restored and maintained in full kelp forest cover at Leigh and Tāwharanui. These findings are discussed in more detail below.

The first era of research at Mimiwhangata: 1970s-1980s

15. In the early 1970s, Mimiwhangata was owned by New Zealand Breweries Ltd, which commissioned a series of studies (referred to at 1, 2 and 3 of Schedule 1) to document the environmental values of the area including the waters of Mimiwhangata. As part of that study, the marine ecology team of the late Dr Bill Ballantine (University of Auckland), the late Dr Roger Grace (independent scientist) and the late Wade Doak (marine explorer and author) were brought together. In 1972 and 1973, the team completed extensive survey work over the area we now know as the Marine Park at Mimiwhangata. As part of this work, they completed an ecological report and the first subtidal marine habitat map in New Zealand (referred to at 3 of Schedule 1). They developed principles and methods for this mapping that form the basis of what we still use today. The Mimiwhangata habitat map was added to by Dr Grace, with a further area covered at adjoining Paparahi Point in 1981 (referred to at 7 of Schedule). In both habitat maps, the kina-grazed zone where the shallow *Ecklonia radiata* forest was degraded covered significant areas. This indicates that, as far back as the 1970s, overfishing was affecting the ecology of the shallow reefs, although the link between overfishing and the decline of the algal forests was not fully understood at the time.

16. In 1976, Dr Grace set up a monitoring program for the area that focused on species that were thought to be affected by fishing pressure. Permanent transects were established to track abundance of reef fish, crayfish, mussels, tuatua, rock oysters, and scallops. Monitoring reports were completed regularly up until 1986. These reports showed that, generally, reef fish abundance levels were static over the period, with abundance levels generally low and large individuals generally missing from the populations. Mussels, tuatua, rock oysters and scallops were in decline. The Marine Park was fully established in 1984 with the gradual removal of all commercial fishing from the Park over the period 1984-1993. Recreational fishing was permitted, but crayfish could only be hand collected or potted in a single pot per person, party or boat. Unfortunately, for various reasons monitoring ceased in 1986.

17. By 1987, Dr Grace had growing concerns that kina barrens were increasing within the Marine Park and that there was no apparent recovery of crayfish or fish from what he then described as an overfished state. At this time, the ecological significance of the increasing kina-grazed zone was not fully understood. Based on these first periods of monitoring, from 1980 to 1987 Dr Grace made the case in his reports for New Zealand Breweries that the current partial protection approach should be carefully monitored to ascertain if recovery of habitat, reef fish and crayfish was occurring under the Marine Park management rules. During this period, the then-Ministry of Fisheries had oversight of the Marine Park.

18. By the 1970s and 1980s, it was apparent that commercial fishing had increased dramatically in the coastal zone of northeast New Zealand, with advances in fishing technologies, growing markets domestically, the beginning of export markets, and rapidly growing foreign ownership and participation in inshore fishing in New Zealand. While the 1973 Mimiwhangata report made a valuable contribution to the descriptions of the habitats of Mimiwhangata and description of the diversity of the reef community, it did not attempt to describe or measure the impacts of fishing on the shallow reef ecology. However, there were many observations made in that report that could be compared to historical anecdotal accounts of the size of fish and crayfish with past decades.

19. Local knowledge, anecdotal accounts of recreational fishers, local commercial fishers and local Māori were describing significant declines in local fish and crayfish stocks. By this time, it was generally known that school fish like kahawai were declining, hapuku were disappearing from the shallow reefs, tarikihi were reduced, snapper were dramatically reduced in size, and crayfish numbers were described as only a small fraction of what was once present. Large individual crayfish were, by this time, rarely seen. This summary of where we were at in the 1970s is supported by fisheries' historical data and population modelling at large scales. The problem for the scientists in reporting on these observations is that at that time there were only anecdotal descriptions of natural abundances and a cultural history held by the hapū. In other words, fishing was allowed to take place in all locations for decades without an accurate baseline of information on what is a natural state and balance for these areas. This lack of a "natural baseline of information" exacerbates the difficulty of understanding ecological impacts of continued heavy fishing.

The second era of research at Mimiwhangata: 1999-2011

20. In the period between 1986 and 1999, the land at Mimiwhangata Peninsula came into government ownership, with DOC having management responsibility for the land and the then-Ministry of Fisheries having responsibility for compliance with the regulations applying to the Marine Park. In this 13-year period, there was no program of marine monitoring and the compliance effort was limited to signage and DOC officers reminding visitors of the regulations.

