A Marine Cultural Health Index for the sustainable management of mahinga kai in Aotearoa – New Zealand

A report for Te Rūnanga o Ngāi Tahu

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About this report series

*He Kōhinga Rangahau* is the research report series of *Te Tiaki Mahinga Kai*, a national coalition of tangata kaitiaki, researchers, and managers dedicated to sustained enhancement of the cultural, economic, social, and environmental wellbeing of Māori and New Zealand as a whole. This will be achieved through the application of mātauranga and science associated with mahinga kai to modern customary fisheries practices. See [www.mahingakai.org.nz](http://www.mahingakai.org.nz) for a detailed description of the kaupapa. *He Kōhinga Rangahau* means “the gathering together of research findings.” This report may be used and cited by anyone with due acknowledgement to *Tiaki Mahinga Kai* and its funders.

Suggested citation for this report

Executive Summary

*Kaitiaki* (environmental guardians) from across New Zealand have voiced deepening concerns about the depleted state of some in-shore fisheries and ecosystems. Recent studies reveal that many *kaitiaki* and other community members are dissatisfied with a diminishing abundance of some *taonga* (treasured) species. A Marine Cultural Health Index (MCHI) monitoring toolkit has been developed to enable Ngāi Tahu to establish restoration targets and sustainable *mahinga kai* (the practice of customary food gathering, the places where food is collected and the resources themselves) harvest strategies within their *taiao purae*, *māaitai*, and other coastal protection areas. The toolkit, derived from local and traditional knowledge of 100 informants, incorporates a range of environmental indicators. It may be used to assess and record (i) the current ecological state of Ngāi Tahu’s *rohe moana* (coastal marine area over which Ngāi Tahu exercises its *kaitiakitanga*), (ii) changes in marine ecosystem health over time, and (iii) effectiveness of local fishing rules and reseeding strategies instigated to sustain customary fishing use and management practices.

This report presents a summary of a range of environmental indicators of marine ecosystem health that have been used in the past, both overseas and in Aotearoa - New Zealand. We first review the need to incorporate traditional ecological knowledge (TEK) into monitoring tools and summarise similar Cultural Health Indices applied to other ecosystems and community-led monitoring tools.

Theoretical and empirical case study evidence from around the world emphasise the importance for participation of local environmental guardians in goal-setting, compliance, and monitoring of natural resources for sustainable management. The development of a simple and repeatable environmental monitoring tool that encourages locals to participate in ways that reflect their cultural values and that triggers their individual and social wellbeing. Despite a growing trend to include Traditional Ecological Knowledge (*Mātauranga Māori*) when investigating environmental indicators, we could not find any examples overseas or elsewhere in New Zealand where indigenous peoples’ values are used in a manner that allows a formal aggregate score of marine environmental health to be reported. The semi-quantitative monitoring method used by Ngāi Tahu to assess stream health (*a Cultural Health Index for the assessment of the health of streams and waterways*), which has now been modified to assess marine ecosystem health, is therefore a world first.

A comprehensive outline of the MCHI toolkit is provided in this report and includes descriptions of how the indicators were selected and structured. Indicators were weighted based on 100 interviews of community representatives. We selected the top 30 indicators, to include in the MCHI toolkit. The survey is to be conducted both for a benchmark state (historical time period) chosen by the surveyor, as well as the current state, and should be repeated consistently to build an accurate database of the site’s overall environmental and cultural health.

The MCHI toolkit is divided into four sections: a) Key Cultural Indicators; b) Habitat Threats & Quality Indicators, c) Benchmark Questions, and d) Survey Results. The Key Cultural Indicators are set in a hierarchical structure, leading to final scores (0-4) that signal varying degrees of alerts. These indicators include *site contamination* and the *ability to get a feed* as the highest weighted indicators, followed by *taste and condition of kai species*, and *replacement of kai*. Surveyors are asked to choose their most highly prized kai species for this evaluation. *Habitat Threats and Quality Indicators* include supplementary threats such as water clarity, sedimentation, invasive species, and presence of provision species. All survey data can then be sent to Toitū Te Whenua for entry into the Ngāi Tahu *State of the Takiwā* database, where overall site assessments will be archived and analysed. Once the stand-alone prototype MCHI has been sufficiently field tested it will be fully incorporated into the Ngāi Tahu *State of the Takiwā* database itself.

The vision of Ngāi Tahu is that the MCHI will become a tool allowing communities to independently, inexpensively, and robustly assess the state of their *rohe moana*. Once tested, the MCHI may be adapted and applied to coastlines around the country. Community members will be able to easily record and begin compiling an archive of observations from a range of assessors. As more people use the MCHI over months and years, records of long-term changes in environmental health can be used to support additional management actions and restoration activities. Comparisons between areas can also shed light on the health of New Zealand’s marine environments as a whole.
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Please Note: View the Ngāi Tahu Marine Cultural Health Index Manual and Toolkit (2013) to see the practical application of this report.

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## Table of Contents

**Executive Summary** .................................................................................................................. 3  
**Contract and Report Details** ................................................................................................... 4  
**Acknowledgements** .................................................................................................................. 4  
**Table of Contents** ..................................................................................................................... 4  
**List of Figures** ........................................................................................................................... 5  
**List of Tables** ............................................................................................................................. 7  
**1. Introduction: A need for this monitoring tool** .............................................................. 9  
  1.1 What is a Marine Cultural Health Index? ................................................................. 9  
  1.2 Why develop a Marine Cultural Health Index? ....................................................... 9  
    1.2.1 A tool to put Kaitiakitanga into action ............................................................. 9  
    1.2.2 The importance of developing a Marine Cultural Health Index for Ngāi Tahu ... 11  
    1.2.3 An inexpensive and efficient tool...................................................................... 12  
    1.2.4 Preservation of Māori cultural resilience .......................................................... 13  
    1.2.5 Promotion of collaborative management ......................................................... 13  
  1.3 Objectives of the report ................................................................................................. 14  
**2. Summary of Health Indicators and Monitoring Toolkits** .............................................. 15  
  2.1 Defining indicators ........................................................................................................... 15  
    2.1.1 Indicators ............................................................................................................ 15  
    2.1.2 Indicators - Rapid measures showing the bigger picture? ............................ 15  
  2.2 Examples of scientific marine health indicators ......................................................... 17  
  2.3 Use of Traditional Ecological Knowledge for monitoring marine health ............ 18  
**3. Development of a New Zealand Marine Cultural Health Index toolkit** ..................... 24  
  3.1 Overview ............................................................................................................................ 24  
    3.1.1 Concerns for the state of local Mahinga Kai .................................................. 24  
    3.1.2 Steps to develop and implement a Marine Cultural Health Index .................. 26  
  3.2 Methods .............................................................................................................................. 28  
    3.2.1 Establishing relationships .................................................................................. 28  
    3.2.2 Interview procedure ......................................................................................... 28  
    3.2.3 Interview locations ......................................................................................... 29  
    3.2.4 Analysis of indicators ...................................................................................... 31  
  3.3 Results and design of the toolkit .................................................................................... 37  
    3.3.1 Composition of the interview panel ................................................................. 37
3.3.2 Most important kai species ................................................................. 37
3.3.3 MCHI Structure ................................................................................. 40
3.3.4 Scientific rationale behind the construction of indicators ................... 43
3.3.5 Indicator groups ............................................................................... 47
3.3.6 Scoring overall Marine Cultural Health ............................................. 49

4. Synthesis & Discussion: Opportunities and constraints for using the MCHI .................................................. 56

4.1 Can one toolkit work for different ecosystem types? .................................. 56
4.2 What was left out of the MCHI? ............................................................... 57
4.3 Standardisation of MCHI scoring to enhance repeatability ........................... 59
4.4 Should the MCHI be considered scientific? ................................................ 60
4.5 Is the MCHI a Māori toolkit? ................................................................. 62
4.6 Will the MCHI reliably detect changes in cultural health? ......................... 63
4.7 Putting the MCHI into practice ............................................................... 64
4.8 Will the marine Cultural Health Index toolkit make a real difference? ........... 68

5 References ........................................................................................................... 72

6 Appendices ........................................................................................................... 82

6.1 Appendix 1 – Glossary ............................................................................. 82
6.2 Appendix 2 – Indicator list .......................................................................... 85
6.3 Appendix 3 – MCHI Community Toolkit Instruction Manual ....................... 88
6.4 Appendix 4 – MCHI Community Toolkit Forms .......................................... 96
6.5 Appendix 5 – MCHI Community Toolkit Scoring & Analysis .................... 112
List of Figures

Figure 1. Map of Customary Protection Areas within the Ngāi Tahu Whānui Takiwā.............................. 10
Figure 2. Steps to develop and implement a MCHI ................................................................. 26
Figure 3. Location of interviews.................................................................................................. 30
Figure 4. Number of interviewees mentioning each indicator versus the total number of words coded to each indicator........................................................................................................ 32
Figure 5. Indicator analysis ........................................................................................................ 36
Figure 6. Age and ethnic composition of interviewees................................................................. 37
Figure 7. Mean words coded per interviewee for each focal species. Error bars denote standard error of the means. Bars sharing the same letter are not significantly different at a significance level of $p \leq 0.05$ as determined by Tukey’s post-hoc analysis. $N = 94$ interviewees for each species................................................................. 38
Figure 8. Proportion of interviewees who discuss each focal species. Proportions were calculated from a total of 94 interviewees for each species................................................................. 39
Figure 9. Mean number of words coded per interviewee concerning four focal species. Interviewees were differentiated into two ethnic groups; Māori and Pākehā (non-Māori). Error bars denote standard error of the means. Numbers above error bars represent the number of interviewees per ethnic group................................................................. 40
Figure 10. Example of a Key Cultural Indicator scoresheet.......................................................... 42
Figure 11. The relative importance of different indicator groups (% or total words coded to top 30 indicators) used in the toolkit, as determined using total word counts........................................ 49
Figure 12. The effect of the relative weightings of the different components (Kai Safety [a], Kai Replacement [b]) of the score for individual species................................................................. 51
Figure 13. Average cultural health for all five species targeted using different discount scenarios (i.e. deciding the relative weightings of subsequent species)................................................................. 52
Figure 14. The effect of the species discount rate on the overall score for site health. The green line represents our recommended 20% discount rate................................................................. 53
Figure 15. The changes in overall Cultural Health of an uncontaminated site using the 20% discount rate for successively more species being targeted................................................................. 54
Figure 16. Changing emphases in a long-term MCHI monitoring plan.......................................... 67
List of Tables

Table 1. Summary of recent research projects and toolkits within Aotearoa - New Zealand that facilitate community involvement and/or incorporate mātauranga........................................... 21
Table 2. Top ten indicators as ranked by total word counts. Includes a description of each indicator and example quotes........................................................................................................... 33
Table 3. The relative importance of different indicator groups used in the toolkit, as determined using total word counts. *Indicators that were not incorporated into the toolkit.................. 48
Table 4. Māori terms, plant and animal names......................................................................................................................... 82
Table 5. Description of each of the top 30 indicators as ranked using ‘total words coded’ and ‘number of interviewees mentioning each indicator’.................................................................. 85
1. Introduction: A need for this monitoring tool

1.1 What is a Marine Cultural Health Index?

The Marine Cultural Health Index (MCHI) is a tool that hapū communities may use to assess and manage local marine harvest areas. An index grounded on local and traditional knowledge, the MCHI allows kaitiaki \(^1\) to assess the cultural and ecological health of their in-shore marine environment, as well as mahinga kai (the practice of customary food gathering, the places where food is collected and the resources themselves).