21. In 1999, I was tasked to plan and implement an investigation into the effectiveness of the Marine Park arrangement at Mimiwhangata. This program of work was carried out in the years between 1999 and 2011. The initial objectives of the project were:

    (a) Engage with the hapū and seek their support and guidance for the investigation and shaping of future options.

    (b) Review what was learned from the previous monitoring program and what methods should be carried forward.

    (c) Identify key monitoring and research questions, objectives and updated survey and research methods to support the investigation.

22. In the planning stage of the second investigation, an expert group was established consisting of myself, Dr Grace, Dr Russell Babcock, Dr Ballantine and Dr Shears from the Leigh laboratory of the University of Auckland (**the**

Expert Group). Some University of Auckland scientists were at that time doing leading work on the effectiveness of full no-take reserves and the recovery of exploited fish species, crayfish and algal forests. Those scientists were particularly interested in the value of the long-term studies of a partial protection at Mimiwhangata, which was paired with the full no-take area of Tāwharanui Marine Park. At that time there was a paucity of evidence in the international literature and in New Zealand on the effectiveness of the various forms of partial protection in restoring or protecting biodiversity, habitats or fisheries. The collective advice from the Expert Group to DOC regarding Mimiwhangata in 2000 was:

(a) While the work at Mimiwhangata stretching back to the 1970s offered one of New Zealand's best long-term monitoring data sets, it lacked a clear, natural (unfished) baseline in which to compare results to. As set out above at paragraphs 18-19, in the 1970s a decline in algal habitats and reef fish abundance was already suspected. Also, there were no adequate unfished reference areas represented in the monitoring. This conclusion was formed and supported by research work on recovery of algal forest and reef fish ecology being studied at the Leigh Marine Reserve.

(b) The extensive historical knowledge of Mimiwhangata held by the local hapū, Te Uri o Hikihiki, would be invaluable to guide us in understanding what could be considered a natural baseline for this area and this would be of great benefit to the study of ecology there.

(c) The early period permanent transects established for reef fish and crayfish should be preserved on the basis of their high value as a long-term data set and usefulness to indicate change over time. Alongside this, set up a monitoring system utilizing baited underwater video (BUV) and randomized underwater diver (scuba) census (UVC) transects. This system would be randomised and include reference areas to the northwest and southeast of the Marine Park. A similar UVC transect should be set-up for crayfish. This combined monitoring design would allow for current statistical methods of analysis to be applied as well as providing a basis for linking the new investigation to other similar investigations in northeast New Zealand and the long-term data set at both the partial protection area of Mimiwhangata and the no-take then Marine Park at Tāwharanui.

(d) The 1973 habitat map at Mimiwhangata needed to be updated, adding adjacent areas on all sides of the Marine Park including the deep reefs outwards to depths of 100 metres.

23. In 2001, a second period of investigation began. Between 2001 and 2004, investigations at Mimiwhangata were undertaken in order to update the 1973 and 1981 habitat maps, including by expanding the mapping area as described at paragraph 22(d). above. The results from the updated habitat mapping are set out in a 2005 paper by Dr Grace and myself for DOC. A copy of that paper is annexed and marked "VCK-1", and the results are discussed in more detail below under the heading "Extent of algal forest decline and kina barrens in Northland". Over this period of investigation, the scientists (including myself) received various contributions of historic ecological knowledge from the

kaumātua of Te Uri o Hikihiki, some of which are recorded in the 2005 paper, and which I discuss in the next section.

Mātauranga and leadership from Te Uri o Hikihiki

24. Early in the second period of the investigations, a strong working relationship was growing between Dr Grace, myself, and the kaumātua of Te Uri o Hikihiki. This relationship was based on the sharing of knowledge. Over time, Dr Grace and myself became increasingly aware of the significance and extent of their knowledge of the area and its value. It helped that the two leading kaumātua, the late Houpeke Piripi and the late Puke Haika, were life-long divers and fishers and were from families which were likewise in the true sense "people of the sea". Houpeke was a renowned historian in a traditional sense and Puke was hugely experienced as a diver and had a keen interest in traditional knowledge. These kaumātua were wanting to assert their traditional authority in the form of restoring 'life' back to Mimiwhangata.

25. Every year we would have several meetings where Dr Grace and I would share descriptions of what we were doing and seeing and then Houpeke and Puke would relate their experience and knowledge where relevant to our research. Consistently with Māori oral tradition, this knowledge was generally shared verbally. This body of traditional knowledge and observations was often recounted in detailed direct observations going back several generations, which pre-dates industrialised fishing in this area and extends to pre-European times. In this respect, this knowledge represents a natural baseline of information regarding abundances. I will recount some of these observations and descriptions as I go through the ecological information below.

26. I have read the evidence of Carmen Hetaraka filed on behalf of Te Uri o Hikihiki in this proceeding. Carmen was the person chosen by the kaumātua, Houpeke and Puke, for the traditional knowledge to be passed on to. Carmen was chosen, schooled and prepared for this role for years by these kaumatua, as is their custom. Today, he holds the mātauranga Māori I refer to above. In addition to the experiences and observations handed down to him, he also has extensive first-hand experience. He is one of Te Uri o Hikihiki's predominant divers and has more experience diving on the coastline within the hapū's rohe moana than anyone else. As such, in my view, the observations made in his affidavit represent some of the best available information within that rohe moana.

Extent of algal forest decline and kina barrens in Northland

27. The 2005 habitat mapping study of Mimiwhangata accurately mapped the shallow habitats at scales of 1:500 or larger. Spatial extent of potential shallow reef *Ecklonia radiata* habitat was calculated at 975 hectares with kina barrens making up 24.9% of that area. It is important to note that the shallow part of the *Ecklonia radiata* forest where this loss is occurring is the most productive zone of the forest due to the higher light levels driving photosynthesis of the algae. By "productive" I mean the collective total biological activity that flows from the primary plant growth of the kelp forest and the many dependent marine organisms that utilise this large quantity of plant material. There are many other benefits to this production than just food, as set out in the affidavit of Dr Jeffs at paragraphs 15–21. The accurate mapping was made possible by the use of aerial photography completed by Dr Grace and myself. These images

had to be carried out in ideal conditions to allow a view of the underwater features and habitat boundaries. An example of one of the oblique angle photos taken in this study is shown in Figure 2 below.

Figure 2 *This image, taken by Dr Grace in 2003, was shot flying over the southeast corner of Rimariki Island looking southwest towards the shore of the Mimiwhangata headland. The lighter, greyer patches of the ocean are kina barrens.*

28. These changes are concerning as this habitat has wide ranging ecological connectivity and importance as a primary coastal energy source. Kelp forests supply energy sources to adjoining habitats via the rapid turn-over of organic matter production and regular storm-induced dispersal of drift kelp to literally fuel beach systems adjacent to reefs, soft bottom areas and the water column plankton and larval communities. The kelp forests themselves support a rich biodiversity of fish and invertebrate species that reside in the forest or visit the forests during part of their life cycle.

29. As part of the 2005 study, we were able to source good imagery from 1950. This allowed us to test the trophic change assumption that kina barrens at scale are not a natural condition. By that I mean we were able to test the hypothesis that removal of crayfish through fishing had created a trophic cascade, resulting in the formation of kina barrens, rather than kina barren being caused by some other, natural cause. Figure 3 below shows a comparison of 1950 to 2003 of a shallow reef at Pa Point situated on the southwest end of Mimiwhangata Bay. In the 1950 image, the dark solid cover on the reef represents a dense algal forest cover with no signs of kina barrens present. In the 2003 imagery you can see the bare rock appearance of the reef that is predominantly kina barren.