1.2 Why develop a Marine Cultural Health Index?

1.2.1 A tool to put Kaitiakitanga into action

Kaitiakitanga is the exercise of guardianship by Tangata Whenua (people of the land) of an area in accordance with tikanga Māori (Māori customs and protocols), and in relation to natural and physical resources. Customary Protection Areas (CPAs) are emerging as the main tools by which Tangata Whenua can exercise kaitiakitanga and traditional management of customary fishing grounds. Mātaitai, taiāpure, and s186 Temporary Closures (as per the Fisheries Act 1996), are collectively referred to as CPAs (Figure 1). These estuarine or coastal areas are identified as places of particular importance for customary food gathering\(^2\), and are managed by local hapū communities on a voluntary basis. Few funds are available nationally for stock assessments, monitoring, and research at sufficiently local scales.

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\(^1\) Māori terms are italicised and a glossary is appended.
\(^2\) Te Rūnanga o Ngāi Tahu, 2007

Tuaki (cockles), East Otago Taiāpure, New Zealand. Photo by Dr Chris Hepburn.
A lack of resources to combat the potential threats of overfishing, invasive species, pollution, and climate change, coupled with a perceived lack of shared knowledge about how ecosystems function make successful protection and enhancement of *mahinga kai* species in CPAs more challenging. This study was commissioned by *Te Rūnanga o Ngāi Tahu* to alleviate some of these challenges through the development of a MCHI tool, to be used by communities to assess the current state and changes.
in the ecological health of their harvest areas, in order to establish restoration targets and test effectiveness of local fishing rules.

1.2.2 The importance of developing a Marine Cultural Health Index for Ngāi Tahu

Māori have a longstanding history and connection with the marine environment, as the sea has traditionally been their largest source of food. Waterways are traditionally viewed not only as resources but, perhaps more importantly, “as the primary sources of collective identity.” The development of an MCHI based on traditional and community knowledge is important to Ngāi Tahu because the marine environment has always sustained its people and helped determine their identity and cultural wellbeing. Two interviewees in this study describe this connection with the marine environment as follows:

“For the Māori boys, especially the Ngāi Tahu ones, that’s what they were. They were gatherers of seafood.”

“We are Tangata Manaaki. That is the culture of Māori, look after people. We always shared our fisheries with the people.... Our people have a customary right to feed oneself and one’s own. They don’t have to die to have it. We have got that right in our fisheries and I will never lie down for that right.”

Ensuring the health of the marine environment is seen as the iwi’s (tribe’s) responsibility and is an important reflection of identity, spiritual wellbeing, and competency as environmental managers and providers.

“The mauri (life force) of the coastal area represents the essence that binds the physical and spiritual elements of all things together, generating and upholding all life. All elements of the natural environment possess a life force, and all forms of life are related. Mauri is a critical element of the spiritual relationship of Ngāi Tahu Whānui with the coastal area.”

“Man-made activities have the potential to degrade or extinguish the mauri of a resource and as a result may offend the mana of the hapū who hold traditional rights and responsibilities with respect to that resource. The mauri of land, water or the sea is degraded if it no longer has the capacity to support traditional uses and values. Across the rohe, one of the principal indicators by which Ngāi Tahu assesses the mauri of a resource is its productivity and the food and other materials sourced from it, hence Ngāi Tahu use of mahinga kai as an environmental indicator.”

Te Rūnanga o Ngāi Tahu October (2002)

Ngāi Tahu’s State of the Takiwā programme envisions a centralised monitoring and database system, which assesses and analyses the health of important mahinga kai sites within the Ngāi Tahu takiwā. A general monitoring tool was developed to assess the environmental health of a chosen site or habitat. The use of this tool is to be complemented with a range of marine cultural health indices identified within this report.

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3 Whangapirita, 2004; Selby et al., 2010
4 Bird et al., 2009
5 Te Rūnanga o Ngāi Tahu, 2005
6 Te Rūnanga o Ngāi Tahu State of the Takiwa scoping document 2004
Many committees that manage CPAs, such as the East Otago Taiapure (Karitāne) and Te Whaka ā Te Wera Mātaitai (Rakiura) have experienced difficulties transmitting their knowledge of the state and changes within their CPAs to governmental agencies. A tendency for Mātauranga Māori (‘Traditional Ecological Knowledge’ or TEK in the international context\(^7\)) to be dismissed as ‘anecdotal’ and non-scientific often leads to unreliable inference when presented to government.\(^8\) A great wealth of knowledge is present, which is transmitted orally and actively updated when discussed within the community.\(^9\) However, no written record or database is readily available for reference or formal analysis. The MCHI is a tool to formalise and standardise the collection, and to store and analyse the mātauranga so that it can be set alongside quantitative data gathered by science. This can potentially provide a more complete health analysis of harvest areas as it will encompass holistic, broad, and spiritual indicators alongside scientific data.

1.2.3 An inexpensive and efficient tool

Scientific monitoring of the environmental health of marine ecosystems can be complicated, time-consuming, and expensive. The inherent difficulty of marine research has led to relatively poor scientific knowledge of the ocean compared to our understanding of terrestrial and freshwater ecosystems. Marine habitats are somewhat poorly described, as their extent is uncertain and their resilience to anthropogenic disturbance is not well-known.\(^10\) There is no comprehensive, systematic, standardised, stratified random and repeated scientific survey of fish and other marine biodiversity, or the health of their habitats around New Zealand. Some catch-per-unit-effort statistics are published for the main commercially exploited species. However, their reliability as indicators of trends in fish stocks is compromised by failure of underlying assumptions and aggregation of statistics over large areas.\(^11\) The absence of widespread monitoring of New Zealand near-shore waters means that science is virtually silent with regards to reliable evaluation of whether current fishing is sustainable and of whether marine ecosystem health is degraded, degrading, stable, or restoring.

Most scientific health indicators are based on chemical, biological, and physical analyses that demand precise and standardised methodology both in the laboratory and the field.\(^12\) Such scientific procedure has the capacity to provide robust, calibrated, and repeatable findings. Remote communities, however, may lack the appropriate resources, money, technology, or expertise to execute scientific studies of in-shore fisheries stocks.\(^13\) This project therefore aims to achieve a similar level of calibration and robustness using traditional and indigenous monitoring methods by adopting a community-based approach.\(^14\) Utilising traditional monitoring methods has proven to be a useful, inexpensive, and rapid monitoring tool, both in Canadian and New Zealand case studies.\(^15\) TEK and local knowledge may be accumulated over centuries and, with regards to this study for

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\(^7\) Berkes, 2008
\(^8\) Moller, 1996; Newman and Moller, 2005
\(^9\) McCarthy et al. subm.
\(^10\) Pauly et al., 1998; Craig et al., 2000
\(^11\) Richards et al. in prep.
\(^12\) Dave, 2001
\(^13\) McCarthy et al., subm.
\(^14\) Also known as the “local eyes and ears” approach
\(^15\) Moller et al., 2004
example, have derived from individuals who have lived the majority of their lives near a particular coastal area, therefore understanding the processes and health of that area intricately.

Additionally, Tangata Whenua may be suspicious of science and have little confidence in a methodology that is foreign, unintelligible, and administered by outsiders who may have their own agendas. A practical advantage of an MCHI based on community and traditional knowledge is that it is easily accessible, as well as comparatively inexpensive and quick, so that kaitiaki managing CPAs can implement local-area analyses with little impediment.

1.2.4 Preservation of Māori cultural resilience

Recent studies conducted in both the North Island and South Island of New Zealand have revealed that kaitiaki and other local community members are seriously concerned with the state of inshore mahiinga kai stocks. In these studies locals collectively referred to reduced accessibility to seafood; habitat degradation; declining abundance of important customary shellfish, finfish and crustacean species; and reduced biodiversity. Such consequences included longer harvesting times, an increasing harvest bias in favour of those with money and equipment, and a range of negative implications to Māori cultural resilience associated with the loss of taonga species. In particular local informants stated that the depletion of culturally important kaimoana may have far reaching effects for Māori manaakitanga (hospitality and ability to feed guests) and mana (pride and prestige). This depletion may also contribute to the loss of important traditions associated with long established harvesting practices, while severing spiritual connections to harvest sites.

These studies paint a grim picture of fisheries decline at the local community scale. Adopting a MCHI that allows kaitiaki to efficiently score the overall health of local harvest sites will not only help drive decisions for effective management of local harvest areas, but may allow kaitiaki to maintain cultural resilience by utilising their traditional knowledge.

1.2.5 Promotion of collaborative management

There has been a shift in recent years towards collaborative resource management efforts using various worldviews. Community participation in monitoring activities is key to improving environmental beliefs and management practices of local participants. Because environments are rapidly changing in the face of new global and local threats, partners engaged in co-management have often emphasised that the learning process itself is an important outcome of successful ‘adaptive co-management’. If we are to better manage adaptive co-management to capture cultural, economic, and environmental benefits, we will need to learn how to best guide partnerships to promote socioecological resilience. It is the combined effects of this new

16 Moller 2001, 2003; Moller et al., 2004
17 Dick et al., 2012 in press
18 McCarthy et al., subm.
19 Jacobson et al. subm.
20 Moller et al., 2004; Hoberg et al., 2012
21 Agrawal, 2005
22 Berkes et al., 2003; Berkes and Turner, 2006; Turner and Berkes, 2006; Berkes, 2007
‘environmentality’ that creates environmental and social benefits through subsidiarity.\(^\text{23}\) The MCHI is needed to help communities learn how to protect and enhance marine habitats and fish stocks.\(^\text{24}\)

The recent establishment of many CPAs in New Zealand has enabled local hapū communities and other invited groups to sustainably manage local coastal resources, including in-shore fisheries stocks. *Kaitiaki* have the authority to implement management rules within CPAs, and may draw on scientific monitoring schemes and/or *mātauranga* to assess the state of local fisheries.\(^\text{25}\) Long runs of experience in small areas (diachronic data) are common amongst TEK systems and can be powerful ways of detecting long-term trends,\(^\text{26}\) often complementing the short-duration scientific surveys, conducted at several locations (synchronic data).

While the holistic and qualitative nature of *mātauranga* and traditional management practices may differ considerably from western-styled fisheries management, both approaches ultimately strive to achieve similar goals: stock sustainability, maintenance of a rich environment, and the guaranteed availability of food for *mokopuna* (grandchildren).

### 1.3 Objectives of the report

The proposed goal of the MCHI is:

To develop, evaluate, and perfect a Cultural Health Index to allow *Tangata Whenua* to establish restoration targets and sustainable *mahinga kai* harvest strategies on Customary Protection Areas and unprotected coastal areas within the *Ngāi Tahu Whānui takiwā*.

Project aims and objectives:

1. To establish relationships, partnerships, and trust between the University research team, Ngāi Tahu *kaitiaki*, and other community members, from multiple sites along the eastern coastline of the South Island of New Zealand.

2. To attain a comprehensive list of marine cultural health indicators based on the constructs of study participants.

3. To review existing monitoring tools, and the integration of TEK into such tools, both in New Zealand and overseas.

4. To develop, evaluate, and assess a Marine Cultural Health Index based on local and traditional knowledge, which can be used by communities within the *Ngāi Tahu Whānui takiwā*.

5. To ensure that Ngāi Tahu and relevant community members have ownership over the tool and that information is shared transparently among researchers and community members.

At a more intangible level the project aims to give *kaitiaki* their own voice, to allow community participation as well as both processes and outcomes that reflect their own cultural values.

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\(^{23}\) Talepa et al., 1997; Moller et al., 2000; Agrawal, 2005; Tipa, 2006

\(^{24}\) This is called ‘Adaptive Management’, or “learning by doing” in the international management literature (Walters and Holling, 1990); and Adaptive Co-management when it is used in co-management context by Indigenous people (Berkes and Turner, 2006)

\(^{25}\) Ministry for Primary Industries, 2009

\(^{26}\) Newman and Moller, 2005; Clucas et al., 2012
2. Summary of Health Indicators and Monitoring Toolkits

2.1 Defining indicators

2.1.1 Indicators

We define an indicator as a measure, identified through traditional knowledge and/or scientific research that represents the state of an ecological system, population, or individual. An indicator should be based on a common standard and, when monitored over time, give an indication of positive or negative change.

A definition for a Māori Environmental Performance (Health) Indicator (MEPI) resulted from a series of discussions within the Coordinated Monitoring of New Zealand Wetland Project:

A MEPI is a tohu created and configured by Māori to gauge, measure or indicate change in an environmental locality. A MEPI leads a Māori community towards and sustains a vision and a set of environmental goals defined by that community.

A scientific definition of an indicator is as follows:

An environmental indicator is a numerical value that helps provide insight into the state of the environment or human health. Indicators are developed based on quantitative measurements or statistics of environmental conditions that are tracked over time. Environmental indicators can be developed and used at a wide variety of geographic scales, from local to regional to national levels.

We see the combination of both the MEPI and scientific definitions as a valuable framework from which to build the indicators for our MCHI tool.

2.1.2 Indicators · Rapid measures showing the bigger picture?

Environmental indicators are widely used to assess the health of marine ecosystems. Early biological indices focused on assessing a restricted list of indicators of key threats. Some of the most commonly used biological indices include measurements of selected environmental toxin levels, faecal contamination, or chemical stress on organisms and communities, in order to evaluate anthropogenic effects. None of these indices view or assess habitats as complex social-ecological systems. By thoroughly applying ecological principles to a combination of indices covering different

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27 Harmsworth, 2002
28 Morgan-Williams and Mulcock, 1996
29 MfE 1998b, 1999
30 USEPA, 2010
31 For example, Karr 1991 and Karr 1999
aspects of environmental health, the diversity of human impacts on the marine environment can be assessed. Best results will be achieved with an index that is sensitive to all anthropological stresses placed on biological systems. Ideally, this index should be less sensitive to natural variation in physical and biological environments, so that we can assess whether or not anthropogenic stresses are indeed the primary factors of change. The most appropriate indicator will not vary considerably from one moment to the next, so that statistical requirements for accuracy can be obtained rapidly and inexpensively.

Other ecological indicators focus on monitoring a particular ‘indicator species.’ Given the great diversity of species, monitoring all biological components of managed ecosystems is impossible. Based solely on pragmatic considerations, management of biological systems may be simplified and more cost-effective by considering only a small group of indicator species as surrogates for the complete system. An indicator species is a species that is closely associated with a specific habitat type or component of the habitat, which can be monitored to determine the possible reactions of various species to changes in this habitat type. These species are often the keystone species of a habitat. Moreover, if an indicator species is positively associated with a number of other species, the management and habitat needs of other species have presumably been met once this species is healthy. Indicator species may be plant or animal species, and in some cases may be used to refer to groups of species. Usually more than one indicator species must be selected per habitat, because a single species can only serve as an ecological indicator for a narrow range of conditions within a habitat type.

Use of indicator species to guide ecological management has been controversial. The general consensus that has arisen argues that no species is likely to be a wholly satisfactory indicator of the viability of other species because of important differences in dynamics of individual species. However, some species may still be able to provide an integrated indication of the status of some portion of the CPA, when coupled with other environmental indicators. Critics of indicator species have therefore recommended an alternative ‘focal species’ concept; essentially a “multi-species approach for defining the attributes required to meet the needs of the biota in a landscape and the management regimes that should be applied.” “The focal species approach involves identification of a set of species for the management of key threatening processes and habitat restoration. These are the species considered to be most sensitive to processes such as habitat loss, modification and fragmentation, predation, salinity, resource depletion,” and in the context of the current project, overfishing. The term encompasses several existing species definitions used to assess ecological integrity including indicator species, keystone species, ecological engineers, umbrella species, flagship species, link species, and species of special concern. ‘Taonga species,’ species that are of special concern to Māori, are a local variant of the latter. Chosen focal species are those judged most important to customary fishing practices, as well as those that are practical to monitor, in order to accurately track long-term sustainability of the CPA. In practice the Ngāi Tahu MCHI may give special emphasis to the abundance and condition of taonga species, especially when the

33 Szaro and Balda, 1982; Landres et al., 1988
34 Hutcheson et al., 1999
35 Lambeck, 1997, p. 849
36 Huggett 2007, p. 2
placement of CPAs is determined by the ready availability of that particular species. However the holistic nature of *kaitiakitanga* suggests that it would be unwise to rely completely on a single-species approach, just as critiques of the indicator-species approach by ecologists have cast doubt on its utility for environmental health monitoring.

Combining a variety of indicators from several indices spanning a broad array of measures may provide more reliable assessments of ecosystem health. The development of integrative ecological indices and the eco-region approach, an ecologically and geographically defined assessment area, along with the recognition of the importance of cumulative impact assessments at regional scales are historical examples addressing these issues. The development of Cultural Health Indicators can be seen as a further step along this quest for integration, with added features such as semi-quantified and qualitative assessment criteria, as well as the integration of economic, social, and cultural values. A fundamental assumption behind Cultural Health Indicators’ presumed reliability is that qualitative indicators such as smell, sound, and visual assessments are natural ways that users and observers of the environment have historically assessed its health.

### 2.2 Examples of scientific marine health indicators

The Swedish Environment Protection Agency states that all environmental health indicators should be a reflection of the state of the environment in relation to all important and specific threats. In 2000, the Swedish government published a monitoring system for coastal marine areas to address the main threats to the coastal environment. The monitoring system focused on:

1. Eutrophication (a process of nutrient enrichment in waterways)
2. Environmental pollutants
3. Physical disturbance (exploitation of the coast)

Eutrophication is determined by measuring the concentration of nitrogen, phosphorus, and silica in the habitat, calculating the chlorophyll content and water clarity, and assessing the benthic fauna and macro-vegetation. Although heavy metal content and organic pollutants are determined in sediment and biota, other environmental pollutants that potentially pose threats are not assessed. Physical disturbance of the environment is primarily assessed by the amount and type of buildings along the shore, the percentage of coastal area they envelop, and the size of present jetties. The monitoring system is part of a greater project that aims to correct current major environmental problems for future generations.

One of the major modern water-quality indicators used globally is the presence and concentration of faecal contaminants such as coliform bacteria. While the presence of faecal bacteria as an

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37 Karr 1981, Karr et al. 1986
38 Hughes et al. 1986, 1987
39 Preston and Bedford, 1988
40 Moller et al. 2004
41 Dave, 2001
42 Swedish Environment Protection Agency, 2000
43 For example, PCB and DDT
44 Dave, 2001
45 Dufour and Bartram, 2012; Griffith et al., 2009; Bonilla et al., 2007; Ki et al., 2007; Elmir et al., 2007; Boehm and Weisberg, 2005
adequate assessor of overall marine ecosystem health is debated, it certainly is an important indicator for the assessment of food gathering areas such as mahinga kai grounds.46

The New Zealand Ministry for the Environment has published several reports on environmental performance indicators as ‘signposts for sustainability.’47 Literature review of coastal and estuarine indicators and monitoring methods in English-speaking countries reveals that governments did not start identifying environmental indicators nor establishing structured monitoring methods until the 1980s. The proposed indicators were mainly “issue-related,” such as food consumption, percentage of aquatic and wetland species at risk of extinction, volume of significant marine spills, chemical analysis, and aesthetic condition.48 Due to a lack of indication otherwise, we assume the environmental indicators listed in Ward (1997) are entirely scientifically based. With the exception of Victoria, Australia, no indicator for cultural importance of a site is mentioned. Furthermore, there was no recognition of the importance of environmental indicators that derive from traditional and community knowledge, rather than science.

Inclusion of the ‘human dimension’ into environmental indicators, as advocated by the American School of Ecosystem Management,49 began in New Zealand in the mid-1990s and since the 2003 Millennium Ecosystem Assessment has been embraced worldwide in the Ecosystems Services framework.

In summary, the types of indicators commonly in use overseas and in New Zealand are predominantly based on science and measurable only with technical equipment and expertise. They nearly all measure potential threats to ecosystem health rather than the effects of those threats. From the mid-1990s, a global perceptible shift towards the inclusion of human uses as indicators of environmental wellbeing gained momentum, though no dimensions specifically related to indigenous peoples.

2.3 Use of Traditional Ecological Knowledge for monitoring marine health

The Food and Agriculture Organization (FAO) of the United Nations states:50 (i) indicators need to be developed and approved by indigenous people to be of maximum value; (ii) indicators need to be either qualitatively or quantitatively assessable; and (iii) indicators need to be conveyable to all concerned parties. These are the principles motivating our MCHI design.

Development of an MCHI should therefore be seen within a wider context of environmental co-management.51 Canada was the first country to pass inclusive ocean management legislation, passing the Oceans Act in 1997.52 Canada’s policy considers and incorporates TEK into resource management. Governmental institutions – national, territorial, and provincial – have committed to respecting, preserving, and promoting TEK. In some cases the aim is to integrate and combine TEK with other sources of knowledge to improve natural resource management.

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46 Roberts et al., 2005
47 For example, Ward, 1997; Ward and Snelder, 1997; Robb and Ward, 1998
48 Ward, 1997
49 Grumbine, 1994
50 Woodley et al., 2006
51 Tapa, 2006
52 See several authors in Berkes et al., 2005
In order to improve the inclusion of TEK in Canadian policy, new co-management institutions were established. These institutions are seen as important elements for the success of the incorporation of TEK, as they facilitate communication for those learning and working together on resource management conflicts. One such institution is the Fisheries Joint Management Committee (FJMC), which provides information of marine indicators by using traditional knowledge. Resource harvest management was viewed as the main reason for the re-introduction of TEK in Canada’s policies; thus, the FJMC has developed and implemented programs such as a beluga-whale monitoring program, which is based on traditional knowledge that has evolved from over 500 years of harvest experience. A formal monitoring program was developed and refined over almost three decades. Scientists now conduct surveys and report outcomes to communities through workshops, meetings, and posters, as well as publish their findings in scientific journals.