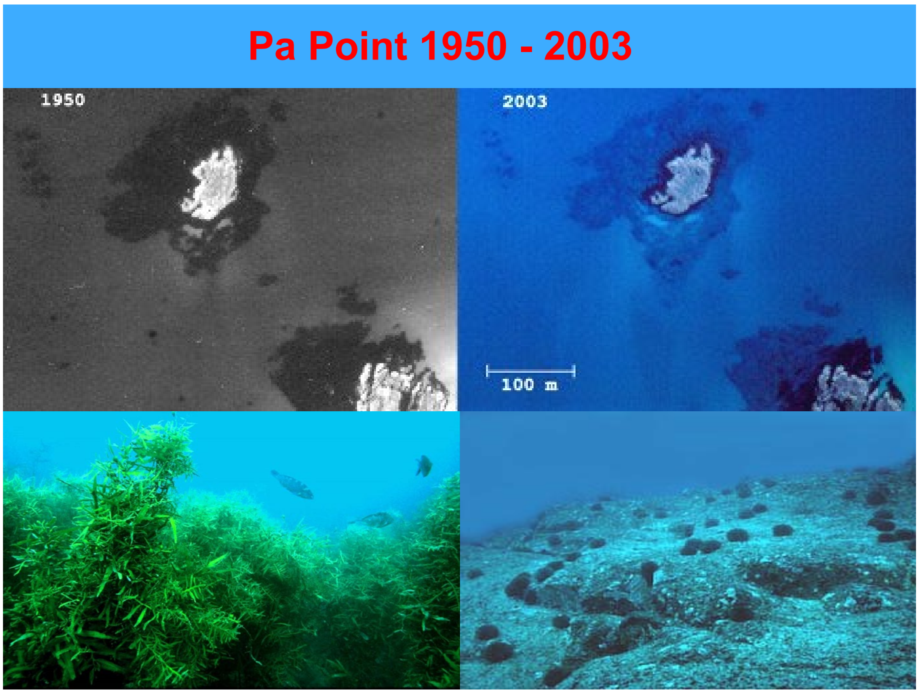

Figure 3 *This time series imagery comparison between 1950 and 2003 shows a completely dense cover of kelp in 1950 contrasting with extensive kina barrens in 2003. The lower images show typical images of a healthy kelp forest and a mature kina barren. The kelp in the lower left image is the species Carpophyllum flexulosum that replaces or mixes with the common kelp species Ecklonia radiata where there is relatively low wave exposure, which is the case in this location at Pa Point. (Images Grace and Kerr)*

30. As we were doing this work, on several occasions we asked the kaumātua Houpeke and Puke if they recalled extensive kina barrens being present in the early days of their diving (which predates the 1970s). We also asked if there were any examples of descriptions of kina barrens in the historical accounts of their ancestors. The answer to these questions was consistently no, kina barrens were not present prior to the 1960s-1970s. The kaumātua felt that fishing had impacted the life of the area to such an extent that the mauri was threatened and impacted, and that action had to be taken to allow natural or active restoration to take place.

31. In other words, the traditional knowledge held by the Te Uri o Hikihiki kaumātua about the trophic change assumption is entirely consistent with our findings of time series analysis in 2005. More recent time series studies have been completed in the Bay of Islands,[3] in the Maitai Bay Rahui,[4] and at the Leigh Marine Reserve.[5] At these three locations the same trend of decline from

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3 Booth, J. D., 2015. Flagging kelp: potent symbol of loss of mauri in the Bay of Islands. An essay prepared for Fish Forever, Bay of Islands Maritime Park Inc.

4 Kerr, V.C., Rutene, W., Bone, O., 2020. Marine habitats of Maitai Bay and the exposed coast of the Karikari Peninsula. A report prepared for Te Whānau Moana/Te Rorohuri, Maitai Bay, Karikari Peninsula, Northland and the Mountains to Sea Conservation Trust.

5 Leleu, K., Remy-Zephir, B., 2012. *Mapping habitats in a marine reserve showed how a 30- year trophic cascade altered ecosystem structure.* Biological Conservation, 155, 193–201.

a full forest cover to extensive kina barren progresses from the 1970s onwards. The findings of the Maitai Bay Rahui study are discussed further below at paragraph 36.

32. In the period between 2005 and 2020, I have completed four habitat studies that follow a similar methodology to the Mimiwhangata 2005 study. The habitat studies, taken collectively, look in detail at a range of sites covering the entire length of the east coast of Northland. These are not minor or trivial samples; they cover hundreds of hectares of reef carefully mapped at fine scales. While we might remain interested in the variations involved in this process of decline of kelp forests (for the reasons described in Dr Shears' affidavit, including wave exposure), there can be no disputing it is large scale and ecologically significant.

33. In 2017, Dr Grace and I produced a GIS-based meta study to estimate the extent of kina barren habitat for the entire exposed Northland east coast from Ahipara in the Far North to Tāwharanui at the entrance of the Hauraki Gulf. Two large scale habitat maps covering the entire study area and six fine scale maps of kina barrens within the study area were used to compute the extent of kina barrens. That study was originally produced by us for the Motiti Rohe Moana Trust and was referred to in both the *Motiti* and *Northland Regional Council* proceedings, and is available to the public on my website. A copy of the study is annexed and marked "VCK-2".

34. The study's findings included:

    (a) The projected estimate of kina barren extent represented 17% of the available rocky reef system within the study area.