The monitoring system’s scientific survey estimated a far lower number of whales than what indigenous community members observed during their everyday involvement with the whale population over the years. This disparity resulted from an inadequate account for whales that were submerged or outside the survey area. After several improved surveys and corrections informed by TEK, the whale population was shown to be roughly five times greater than first stated, crediting the knowledge of indigenous community leaders. This case study exemplifies how customary users’ knowledge can challenge and support scientific evaluations of resource abundance, and emphasises the importance of the establishment of complementary institutions for co-management. Despite the positive outcomes of this study, however, no tool was developed to formalise measures of population size and health from traditional knowledge, setting it alongside parallel science survey measures. We now propose a parallel tool for Tangata Whenua in the MCHI, to combat this challenge.

A Spanish-American co-evaluation study on ecological indices developed from TEK concludes that the validation of indices mainly depends on the method and replication used to identify indicators.53 While multiple-choice tasks are the most commonly used method to measure TEK, a combination of multiple-choice surveys, interviews, and questionnaires reveal different stories. Low, and at times no, correlation was found between data collected using different methods. This may indicate that methods need to be adjusted to suit each respondent. Additionally, distinguishing between practical and theoretical cultural knowledge is necessary, as they do not always concur. Practical cultural knowledge is considered culturally specific and local, whereas theoretical knowledge shows an association to scientifically validated ecological knowledge, providing general principles that can be applied across different cultures and several places. Traditional ecological knowledge is considered a complex phenomenon that inextricably links knowledge, practice, and belief.54 Not all of it can be scientifically validated nor do holders of TEK normally seek reference to science for its validation.55

It is therefore important to realise that participants living outside a community may be able to contribute theoretical knowledge, but will not necessarily have the practical skills or local experience to reliably develop and apply an MCHI. Similarly, local participants may be able to accurately assess local changes to specific ecosystems, yet lack general cultural constructs that could provide linkages between areas and cultural grounding. Our interview panel therefore includes a variety of general

53 Reyes-Garcia et al., 2006
54 Berkes, 2008
55 Dickison, 2009; Moller et al., 2009; Stephenson and Moller, 2009; Don, 2010
cultural advisors and local experts, whose knowledge is incorporated in different ways into the final results of the MCHI. Use of information from other iwi to design the Ngāi Tahu MCHI is perfectly acceptable in the latter context, but local experience will be paramount in grounding the index for local conditions.

The 2007 United Nations Environmental Program (UNEP) Convention on Biological Diversity investigated causes for the decline of traditional knowledge and interconnected factors such as spiritual values, language, culture, and land. Through this convention, several countries (Bolivia, Canada, Brazil, Bangladesh, Australia, and Thailand) endeavour to protect traditional knowledge through legislation and policy. Each policy promotes an inclusive and holistic approach that can (but does not need to) include traditional knowledge.

Policy or legislation that does not sufficiently protect TEK poses a direct threat to its retention and use, as the interests, needs, and rights of indigenous communities are not adequately incorporated. Fortunately the last decade has shown some increasing international recognition of TEK as a legitimate source of information for environmental policy and management.\(^{56}\) In particular the recently established Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) proposes to complement scientific knowledge with the rich diversity of local knowledge and TEK around the world, to inform policy processes in more meaningful ways.

The proposed Ngāi Tahu development of an MCHI offers a great opportunity to implement some of the suggestions made in the UNEP report to respect, retain, and practice local knowledge. Putting an MCHI into practice not only offers immediate management information to guide protection and restoration of depleted kai species and areas, it also acts as a teaching and cultural transmission tool to keep the knowledge alive and allow communities to use that knowledge to adapt to new circumstances.\(^{57}\)

International literature generally states the need for the protection of traditional knowledge, as the issue gains momentum worldwide. Although research is concentrated in only a few nations, it demonstrates that an equal collaboration with indigenous people, and a sensible partnership between traditional knowledge and modern science, will lead to the best outcome: sustainable management of our environment while simultaneously promoting cultural wellbeing.

Development of an MCHI for Ngāi Tahu communities combines two challenges: the integration of core Māori values via the use and recognition of mātauranga, and the creation of a tool that can be applied by local kaitiaki without technical difficulty. Several research projects and community-based tools that have already been developed for environmental monitoring can therefore inform our tool development, even if they do not explicitly incorporate Māori values (Table 1). There are currently a limited range of toolkits in New Zealand that simultaneously incorporate mātauranga and actively facilitate ongoing community involvement.

\(^{56}\) Hoberg et al., 2012
\(^{57}\) Berkes et al., 2003
Table 1. Summary of recent research projects and toolkits within Aotearoa - New Zealand that facilitate community involvement and/or incorporate mātauranga.

<table>
<thead>
<tr>
<th>Toolkit title, year, author(s), and main contributors</th>
<th>Goals</th>
<th>Methods / Generation of tool</th>
<th>Results and Indicators</th>
<th>Community involvement?</th>
<th>Use of mātauranga?</th>
</tr>
</thead>
</table>
| **Māori methods and indicators for marine protection** (2007). Ngati Kere, Ngati Konohi, Ministry for the Environment, Department of Conservation. | • To identify iwi/hapū objectives, interests and expectations for marine management  
• To define a process to identify iwi/hapū marine indicators of environmental health, then pilot implementation of such indicators  
• To measure different species assemblages at a range of trophic levels, to test how marine reserves and controlled areas, including taiapure and mātaita, contribute to meeting iwi/hapū and conservation objectives | • 30 interviews conducted with tangata whenuā within the Ngāti Kere rohe moana.  
• Interviewees were presented a questionnaire with 21 multiple-choice questions divided into four categories: personal experiences, indicators, practices, and marine protection. | • Lists of popular food-gathering areas, areas of lesser importance, and important kai species were described.  
• Nine indicators of ecological health were identified including the number, size and availability of certain species; level of community knowledge and involvement in marine management; distribution of no-take areas; and frequency of prosecutions for illegal takes. | Yes | Yes, for indicator selection |
| **A cultural health index for streams and waterways** (2003; 2006). Gail Tipa, Laurel Teirney, Ministry for the Environment, Te Rūnanga Otakou, Te Rūnanga o Moeraki, Te Rūnanga o Arowhenua, and Ngāti Kahungunu. | • To provide a way for Māori to take an active role in managing freshwater resources  
• To provide an opportunity for resource management agencies to discuss and incorporate Māori perspectives and values for stream health into their management decisions | • Interviews with kaumātua and iwi resource managers. Interviewees were guided through a set of questions relating to aspects of stream health, assessment, mahinga kai, management, and monitoring. | • 30 indicators identified.  
• Quantitative index developed allowing for distinction between positive and negative statements, a rating scale (1-5), and overall assessment of stream health.  
• Field testing of index at 46 sites and subsequent development of a data collation and analysis system. | Yes | Yes, for indicator selection |

- To design a protocol to assist monitoring and restoration of remaining wetlands in New Zealand.
- A list of Māori wetland indicators were identified during one-on-one interviews, participatory workshops, discussion groups, and field trips with members from various iwi.
- The Māori wetland indicators were categorised as follows: a) presence and absence of culturally significant species; b) presence and abundance of unwanted flora and fauna; c) assessment of the presence of *mauri* (life force, internal element, essential essence of all being); and d) assessment of the presence of cultural heritage, which establishes and identifies both connection and relationship to a wetland.
- These indicators were incorporated into the final handbook alongside scientific indicators of wetland health.


- To provide hapū and iwi with information, and a suggested process for undertaking a survey of *kaimoana* resources.
- Guide was designed from data, information, and experiences originating from activities and surveys of all parties involved.
- It includes consideration of traditional methods passed on through *waiata* (Māori songs), *karakia* (prayers), and *kōrero* (discussions) together with methods used in earlier surveys and modern science.
- Several templates are provided, including lists of issues, values, and aims; *hui* minutes; timelines; and data records for qualitative and quantitative surveys.
- No specific list of indicators are supplied, but a general process to identify important measures for a given area is provided.


- To investigate the use of customary environmental indicators for customary fisheries in the Waihou and Manaia Harbour Catchments and in the lower Firth of Thames, and to ascertain the effect that an extensively modified river catchment is having on these catchments
- Information was gathered by interviewing *kaumātua*.
- An information protocol was established to protect *taonga* status of the traditional information gathered.
- Customary indicators were categorised into celestial phenomena, seasons, weather, stages of plant and animal life cycles, observed changes in fish behaviour and shellfish location.
- Indicators provide information on runoff contamination; water quality and hydrology; habitat quality and characteristics; stock assessment; seasonal productivity; phytoplankton availability; marine farming impacts; and commercial, recreational and customary fishing impacts.

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<td>• To provide hapū and iwi with information, and a suggested process for undertaking a survey of <em>kaimoana</em> resources.</td>
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</tr>
<tr>
<td>Yes</td>
<td>The guideline package is intended for hapū and iwi use.</td>
<td>No direct community involvement aside from <em>kaumātua</em> interviews during the construction phases.</td>
</tr>
<tr>
<td>Yes, for indicator selection</td>
<td>Mātauranga was not specifically obtained, but consideration for traditional methods was sought.</td>
<td>Yes, for indicator selection</td>
</tr>
<tr>
<td>Title</td>
<td>Description</td>
<td>Yes, the instruction encourages and facilitates community involvement</td>
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<tr>
<td><strong>Turning the Tide: An Estuaries Toolkit for New Zealand Communities</strong> (2007). Gretchen Robertson, Monica Peters, New Zealand Landcare Trust, Ministry for the Environment.</td>
<td>• To produce a community resource to facilitate better understanding of local estuaries. • The authors derived indicators from the <em>National Protocol for Estuary Monitoring</em> (Robertson, 2002) and adapted them for community use. • A simple and inexpensive instruction manual was developed to encourage communities to take an interest in their local environment, and to provide guidelines on how to monitor their local estuaries by addressing the current state, future goals, threats and impacts.</td>
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<tr>
<td><strong>The New Zealand Stream Health Monitoring and Assessment Kit (SHMAK)</strong> (2002). NIWA, New Zealand Landcare Trust.</td>
<td>• To enable non-scientists to collect consistent, scientifically valid information from small rural streams and to use that information to make assessments of stream health. • Stream health indicators are based on modern science and cover biological data collection, stream habitat and land-use, and farm management information. • The kit comprises a manual with monitoring forms, full instructions and background information; coloured identification guides for bugs and slime; and a set of monitoring equipment.</td>
<td>Yes, it facilitates monitoring by community members</td>
</tr>
<tr>
<td><strong>NIWA’s Stock Assessment Kits</strong> (2002). MacDiarmid and Blair (2002); Blair and MacDiarmid (2002); Cole et al. (2002), Ministry of Fisheries.</td>
<td>• To provide a community guide that could detect changes in stock, based on modern science, to complement anecdotal information on population changes. • No information relating to the development process of the assessment tools could be found • Community guides explain the necessity to monitor stock of the target species. • Objectives are given and instructions regarding recording, analysing, and interpreting the data are provided. Abundance and size at a certain site and depth, for example, are the monitoring criteria for crayfish and finfish (blue cod, butterfish, <em>tarakihi</em>, blue <em>moki</em>, red <em>moki</em>).</td>
<td>Yes, it facilitates community monitoring</td>
</tr>
<tr>
<td><strong>Nga Waihotanga Iho: The Estuarine Monitoring Toolkit for Iwi</strong> (2012). NIWA.</td>
<td>• To develop a toolkit that will allow <em>tangata whenua</em> to measure environmental changes in their estuaries. • To create a tool based on sound scientific principles while also encompassing values pertinent to <em>tangata whenua</em>. • <em>Tangata whenua</em> values were defined and taken into consideration during consultation with two hāpu on the east and west coast of the North Island. • The manual is expected to be released by late 2012 and will be available in both Te Reo and English (see Rickard and Swales 2009 for brief progress summaries).</td>
<td>Yes, it facilitates monitoring by <em>tangata whenua</em></td>
</tr>
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</table>
3. Development of a New Zealand Marine Cultural Health Index toolkit

3.1 Overview

At a fundamental level, the driver behind the development of this MCHI is people’s desire to get a feed and no more than a feed, at minimal effort from key places to feed themselves, their whānau (family), and their guests. People want to have confidence in the health and harvestability of their mahinga kai and know that kai will still be there for their mokopuna (grandchildren) to harvest. The MCHI aims to provide this ability to everyone, including the frail, without the need for expensive gear, to guarantee efficient and sustainable harvests now and in the future.

3.1.1 Concerns for the state of local Mahinga Kai

Kaitiaki and other local community members from both the North and South Islands of New Zealand are concerned with the current state of in-shore fisheries. Informants from these studies discuss how access to important in-shore seafood species has become increasingly difficult during the course of their lifetimes, with noticeable declines in the abundance of many important kaimoana species occurring from the 1970s onwards. Even where food species are present, they are typically more difficult to obtain, take longer to harvest, and may require expensive gear to collect.

At one time, we could go down even when the tide was high and collect cockles off the beach, and that would be way back in 1960. We didn’t have to wait for the tide because it was so plentiful. (Kaitiaki 1)

You used to get a lot of good blue cod. They disappeared, the blue cod, and about 1996 was the last good year of red cod that we had. (Kaitiaki 2)

The groper’s almost nonexistent. Red cod, there’s only a few. Flounder is low key in the thing, bugger all Eels. Used to get all the eels we wanted. I hear very few eels get caught out here either, so there’s four species pretty well gone and there has to be a reason for it. (Kaitiaki 3)

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58 See Dick et al., 2012 in press; McCarthy et al., subm.
59 Unless otherwise indicated, direct quotes are from our interviewees, excerpts from those presented in fuller form in Bird et al. (2009), Futter and Moller (2009), McCarthy et al. (subm.).
Māori also stress the cultural implications of kaimoana depletion and biodiversity loss. They claim these threats affect kinship connections, reduce opportunities for communal activities, and erode their ability to feed their guests, thereby failing to demonstrate their prowess in managing their local environment. Many interviewees linked the availability of abundant kaimoana stocks and the opportunity to actively manage fisheries as important parts of their cultural identity.

Mahinga Kai is the bloodline to us. We don’t have it, we won’t survive... we have seen depletion of fish stocks and fisheries. Papatuanuku – the environment – is suffering because of manmade destruction. (Kaitiaki 4)

Even the Maraes [meeting houses], like when we travel, we always take oysters... you always feed your visitors your best food from your area. (Kaitiaki 5)

I’ve always been taught that we don’t own the land or the sea or anything that grows on the land or in the sea. It owns us. And if we show that respect, then it will show respect in turn, and that to me is what kaitiakitanga is all about. But a lot of our people today have forgotten about that [connection]... and we have seen the depletion of fisheries. (Kaitiaki 6)

Many interviewees spoke of their love, pride, and fierce determination to protect and restore their local place. Kaitiakitanga is reinforced by and, in turn, reinforces a sense of place for the kaitiaki. This act of reciprocity becomes an immediate and often repeated tangible justification for restoring the fisheries and wider environmental health of their local area. Some informants lamented the fact that “these days our people hunter-gathered in supermarkets.” They viewed their lives as impoverished in important ways related to community connection, loss of pride, and lack of provisions for their own whanau, elders, and visitors.

The same 100 South Island kaitiaki and other community members who voiced these concerns were asked to also describe a series of cultural and ecological indicators that they may use to assess the health of their local CPAs and other harvesting areas. The development of the MCHI in the present study is subsequently based on the testimonies of these locals.

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Dick et al. (in press); McCarthy et al. (in prep)
McCarthy et al., subm.
3.1.2 Steps to develop and implement a Marine Cultural Health Index

**Step 1**
Tangata Whenua raise concerns regarding the state of local in-shore fisheries. The purpose of the study is defined by interested locals.

**Step 2**
Interviews are undertaken with Tangata Whenua and community members. Qualitative data is collected and analysed. Ecological health indicators are identified based on qualitative data.

**Step 3**
Selection of assessed sites, by Tangata Whenua and community members.

**Step 4**
Development of MCHI toolkit based on local and traditional knowledge

**Step 5**
Field-testing of toolkit

**Step 6**
Refinements / modifications to MCHI toolkit

**Step 7**
MCHI scores calculated

**Step 8**
Scores recorded and stored on a centralised database

**Step 9**
Monitoring program developed

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Figure 2. Steps to develop and implement a MCHI
Step 1: The implementation of any toolkit begins with defining the purpose for its development. In this case, kaitiaki and other community members have raised concerns over the state of their in-shore harvest areas (see section 3.1.1). They are unsatisfied with the current level of assessment of their rohe moana and are seeking a relatively quick, inexpensive, and effective monitoring method that can be independently conducted by communities, and which incorporates local and traditional knowledge.

Step 2: Marine ecological health indicators based on local and traditional knowledge are gathered from a representative pool of locals who have a) an intricate knowledge of their local harvest areas of concern and b) an imbedded interest in sustainable management of the marine harvest areas of concern.

Step 3: The indicators are categorised, weighted, and synthesised into a series of questions targeting different aspects of the environmental, biological, and cultural health of an in-shore harvest area.

Step 4: The in-shore assessment sites are defined by the community members themselves. This helps ensure that locals retain ownership of the toolkit.

Step 5: Initial testing of the MCHI toolkit at specified sites is a collaborative approach, undertaken by local kaitiaki and other community members alongside Toitū Te Whenua staff and the research team members who helped design the toolkit. This way, questions, suggestions, or feedback by the surveyors regarding the toolkit may be addressed on-site.

Step 6: The toolkit allows for refinements and modifications by local kaitiaki and community members where necessary.

Steps 7 and 8: Environmental, biological, and cultural health scores are calculated according to indicator weightings and stored on a centralised database.

Step 9: Ngāi Tahu kaitiaki and community members develop a long-term monitoring program of selected sites with support from Toitū Te Whenua. Recommendations for monitoring frequency and duration are offered by the research team. Repeated assessments of various sites build a spatial and temporal picture of marine coastal health along selected harvest sites.
3.2 Methods

3.2.1 Establishing relationships

The early establishment of relationships among all concerned parties involved in the construction of any community toolkit is vital. We first established these relationships through an initial meeting between the University of Otago research team, members of the East Otago Taiāpure Committee and other Ngāi Tahu community members in 2006 and 2007. Formal introductions were made and a tentative outline for the proposed MCHI project was presented by the University of Otago research team. The direction and scope of the MCHI project subsequently developed via collaborative discussions between members of the committee, communities and research team and in many cases, researchers attended and presented at successive community management committee meetings as the kaitiaki established and managed their CPAs.

Group discussions were encouraged and taped, with the consent of those present, for archival purposes. Locals were then invited to participate in one-on-one discussions with research leaders regarding the development of the MCHI. From these discussions as well as from similar work conducted on Māori methods and indicators for marine protection and A cultural health index for streams and waterways, a questionnaire was developed in order to derive a list of ecological health indicators from locals. The questionnaire was later abandoned in favour of a semi-directed interview process whereby local kaitiaki and community members were guided through a series of open-ended questions regarding ecological health indicators.

3.2.2 Interview procedure

Seventy-one semi-structured interviews were conducted with 100 individuals ranging in age from approximately 20 to 90 years, between December 2007 and November 2009. Snowball sampling (a sampling technique where existing interviewees recruit other relevant interviewees from among their acquaintances) was used to identify individuals who had a direct stake in or relationship with their local marine environment and resources therein. Most interviews (74%) were conducted with a single informant, but occasionally 2 (22%), 3 (2%), or more (2%) participated in the discussion at the invitation of the targeted interviewee. We used purposeful selection to interview those who would expand or challenge our understanding of the value and state of local fisheries stocks, from a variety of disciplines, ethnicities, and age groups, and spread throughout South Island’s eastern and southern coasts. Many interviewees were kaitiaki and some were appointed as Tangata Kaitiaki, who are officially appointed managers of customary fishing regulations, responsible for issuing authorisations and setting policies for their local communities. Many interviewees were active members of community management teams who instigated, monitored, and managed CPAs, which are established under national fisheries legislation.

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62 Fossey et al., 2002; Polkinghorne, 2005
63 Bess, 2001; Memon et al., 2003; Ministry for Primary Industries, 2009; Memon and Kirk, 2011; Memon and Kirk, 2012
The duration of each interview ranged from approximately 30 to 270 minutes. Each was audio-taped and transcribed verbatim. Interviewees were guaranteed anonymity. All but one of the people we approached agreed to be interviewed, so virtually no bias results from refusals to participate.

A number of open-ended questions were used to gently guide the discussion of the state of local fisheries. The interviews were all conducted in English, but many informants referred to Māori terms and concepts, especially with reference to fish and shellfish. We provide a glossary of key Māori concepts, as well as both the Māori and taxonomic names for species in the appendix. Additionally, we briefly define the most significant concepts at first mention in the report. Interviewers took great care not to lead interviewees into discussion over particular species, resources, or marine health indicators. Nearly all interviews were conducted in the interviewee’s own home without other listeners.

3.2.3 Interview locations

Interviews were conducted primarily in settlements and cities along the eastern and southern coastline of the South Island of New Zealand. Participants resided as far north as Blenheim and as far south as Rakiura (Figure 3).
Figure 3. Location of interviews.
3.2.4 Analysis of indicators

The identification and weighting of various marine ecological health indicators for the development of the MCHI toolkit was achieved via a deliberate process as outlined below.

Coding and identification

The testimonies of all 100 interviewees were transcribed verbatim and entered into NVIVO™ version 9, a software package designed specifically for qualitatively and quantitatively analysing media sources.

Using NVIVO™ version 9, a team of coders read through each interview, identifying potential ecological health indicators while coding areas of text that pertained to each identified health indicator. The result was a branching tree structure of 107 indicators, each referenced with quotes from various interviewees.

Weighting

Once identified, the relative weightings of each indicator were based primarily on two criteria:

1. The number of total words coded to each indicator. Based on the assumption that interviewees chose to talk most about indicators that were of greatest importance to them, a word count for the amount of material coded to each indicator helped establish an indicator hierarchy.