    (b) Inside the no-take marine reserves within the study area, kina barrens covered 1% of the available reef, compared with 21.23% in the partially protected Marine Park at Mimiwhangata, where recreational fishing is permitted.

    (c) Within the shallower, preferred kina habitat zone (1-10 or 1-15 metres depth, as opposed to 1-30 metres for the entire study) the incidence of kina barrens is much higher: 25-40%.

    (d) The prevalence of kina barrens within the preferred kina habitat zone has disproportionate effects on kelp forest productivity. Shallow water kelp forests are much more productive than those found in deeper water, where the prevalence of kina was not as common.

    (e) The large and persistent urchin barrens observed, which had developed in the last five decades, were most likely to be caused by removal of predators rather than other factors, which I discuss below.

35. The study observed that, while reduced predation of kina is suggested as the primary cause of long-term urchin barren formation, other factors had been identified as affecting the dynamic between urchin population density, urchin grazing, and the persistence of urchin barrens. Of those identified factors, however:

(a) Wave exposure, complex topology, and sedimentation may have a positive effect on algal forest stability in that there could be a tendency for the algal forest to persist even in the face of removal of predators of kina.

(b) Storm damage, and urchin and kelp disease outbreaks have short-term impacts, and are not a major factor in kina barren formation or persistence given the high reproductive potential and growth rates of algal forests.

36. As noted above, between 2017 and 2020, I conducted a marine habitat survey of the waters in and around Maitai Bay on the Karikari Peninsula in the Far North. That study calculated the extent of kina barrens as covering 39.9% of estimated historic area of high productivity kelp forests. A copy of that study is annexed and marked "VCK-3".

37. The results of that study validate the results of our 2017 study in terms of the 25-40% incidence of kina calculated for the "preferred kina habitat zone". This is because the study at Maitai Bay introduced a more refined method of expressing the ecological significance of kelp forest loss. Prior to this study, we had generally mapped the total spatial area of the kina barrens and total spatial area of the entire potential and existing *Ecklonia radiata* kelp forest, which allowed us to calculate a percentage of the loss of forest. The problem with this first approach is two-fold:

(a) First, kina prefer an upper zone of the kelp forest, which varies locally as result of wave energy and water clarity. Typically, in Northland waters this zone where kina are active is between 2 and 12 or 15 metres depth. Below this depth, kina are not typically active.

(b) Second, in waters deeper than 12-15m, the *Ecklonia radiata* forest thins out and is less productive in an increasing trend until around 30 metre depths where it is very sparse and then gives way to encrusting invertebrate communities (because light penetrating from the surface is no longer strong enough to support plant growth).

38. The new calculation method developed for the 2020 study addressed these issues by effectively dividing the kelp forest by depth into a high productive (shallow) zone where kina barrens may arise and a (deep) zone where the kelp forest is less productive (and therefore less ecologically significant) and where kina barrens do not typically form. The point of refining this simple calculation is that it enables us to evaluate, in a more defined way, the ecological implications of this loss we are observing.

39. Finally, I note that in his statement of defence, the Minister says that kina barrens are "usually mixed with algal habitat".[6] The widespread kina barrens I have referred to in my evidence and in the various habitat studies are not described in this way. While there may be small kina grazed areas with remaining macro algae and various encrusting algae, this condition is minor in significance compared to the areas mapped as kina barrens.

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6 At [19].

40. In the various evidence offerred on kelp forests and kina barren establishment, I have described the findings using a simple habitat classification that is either kelp forest or kina barren. This is a defined classification in our marine habitat mapping. While it is of course a simplification to facilitate mapping on large scales, it needs to be noted that this classification has a tremendous amount of ground-truthing work behind it to validate how it is used, and typically this process is defined in any report. In any case, the kina barrens referred to in my evidence do not have significant percentage areas of large brown kelp species and generally algal species are dramatically reduced to seasonal filamentous and a variety of encrusting coralline red algal species. To the human eye, at any scale, these areas look bare. The functional aspect of the kelp forest has been reduced to near zero as an algal forest habitat.

Crayfish (red rock lobster and packhorse lobster) abundances over time based on ecological and Mātauranga Māori evidence

41. I will now provide further detail of what has been learned from the ecological studies associated with Mimiwhangata and I will relate the science to the long-term ecological evidence held within the mātauranga Māori of Te Uri o Hikihiki.