2. The proportion of interviewees who mentioned each indicator. Indicators were also ordered according to the breadth of mention among interviewees, to confirm that several interviewees deemed the indicator in question as pertinent, rather than a select few. Indicators with the greatest proportion of interviewees referring to them were deemed most significant.

The two main criteria for weighing each indicator were then pitted against each other to investigate any correlation between the two. Regression analysis performed for all 107 indicators revealed a significant positive relationship between the number of interviewees mentioning each indicator and the number of total words coded to each indicator ($F_{1,108}=437.46$, $p<0.001$, $r^2=0.82$) (Figure 4). We may therefore be confident that both criteria paint a similar picture of indicator ranking.
To ensure that the toolkit would remain accessible and easy-to-use, with focus on the key issues, we chose to examine solely the top 30 of all 107 indicators identified. Indicators 31-107 were not nearly as focused on the overall ecosystem as those in the top 30, and instead were often subcategories of the top 30, or indicators relating to specific habitat types or conditions. For example, the indicators ‘presence of septic tanks’, ‘number of sewerage outlets,’ and ‘filtration area for sewage’ were each discussed by only a handful of interviewees and were aggregated into the broader, more heavily discussed general indicator of ‘pollution – sewage,’ an indicator that primarily investigates whether kaimoana are safe to eat.  

While culling the list to just 30 indicators potentially loses some valuable information of local importance, it avoided a stream of overlapping, redundant, and only locally occurring indicator definitions.

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64 See Appendix 2 for a brief description of the top 30 indicators
Table 2. Top ten indicators as ranked by total word counts. Includes a description of each indicator and example quotes.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description of each indicator and example quotes</th>
<th>Total words coded</th>
<th>Number of interviewees mentioning indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>General abundance of kai (Is there enough to get a feed?)</td>
<td>A high abundance of one or more taonga species (enough to consistently get a feed) usually harvested in the area, is an indicator of good ecosystem health. Many interviewees complain of a general decrease of kai abundance during the course of their lifetimes.</td>
<td>13402</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>“Years ago, I had been to this place and the whole bottom was covered in pāua, and then I went there the other day and just searched and searched and searched, and all I could find was shells everywhere... not healthy.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“In those days there was that much fish around it was embarrassing. There was a lot there. Dad used to take us out floundering. We used to go cray-fishing, and set pots and that in the harbour...now there’s less.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taste and condition of kai</td>
<td>The condition of various kai species, especially shellfish, is an indicator of overall ecosystem health. Condition is determined by taste, absence of worms and parasites, and for shellfish, a high flesh-to-shell ratio.</td>
<td>5302</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>“Somebody brought some cockles up from Otago, Dunedin Harbour, and they were the sweetest most beautiful cockles I have ever tasted. But these ones leave a liquorice taste, vile, horrible, and they are muddy. If I don’t like the taste, I won’t touch them.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“The shells go rotten and the worms actually go right through the inside of the shell... absolutely riddled with worms.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age and size structure of kai (Are there breeding stock and a healthy range of sizes?)</td>
<td>Many large individuals within a species indicate a healthy breeding stock and greater chance of population stability, while a good distribution of sizes indicate a healthy kai population. Many interviews talk of a significant reduction of large kai individuals over the past 40 years.</td>
<td>4735</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>“There are only little ones now. But when there are lots of big ones, the place is healthy.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“They are not as big as they used to be. I can remember just going off the island, this is going back a few years now, and bringing mussels in and cutting them in three because they were so big.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>“You always got your big ones, you always got your middle-sized ones, and you always got your small ones.”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recruitment (Is the kai replacing itself?)</td>
<td>Regular recruitment indicates a healthy population. A large number of juveniles mean a greater chance of population stability, since they will be building the future generation of that species.</td>
<td>4608</td>
<td>16</td>
</tr>
</tbody>
</table>
|                                                 | “You look at all the size groups, but in particular you would want to
have knowledge of what the juvenile habitats were. If there was a lack of large-sized animals, you would say, well what does the potential recruitment look like?”

“In 2000, 2001, and 2002 we had good larval settlement at Moeraki. And [larval settlement] was brilliant in 2003. So we had three reasonable years there and one very good one of larval settlement. Now that spun on through the fishery. The fishery saw a severe decline in the mid-1990s. Catches were way down and people were saying it was the end of the fishery. But obviously if you have poor larval settlement for a few years in a row, your fishery is going to be very adversely affected.”

| Pāua numbers | Pāua (abalone) was the most discussed species among interviewees. Many consider pāua as an indicator species, reflecting the health of their ecosystem. There were several accounts by interviewees of pāua depletion, recognising the need to travel further to gather pāua as well as a loss of large individuals. | 4295 | 23 |
| Harvest success (How long does it take to get a feed of kai?) | The length of time it takes to gather/fish/harvest kaimoana is an indicator of ecosystem health. Interviewees complain of having to wait much longer to gather a feed than in previous years. | 4049 | 30 |
| Pollution – sewage (Is the food safe to eat?) | The presence of sewage indicates that an area is not suitable for harvest. Interviewees typically use smell or a visual inspection of the waterways, to assess a harvest area for sewage contamination. Some interviewees also look for signs of nearby sewage outlets and septic tanks before deciding whether to harvest an area. | 3731 | 32 |
and got violently ill... I was up all night vomiting, diarrhea. I said I know [it is not healthy] because anything that is slightly off will give me the runs or [make me] vomit.”

### Presence and absence of kai (Have the fish disappeared?)

The absence of a once regularly harvested species from a site indicates either poor ecosystem health or overfishing.

“Red cod have disappeared and I don’t think that’s a human thing. I’m not sure what it is but it’s gone from being quite a healthy red cod fishery to, it’s just gone!”

“You used to catch flounder... and whitebait, another thing that has gone from here.”

### Sedimentation

High levels of sedimentation, siltation, and gravel deposition affects the harvestability of an area. In particular, interviewees alluded to smothering sediment loads reducing the available habitat for shellfish growth, fouling up reefs and blocking light for kelp growth. Interviewees state that sediment loads are affected by swell, wind, erosion, and dredging, and may be carried down by rivers.

“Well, what is happening is that you get soil pollution when areas of farm land are worked up and it rains. That soil is washed into the sea. It’s what you see when it floods, the brown water, because it’s got soil particles in it. We seem to be very prolific in working the ground close to streams and rivers. And that soil gets washed into those streams and rivers and finishes up at sea and pollutes the marine environment.”

“We now notice the silting up in the winter... The [silt] really should be held back by the trees. They are so busy running around fencing off creeks and things but in the winter, clay comes down off those hills. When we first got here it was good, they had a mooring in that [area]. But now it’s just thick, thick mud. And it just washes down off those hills.”

“You used to be able to get mussels off the rocks that were clean, and know they’re covered in muck.”

### State of nearby river

Rivers have the potential to transport pollutants from the land to mahinga kai areas. The health of a nearby river (as determined by its smell, colour, clarity, and type of surrounding land use) is an important indicator of mahinga kai health.

“The sieving of the water before it gets into the Clutha [River] is all gone because there are no big marsh areas. The flaxes have all been cut away from the rivers and you’ve got your farms right up to the rivers now... all that ground used to be flax, now it’s all cow, now it’s all cow shit straight in the river.”

“You need to check those waterways, the rivers, the storm waters etc... Everything that comes down [to the ocean], that’s important.”

“I think farms have had a huge impact on the health of the Clutha River.”
**Key Cultural Indicators**

A series of **Key Cultural Indicators** were identified through the following set of criteria: 1. Those that were most commonly talked about among interviewees; 2. Those with the largest number of words coded to them; 3. Those with broad-scope definitions which encompass the definitions of more specific subsequent indicators (in some cases Key Cultural Indicators were a combination of indicators with overlapping definitions); and 4. Those which interviewees considered most pertinent when assessing the overall health of CPAs and other local harvest areas.

The variety of quotes coded to each Key Cultural Indicator were examined to reveal which aspects and themes of each Key Cultural Indicator were most important. The frequency of certain themes arising from the quotes, and the severity of each theme to the health of the ecosystem, as outlined by the quotes, helped determine the ordering of four hierarchical questions assigned to each Key Cultural Indicator.

**Habitat Threats & Quality Indicators**

Some indicators were assigned to a supplementary list specifically relating to habitat threats and quality (such as water clarity, sedimentation, presence of invasive species, and presence of seaweeds) because they were quite narrow, specifically representing particular species or places. These consist of the remaining top 30 indicators that were not covered in the Key Cultural Indicators.
3.3 Results and design of the toolkit

3.3.1 Composition of the interview panel

The average number of total words spoken by each interviewee was 7191 ± 591 words. Six interviewees who spoke less than a total of 300 words each were omitted from further quantitative analysis, so the discourse of 94 individuals was analysed.

We partitioned interviewees by a selection of specific attributes. When partitioning by age group we found that the majority of interviewees (57 out of 94) were between the ages of 51-70. We also discovered an ethnic composition of mostly Ngāi Tahu Māori (58 out of 94) across all age groups. Nine individuals self-identified as Māori from iwi other than Ngāi Tahu, while 27 interviewees were of non-Māori (Pākehā) descent (Figure 6). Of the 94 interviewees, 61 were men.

![Figure 6. Age and ethnic composition of interviewees.](image)

3.3.2 Most important kai species

A handful of in-shore species proved to be exceptionally important to interviewees. While a few species of finfish as well as the tītī (muttonbird) were regularly discussed in interviews, the top 10 species of particular interest were as follows: 1. pāua (abalone), 2. kutai (mussels), 3. kōura (crayfish), 4. rāwaru (blue cod), 5. tuaki (cockles), 6. tio (oysters), 7. pātiki (flounder), 8. tuna (eel), 9. tītī (muttonbird), and 10. kina (sea urchin). Slow-moving and, in some cases, sessile animals are typically easier to harvest than
free-swimming species and have been part of the staple diet of Ngāi Tahu coastal communities for centuries.\textsuperscript{65}

\textit{Pāua} was the most discussed species with an average of 677 ± 97 words coded per interviewee, nearly double that of the next most discussed species, \textit{kutai}, averaging 387 ± 53 words per interviewee (Figure 7).\textsuperscript{66} Given that our interviewees were distributed over 900 km of the South Island, it was revealing that the majority considered \textit{pāua} to be of greatest significance. The nationwide distribution of \textit{pāua}, coupled with its ease of harvest and high commercial value, are contributing factors to its popularity among interviewees.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure7.png}
\caption{Mean words coded per interviewee for each focal species. Error bars denote standard error of the means. Bars sharing the same letter are not significantly different at a significance level of \(p \leq 0.05\) as determined by Tukey’s post-hoc analysis. \(N = 94\) interviewees for each species.}
\end{figure}

The appearance of \textit{tītī} (sooty shearwater) in the key species list is remarkable considering that very few interviewees were muttonbirders and that the discussion focused on the health of local areas along the Te Wai Pounamu coast, a considerable distance from their breeding areas.\textsuperscript{67} This reflects the significant cultural importance of the \textit{tītī} harvest for Rakiura Māori within Ngāi Tahu whānui.\textsuperscript{68} Migration of the birds down the coast in spring, and return to the northern hemisphere in autumn and early winter is noted by many of the kaitiaki, but little feeding in their local area happens and the numbers fluctuate

\begin{itemize}
\item \textsuperscript{65} Smith, 2011
\item \textsuperscript{66} A one-way ANOVA revealed a significant difference in the amount of words coded to each of the most mentioned kai species \((F_{8,825} = 13.74, p < 0.001)\).
\item \textsuperscript{67} Newman et al., 2009
\item \textsuperscript{68} Newman and Moller, 2005; Stevens, 2006; Kitson and Moller, 2008; Moller et al., 2009
\end{itemize}
enormously from year to year and seasonally. For this reason we have excluded tītī from calculation of MCHI indices and assert that one of the criteria for inclusion of a species as an indicator is close and local coupling of the species to the CPA or traditional fishing ground being monitored.