42. In 2006, a paper was published by Dr Shears and our monitoring team that compared the full data set of red rock lobster monitoring at Mimiwhangata Marine Park (where there was partial protection with commercial fishing phased out gradually over the period 1984-1993) against the data from Tāwharanui Marine Park (full no-take protection from 1983 onwards). The Tāwharanui data included data from adjacent sites which were outside the Marine Park and served as fished reference sites. The results were described as follows:

> On average, legal-sized lobster were eleven times more abundant and biomass 25 times higher in the no-take marine park following park establishment, while in the partially protected marine park (Mimiwhangata) there has been no significant change in lobster numbers. Furthermore, no difference was found in densities of legal-sized lobster between the partially protected marine park and nearby fully-fished sites (<1 animal per 500 m2). Long-term data from fully fished and partially protected sites suggest long-term declines in lobster populations and reflect regional patterns in catch per unit effort estimates for the fishery. The long-term patterns presented provide an unequivocal example of the recovery of lobster populations in no-take MPAs, but clearly demonstrate that allowing recreational fishing in MPAs has little benefit to restoring populations of exploited species such as *J. edwardsii*.

A copy of this paper is annexed and marked "VCK-4".

43. A version of these results can be seen in graphic form in Figure 4 below. The results are alarming and point to a collapse of crayfish at Mimiwhangata. Additional surveys at points north and south of Mimiwhangata Marine Park

showed similar results with very low levels of crayfish and no larger animals present.

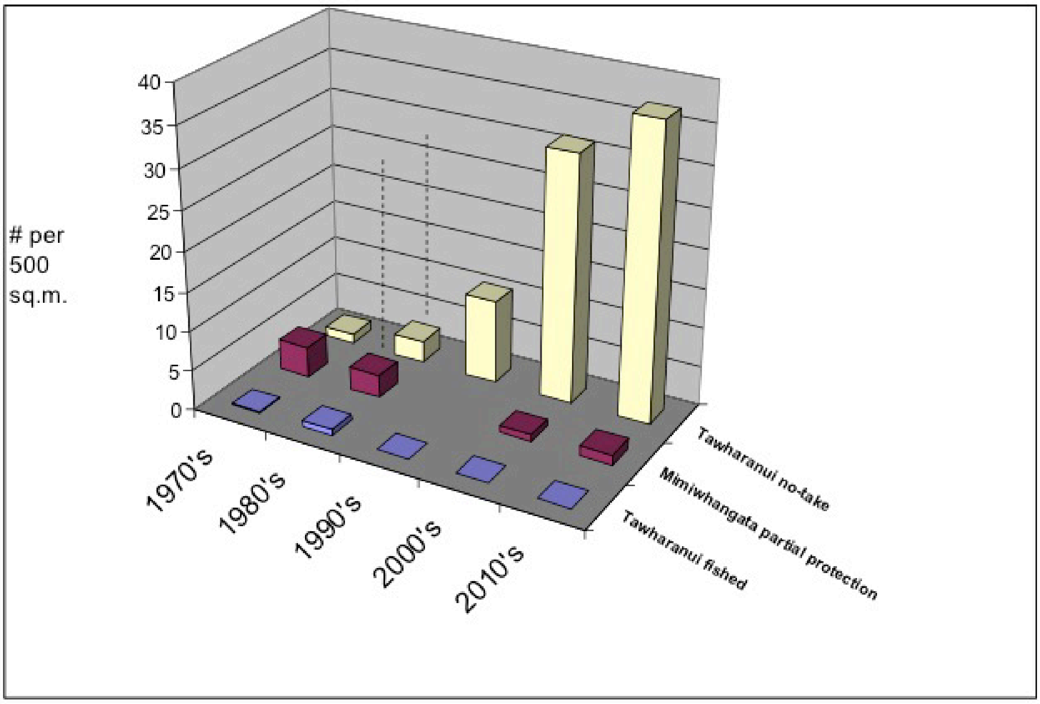

Figure 4 *This graph shows the decadal trends in numbers of legal-size crayfish and the contrast between a recovering population of crayfish in the Tāwharanui no-take area and the very low levels persisting in the Marine Park at Mimiwhangata, which are comparable to fished areas near the Tāwharanui Marine Park.*

44. We had several discussions with the kaumātua, Houpeke and Puke, about these results. They agreed with the description that at Mimiwhangata numbers of both species of crayfish were extremely low, with large animals being now very rare. In these descriptions they were quick to add how dramatic this decline has been compared to their early memories of the crayfish at Mimiwhangata and their historic record. This statement applies to both species of crayfish, the red rock lobster *Jasus edwardsii* and packhorse lobster *Sagmariasus verreauxi*.

45. Puke recited stories about their traditional method of catching crayfish which was in very shallow water where they would feel for the crayfish with their feet or simply see the antennae and then reach down and grab them. Puke also described in great detail the large crayfish that were common. He had a particular method of catching very large packhorse crayfish well over 10 kilograms in weight. Puke would face the large animal as it challenged him approaching with antennae and large claws waving, then in one quick motion would throw a burlap sack over the animal's back and wrap it up in a bear hug before swimming to the surface and getting assistance to land it. Puke was a large and very powerful man, but he described this encounter as one he approached with great caution. He told us that the power in these animals'

foreclaws could easily break bones in a man’s hand. Packhorse crayfish are now rarely seen at Mimiwhangata.

Figure 5 *A packhorse lobster caught off Matauri Bay, Bay of Islands in 1961. These large lobsters were once common on the Northland coast. Large crayfish can easily and quickly open the largest kina and virtually any shellfish species.*

46. While the decline in numbers and standing biomass (loss of large animals) is concerning, there is also a growing story of the ecological consequences of allowing such prolonged fishing pressure. The large-scale loss of algal forest and its causes has been well documented. Removing medium to large crayfish from the system certainly contributes to the formation and persistence of kina barrens. There are also many more subtle impacts associated with population decline. There is a substantial body of literature in New Zealand that delves into these ecological consequences. Dr Alison MacDiarmid wrote a review paper in 2012 that summarises what we know to date. Dr MacDiarmid reviewed historical accounts of rock lobster abundance and ecology dating back to Cook’s voyage which closely paralleled what we were told by the Mimiwhangata kaumātua. A copy of Dr MacDiarmid’s paper is annexed and marked “VCK-5”.

47. I will briefly list the ecological concerns identified in her paper below:

(a) Fecundity in rock lobster increases geometrically with size of female.

(b) Female rock lobster at mating time prefer large males.

(c) Large male rock lobster can service many times more rock lobster than smaller animals.

(d) Low abundance populations lacking in large animals may fail to effectively reproduce or do so at greatly reduced levels to a population with a more normal ages structure.

(e) Rock lobster have complex social behaviours which varies with time of year around growth, moulting and mating periods. There is evidence that low abundance levels and impacted age structures can detrimentally affect these behaviours. There is evidence that recruitment on to reefs is reduced when there are no or few older crayfish present.

(f) Rock lobster periodically leave their home territory on the reef to feed on surrounding soft bottom habitats up to 4 kilometres from the home reef but typically 1-2 kilometres. Management of fishing and design of protection and restoration areas needs to take these behaviours into account.

(g) Research on diets has found that rock lobster have a widely varying diet and may be important in grazing and control algal turf habitats that are often a response to long term persistence of kina barrens.

(h) Loss of genetic diversity is a possiblity at such high fishing levels.

(i) Loss of habitat utilisation due to algal forest decline – most notably in the previously high productivity shallow portion of the *Ecklonia radiata* forests.

(j) Four ecosystem models constructed of shallow coastal reef systems around New Zealand were reviewed by Dr MacDiarmid, which showed that rock lobster have gone from being one of most important predators in the system to the least important in terms of biomass and impact. The rock lobster's role, at present levels of fishing, was described as "ecologically extinct" in ecosystem terms.

48. In my view, based on the research and studies referred to above, and by reference to my observations diving for nearly forty years within the CRA1 area, Dr MacDiarmid's finding that rock lobster are ecologically extinct certainly applies equally to ecosystems within the CRA1 area.

The Minister's TAC decisions

49. I have been asked to comment on the options proposed to the Minister for his 2021/22 and 2022/23 CRA1 TAC Decisions, namely:

(a) In respect of his 2021/22 Decision:

(i) maintaining the TAC of 203 tonnes on the basis that the 2020 rapid assessment update projected that, as a result of the 2020 TAC decision, vulnerable biomass and spawning biomass would increase within the next four years; or

(ii) decreasing the TAC to 180.5 tonnes in order to improve the likelihood that the vulnerable biomass would increase.