Another example of this is tuna (freshwater eel) which are predominantly caught inland, in rivers and lakes, even though they temporarily pass through estuaries and migrate for breeding in coastal waters. They do not feed during this migration and so are only occasionally caught in the coastal waters and estuaries. Their numbers are mainly determined by wetland, stream and lake ecosystem health, restrictions of passage between feeding areas and the sea, and especially commercial harvesting pressure well away from the marine environment. For these reasons we emphasised the ‘coupling’ in the MCHI. It is therefore up to kaitiaki to determine their top mahinga kai species for each site using their mātauranga and/or local knowledge.

When ranking the proportion of interviewees who discussed each species as opposed to the number of words coded for each, we see a similar ranking of species importance with only slight reshuffling in the ordering (Figure 8). For instance, flounder sits as 7th when ranked by mean words coded (Figure 7), but is discussed by the third largest proportion of interviewees (Figure 8).

![Figure 8](image-url)

**Figure 8.** Proportion of interviewees who discuss each focal species. Proportions were calculated from a total of 94 interviewees for each species.

69 McDowall, 2011
Statistically significant differences in the number of words coded to four focal species (kōura bordered on statistical significance) could be explained by ethnicity. Blue cod and kōura were discussed more by Pākehā (non-Māori) than by Māori, while the reverse was true for the tītī, tuna, and pāua. Although pāua was the most discussed species among both ethnic groups, Māori displayed a particular interest with almost twice as many words coded to pāua on average than Pākehā (Figure 9).

**Figure 9.** Mean number of words coded per interviewee concerning four focal species. Interviewees were differentiated into two ethnic groups; Māori and Pākehā (non-Māori). Error bars denote standard error of the means. Numbers above error bars represent the number of interviewees per ethnic group.

### 3.3.3 MCHI Structure

**Surveyor and Site Information**

Surveyors should determine the dimensions of each assessment site according to their mātauranga or local knowledge. It is assumed the sites will generally be traditional fishing grounds. The dimensions will vary depending on whether the mahinga kai species are sedentary or free-swimming. The site could be a reef or just a single rock outcrop, although we suggest assessment sites be of a ‘reasonable’ size to be meaningful and comparable within and amongst CPAs. The fundamental point is for surveyors to define each site clearly so that the exact same area is resurveyed each time.
Upon initial assessment, surveyors must complete two forms: a) Surveyor Information (see Form A in appendix 3) and b) Site Characteristics (see Form B in appendix 3). The **Surveyor Information Form** assesses the surveyor’s depth of experience in the area, as well as his/her relationship to the site. The **Site Characteristics Form** inquires about the site’s location, as well as its geography, human use, and key features of its habitats and ecology. Both of these forms only need to be completed once, and should take less than 20 minutes to complete.

Each surveyor will be allocated a unique ID code for the database storage. Similarly, each monitoring site will be allocated a place name and a location ID code within the database, to match against map coordinates and to efficiently track future site assessments.

**Site Surveys**

At the beginning of each site assessment, surveyors must complete a short (one-minute) cover page, or **Site Survey Form (Form C)**, explaining the time, location, and other pertinent environmental information that will give their scores context.

All surveyors must assess each site both for its Benchmark State as well as its Current State. In the former, surveyors with prior experience and knowledge of the site are asked to cast their minds back, scoring what the site used to be like – to do a ‘virtual’ or mind experiment, imagining that they were standing at this same spot 20, 30, or even 40 years prior. If they have recently used and experienced the site, they are also invited to score its most recent Benchmark State in preparation for the field surveys to identify the Current State. The historical benchmarks provide the community with restoration targets calculated on the very same scoring system, allowing a semi-quantitative measure of how far current marine health has degraded since the surveyor first experienced the area. If the surveyor has lived and used the area for a long period, they may even feel confident enough to score several benchmarks of the MCHI for nominated years at key intervals in their lives in that area.

The **site assessment** is divided into three sections: 1) Key cultural indicators, 2) Habitat threats and quality indicators, and 3) Survey results. All three parts of this assessment should take a total of 20-30 minutes for the surveyor to complete, at each site (depending on whether fishing occurs in support of the survey or not).

The goal of the **key cultural indicators** scoresheets is to evaluate the overall health of the marine ecosystem at the survey site, addressing the greatest concerns. Four indicators are evaluated based on a hierarchical flowchart, where paths lead to scores 0-4, signalling various levels of warnings. One indicator relating to pollution, “Is the food safe to eat?” relates to all species of *kai* in the area (See Form D in appendix 3) The other three indicators are species-specific, relating to the ecological health and accessibility of the most important species for *kai* (See Forms E-G in appendix 3). To evaluate the health of these *kai* species, surveyors are asked to identify their most important *taonga* species (up to five) within the harvest area (this requires the same species to be identified for the Benchmark and Current surveys), which are evaluated based on taste and condition, replacement, and accessibility. We chose to
allow a maximum of five species because we needed to minimise the volunteer surveyor’s time needed to complete each scoresheet; additionally, most communities will presumably choose their rangatira (identity) species. By focusing on – and therefore restoring – these highlighted species, the cultural health of the site should follow naturally.

Figure 10. Example of a Key Cultural Indicator scoresheet.

Te Tiaki Mahinga Kai · New Zealand · Ngāi Tahu Marine Cultural Health Index
The second section of the MCHI Scoresheets concerns **Habitat Threats & Quality Indicators** (see Forms H & I in appendix 3). These indicators include water quality and sedimentation, as well as invasive and provision species. The first of these forms give multiple-choice questions, with 6-7 options each. The goal of this step is to evaluate the health of specific site attributes and to assess any remaining, though supplementary, indicators that may affect the health of this marine ecosystem. This section should guide community members on how to improve an already healthy ecosystem, as it focuses on subtler indicators.

All answers are given scores between 0-4. Scores 0-2 are considered Red Alerts. The health of the habitat, in these situations, is under severe stress; thus, the site needs large and/or urgent restoration efforts to improve towards a healthy state. Score 3 is considered an Amber Alert; while much of the site is healthy and/or the urgency of the dangers is less, it is still in danger and needs both caution and action. Score 4 is Green, signalling a generally healthy site.

Following this section, surveyors who are conducting a **Benchmark Assessment** are asked to complete **Form J: Comparison Questions**, which compare the past and present health of the survey site. This form is purely qualitative, and is not included in the final score. Instead, it may be used as a reference point, to establish restoration targets.

After surveyors have completed all of the MCHI Scoresheets, they are asked to transfer their scores to the **Survey Results Form** (see Form K in appendix 3). This will give a brief summary of their findings, so that community members can quickly and easily refer to the scores. A qualitative assessment follows this scoresheet summary (see **Form L: Overall Assessment** in appendix 3), which allows surveyors to add any additional information about the site, which was not highlighted in the scoresheets.

All scoresheets can then be submitted to Toitū Te Whenua to enter results into the the Ngāi Tahu State of the Takiwā database. Toitu Te Whenua may consistently report periodic summaries to each participating community, to continue building a collaborative and reciprocal MCHI. The final data will be the property of each participating community. Toitū Te Whenua will control access to the central database to ensure that it is only used to assist kaitiakitanga in participating areas. Therefore, community representatives may contact Toitu Te Whenua at anytime to ask questions about the health of their rohe moana.

### 3.3.4 Scientific rationale behind the construction of indicators

**Is the food safe to eat?**

This Key Cultural Indicator (KCI) acknowledges the threats that pollution in its various forms poses to the ecological health and harvestability of marine habitats. Pollutants, contaminants, and faecal matter resulting from point-source discharges and sewage outlets can accumulate in nearby filter-feeding shellfish, reaching levels unsafe for human consumption. Indeed, the periodic prohibition of cockle...
harvesting from sites north of the Dunedin Tahuna wastewater treatment plant is a local example of this. Many interviewees viewed sewage as the ultimate harvesting deterrent:

“What would stop me from fishing from a spot? A sewage pipe.”

“I wouldn’t eat them from there... because of the sewage.”

As such, we have prioritised sewage as the key threat within the KCI relating to pollution.

Additionally, algal blooms, although naturally occurring, may be toxic and pose a direct threat to human health. Algal blooms may be instigated by a variety of environmental conditions including eutrophication, a typical result of agricultural runoff. River systems meandering through cultivated land may also accumulate pesticide and agricultural contaminants, which are subsequently carried to in-shore environments. In 2010 the Ministry for the Environment released new guidelines for measuring and assessing levels of blue-green algae in waterbodies. Warning levels now take into account both the number of cells and their size.

Can you get a feed easily enough?

This indicator (alongside the safety indicator outlined above) was of fundamental importance to the interviewees. It looks at the basic needs of local harvesting communities and assesses the ability for locals to feed themselves and their guests. A diminishing abundance of and reduced access to important in-shore kai species over the last few decades was a recurring theme in interviews.

“In those days there was that much fish around it was embarrassing. There was a lot there. Dad used to take us out floundering. We used to go cray-fishing, and set pots and that in the harbour...now there’s less.”

A dimishing abundance or complete absence of a once plentiful species from an area may be indicative of one or more factors. Such factors include shifts in environmental conditions, the arrival of invasive species, and overfishing. For example, Beentjes and Renwick (2001) describe a relationship between red cod recruitment and sea surface water temperature, with colder waters theoretically yielding higher levels of recruitment. Similarly several interviewees labelled red cod as a species that has disappeared completely from areas north of Timaru in recent decades and attribute their disappearance to rising water temperature. The potential for invasive species to negatively affect coastal fisheries continues to grow due to a process of globalisation of marine flora and fauna primarily due to international shipping. Overfishing and mismanagement of in-shore resources was viewed by interviewees as the most likely cause of diminishing populations of important kai species.

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70 See Otago Regional Council website, and Ryder Consulting Ltd. reports
71 Hallegraeff, 1993
72 Anderson et al., 2002
73 Biosecurity New Zealand
**Is the kai replacing itself?**

Investigating the structure of any population is essential to understanding the species’ viability in an area. The presence of breeding stock is vital for the ongoing success of a species. Studies show a positive relationship between size (or body mass) and fecundity in fish. Larger females typically produce more eggs, and recent laboratory studies have shown that maternal traits such as age and size can be positively associated with offspring growth, size, and survival. Based on these findings, the logical way to assist sustainable harvest of a species would be to refrain from harvesting the larger bracket of individuals. This philosophy is one that resonates with many of the interviewees in this study. The idea of ‘leaving the big ones’ by restricting harvest of both extremely large and extremely small individuals is a basic mātauranga approach. Our interviewees speak of traditional harvesting practices where only individuals up to a certain size are harvested:

> “Well, the tikanga in Māoridom was to my understanding... that you actually didn’t take the biggest, you actually took the smallest up to a certain size.”