(b) In respect of his 2022/23 Decision:

(i) Option 1.1: maintaining the TAC of 203 tonnes on the basis that the TAC was recently decreased and the decrease had assisted in maintaining CRA1 above the BMSY reference level, which is expected to allow rock lobster to continue to fulfil its role in in the ecosystem;

(ii) Option 1.2: decreasing the TAC by 5% (193 tonnes) recognising CRA1 is near the BMSY level and aiming to increase the certainty that the stock will remain at or above this level, which is expected to allow rock lobster to fulfil its role in the ecosystem to an unknown but potentially greater level than option 1.1;

(iii) Option 1.3: decreasing the TAC by 9% (185 tonnes) recognising CRA1 is near the BMSY level and aiming to increase the certainty that the stock will remain at or above this level, which is expected to allow rock lobster to fulfil its role in the ecosystem to an unknown but potentially greater level than options 1.1 or 1.2; or

(iv) Option 1.4: decreasing the TAC by 12% (179 tonnes) recognising CRA1 is near the BMSY level and aiming to increase the certainty that the stock will remain at or above this level, which is expected to allow rock lobster to fulfil its role in the ecosystem to an unknown but potentially greater level than the other options.

50. I have a number of concerns with the proposed options, which I explain below.

Baseline for assessments

51. I have concerns over the numbers the stock assessment model presents. In work that Dr Grace and myself undertook sampling rock lobster numbers, we would describe the population as crashing in many areas, indicating a much lower figure for % of virgin biomass existing than the figures presented to the Minister.

52. Long-term research and monitoring, such as that undertaken at Mimiwhangata, reflects the stocks more accurately, however this information is not used to validate the stock assessments, or calculate the proposed TAC. In any case, as described above, even long-term data such as that from Mimiwhangata does not allow for a natural baseline of information to be established as fishing had already begun to impact abundance of stocks prior to monitoring commencing.

Recovery

53. The advice to the Minister in respect of both his 2021/22 and 2022/23 Decisions refer to biomass increasing as a result of the TAC options proposed. As reflected in the 2006 Shears et al study, once rock lobster stocks have been fished to low levels, there is no evidence that even drastic changes to fishing quotas (for example, allowing recreational fishing only, as was the case at Mimiwhangata Marine Park) will result in long-term recovery.

54. Once stocks are at present low levels, only the application of no-take areas or fishing moratoriums can support recovery effectively. In my view, and based on the findings of the Shears study, the levels of crayfish currently within CRA1 would require no-take, and the adjustments to the TAC proposed for both the 2021/22 and 2022/23 Decisions would not allow for recovery, contrary to what the advice to the Minister suggests.

Ecological effects

55. The ecological effects of allowing crayfish to be taken at unsustainable levels is significant, both in terms of the effects on the aquatic environment (given the established link between removal of crayfish and proliferation of kina barren) and to the species itself, as described by Dr MacDiarmid. These ecological effects are extensively documented and well understood. To the extent that the advice to the Minister stated that the science is controversial, hypothetical or equivocal, or that the matter is complex and the relationship between rock lobster abundance and urchin barrens is unknown, that advice is wrong.

56. These effects, and how to avoid, remedy, and/or mitigate them, do not appear to have been considered at all when developing the TAC proposals that were put before the Minister in respect of his 2021/22 Decision. The advice to the Minister in respect of his 2022/23 Decision is that all of the proposed options would allow rock lobster to continue to fulfil its ecological role within CRA1. As noted above, in my view rock lobster are ecologically extinct within CRA1, and as such cannot fulfil their ecological role at current levels. For the reasons set out above under the heading “Recovery”, in my view the advice that any of the TAC options would allow rock lobster to continue to fulfil, or fulfil its ecological role to a greater extent, is wrong.

AFFIRMED by Vincent)
Carlyle Kerr at Whangarei this)
day of May 2022 before me:)

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Vincent Carlyle Kerr

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Schedule 1: Mimiwhangata research and monitoring reports

1. Commissioner for the Environment. 1982. .Mimiwhangata Marine Park: Environmental Impact Audit. Wellington: Commission for the Environment, December.
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17. Usmar NR, Denny CM, Shears NT, Babcock RC (2003) Mimiwhangata Marine Park monitoring report 2002-2003, Leigh Marine Laboratory, University of Auckland.
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19. Grace, R.V.; Kerr, V.C. 2003: Mimiwhangata Marine Park draft report 2003 historic marine survey update. A report to Northland Conservancy, Department of Conservation.
20. Kerr, V.C., and Dr R. V. Grace, 2004. Mimiwhangata Marine Reserve Proposal: Community Discussion Document. Published by Northland Conservancy, Department of Conservation. Northland Conservancy, PO Box 842, Whangarei, NZ.
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