> “At the moment we figure we are helping the fisheries along because we are catching bigger fish, we are actually catching less individuals per tonne, so that in itself helps... Except... I’m with the Māoris on that, in that it seems smart to me to leave big adult breeding stock there, just like it is for crayfish or anything.”

> “The kōura (crayfish) now, our people when they went to the foreshore to gather kōura they always never took the real huge kōura. They always referred to them as the breeders. Now they did take the odd big one, or the adult kōura... that was some of the things they did, but there was always enough left for the breeding purposes. They were always very, very good in educating our young in how to preserve and to conserve.”

Similarly, the presence of small individuals are important as they signify the recruitment of the species, and the continued reproduction for the future generation. Recruitment and larval settlement patterns are still not comprehensively understood for many marine organisms. Recruitment may vary both spatially and temporally with larval settlement potentially occurring over large patchy areas, as is the case for pāua and other abalone.

**Taste and condition of the kai**

Condition of important kai species may be an indicator of environmental health. The change of a species’ condition may be cause for concern, as its health may often mirror the health of its habitat. For example, shellfish are filter feeders and bio-accumulate whatever contaminants are in the water column. Some shellfish are also considered bio-indicators of the surrounding environment, whereby

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74 Heinimaa and Heinimaa, 2004; Rideout and Morgan, 2010; Beldade et al, 2012
75 Beldade et al, 2012
76 Scott et al., in prep.
77 Richards et al., in prep.
78 McShane et al., 1988
their condition and sensitivity to stress actively reflects the health of their surrounding ecosystem.\textsuperscript{79} Likewise, interviewees expressed that the taste and condition of shellfish and other important in-shore kai species usually reflect the health of the ecosystem as a whole.

\textit{Habitat threats and quality}

High sedimentation loads can have a direct effect on the ecology of in-shore habitats. Increased levels of lingering siltation and sedimentation reduce the amount and depth of light penetration essential for photosynthesis and growth by algae (seaweed and phytoplankton).\textsuperscript{80} This is important as organic material produced from photosynthesis by algae provides the food that marine fisheries are based on.\textsuperscript{81} Reduced light as a result of sedimentation may therefore reduce the productivity of fisheries. Sediment can also directly smother species and provide a physical barrier to settlement of larvae of species including pāua and kelp.\textsuperscript{82} Sediment in the water can also clog the gills of fish, making it more challenging for them to ‘breathe,’ as well as reducing visibility to find food. Suspended sediments also reduce the efficiency at which shellfish can filter-feed, and in the case of high sediment loads, may cause death of frequently harvested shellfish.\textsuperscript{83}

High sediment loads usually reach the in-shore environment during periods of erosion, from land run-off, or are carried down by streams and rivers. Contaminants and nutrients may also be transferred from terrestrial ecosystems to the marine environment and may change the ecology of the receiving area. These threats were regularly described by interviewees. Some seaweeds, including the sea lettuce (\textit{Ulva spp.}) thrive in nutrient-rich environments and have thus been used as indicators of eutrophication.\textsuperscript{84}

The anoxic layer is a layer of sediment depleted of oxygen. Typically these layers reside deeper on the sea floor nearer freshwater outlets such as rivers and streams. This is because, in these areas, there is a constant water exchange and influx of oxygen into the sediment, forcing the anoxic layers to greater depths. Anoxic layers are detrimental to shellfish and the depth at which they reside may change according to environmental conditions. For example, one of the reported effects of sustained aquaculture activity on coastal environments is the deposition and accumulation of organic-rich sediments near the production site, whether from the faeces and pseudofaeces of shellfish, or uneaten food and excretion of fin fish. This can result in an increase in oxygen consumption by the sediment, formation of anoxic sediments, and the production and release of harmful gases such as methane, \textit{H}_2\textit{S}, and \textit{CO}_2 which can affect the water column, benthic macrofauna,\textsuperscript{85} and meiofauna.\textsuperscript{86} It is therefore important that surveyors examine the anoxic layer for any significant change over time.

\textsuperscript{79} Neff, 2002  
\textsuperscript{80} Luning and Dring, 1979  
\textsuperscript{81} Pauly and Christensen, 1995  
\textsuperscript{82} Devinny and Volse, 1978; Airoldi, 2003; Armstrong and Falk-Peterson, 2008; Onitsuka et al., 2008  
\textsuperscript{83} Ministry for Primary Industries, 2009  
\textsuperscript{84} Heisler et al., 2008  
\textsuperscript{85} Pocklington et al., 1994  
\textsuperscript{86} Mazzola et al., 1999
3.3.5 Indicator groups

As outlined above, the toolkit is structured into several major indicator groups, four Key Cultural Indicators and one set of supplementary Habitat Threats and Quality Indicators, which each encompass broad and pertinent themes to evaluate mahinga kai health. Each indicator group is an aggregate of specific individual indicators.

Table 3 and Figure 11 show the number of specific indicators coded to each group, and the total word counts of each group to give an idea of their relative importance. Only 10 of the 30 indicators (22% of the total words coded) were deemed too specialised or habitat-specific to be directly incorporated into the toolkit scoring system. However, some aspects of those indicators have been included in questions concerning ‘comparison questions,’ (see Form J in appendix 3). Thus, they are at least recorded for background referencing in the State of the Takiwā database. Incorporating an accurate account of biodiversity as an indicator requires specialist training and full scientific surveys, which Ngāi Tahu hope to eventually adopt into their full suite of environmental monitoring practices (for example the MCHI could be implemented at different levels of intensity from the most rapid method – the passive, perception survey, through to full, specialist scientific surveys). Furthermore, in the discussion (section 4), we elaborate on some our reasoning for omitting certain indicators.
Table 3. The relative importance of different indicator groups used in the toolkit, as determined using total word counts.

*Indicators that were not incorporated into the toolkit.

<table>
<thead>
<tr>
<th>Indicator group</th>
<th>Number of specific indicators aggregated into group (from the top 30 indicators)</th>
<th>Aggregated indicators</th>
<th>Total number of words coded to each indicator group</th>
<th>Percentage (%) of total words coded to all 30 indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the food safe to eat?</td>
<td>3</td>
<td>Pollution-sewage, Algal blooms, Man-made rubbish</td>
<td>6805</td>
<td>10</td>
</tr>
<tr>
<td>Can you get a feed easily enough?</td>
<td>9</td>
<td>General abundance of kai (includes Finfish numbers, Pāua numbers, Kōura numbers, Flounder numbers, and Red cod numbers, as subcategories), Harvest success, Presence and absence of kai, Intertidal access</td>
<td>22615</td>
<td>33</td>
</tr>
<tr>
<td>Is the kai replacing itself?</td>
<td>2</td>
<td>Age / size structure of kai, Recruitment</td>
<td>9343</td>
<td>13</td>
</tr>
<tr>
<td>Taste and condition of kai</td>
<td>1</td>
<td>Taste and condition of kai</td>
<td>5302</td>
<td>8</td>
</tr>
<tr>
<td>Habitat quality and threats</td>
<td>5</td>
<td>Sedimentation, Invasive species, Water quality / clarity, Seaweed, Eutrophication</td>
<td>9852</td>
<td>14</td>
</tr>
<tr>
<td>Biodiversity*</td>
<td>2</td>
<td>Species diversity, Variety of shells on beach</td>
<td>3404</td>
<td>5</td>
</tr>
<tr>
<td>River health*</td>
<td>2</td>
<td>State of nearby river, Rivermouth health</td>
<td>3884</td>
<td>6</td>
</tr>
<tr>
<td>Other indicators accumulated*</td>
<td>6</td>
<td>Presence of dolphins, Growth rate, Fishing pressure, Tidal flow / flush, water temperature, Community health related to harvest</td>
<td>7650</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td></td>
<td>68855</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure 11. The relative importance of different indicator groups (% or total words coded to top 30 indicators) used in the toolkit, as determined using total word counts.

3.3.6 Scoring overall Marine Cultural Health

Scoring the cultural health of target species

Once all site survey results are submitted to Ngāi Tahu’s State of the Takiwā central database, scores for each site will be evaluated based on the following breakdown.

We first evaluate the overall health of each individual species to be harvested at the site, including species that could only be gathered after restoration (if rebuilding of the stocks is needed). This is calculated by adding each score (0-4) for Replacement, Taste and Condition, and Habitat Threats and Quality, and then multiplying that subtotal by the Ability to get a Feed (harvest effort) score (0-4). This gives a maximum possible score of (4+4+4)*4 = 48 for each individual species. The overall ecological health of that species is therefore divided by 48 and expressed as a percentage. The Ability to get a Feed score is the most important ecological component of each species’ contribution to cultural health, as it affects the abundance and distribution of the fauna. It is therefore logical that it is multiplied in the score rather than added, as are the other components.

However, the stocks not only need to be ecologically healthy to enable harvest; they must also be safe to eat. Even if the pāua living around a sewage outflow are abundant and reproducing, for example,
they cannot feed the people (communities may be deliberately deterred from harvesting pāua contaminated by sewage). We therefore multiply that species total by the overall score (0-4) for Kai Safety (site contamination), to get a maximum score of \(4 \times (4+4+4) \times 4 = 192\). We then express the overall cultural health of the species at the site as a percentage by dividing the combined score by 192. Overall alerts are expressed as red for 0%-50%; amber for 51-75%; and Green for 76-100%.

The effect of the relative weightings of different components of the score for individual species is shown in Figure 12. Overall cultural health provided by a single prized species (#1) spans from 0 to 100% as it is scored from 0 to 4 for Ability to get a Feed, but only if the site is not contaminated (Figure 12a). Even a very ecologically healthy stock (scoring 4 on the horizontal axis) cannot reach amber status (51-75%) unless the Kai Safety score is at least 3. However, a shift in one point for any of the component scores for Replacement, Taste and Condition, or Habitat Threats and Qualities triggers only a marginal increase in that species’ cultural health compared to any shift of one point in Kai Safety or Ability to get a Feed (Figure 12b). For instance, at an uncontaminated site with abundant kai (score 4 in Ability to get a Feed), a shift in evidence of the population replacing itself from 1 to 4 causes a rise in overall cultural health of the species from 75% to 100% (Figure 12b). Correspondingly, a change in Ability to get a Feed from 1 to 4 triggers a much larger increase in health from 25% to 100%, provided that evidence of replacement is scored as 4.

The same scoring system is applied to both benchmark states and current states of the health of the site.
Figure 12. The effect of the relative weightings of the different components (Kai Safety [a], Kai Replacement [b]) of the score for individual species.

Calculating Cultural Health of a Site

We expect the health of individual species, as calculated above, to act as the primary guide for kaitiaki on how to protect and rebuild the health of their kai moana stocks. After all, each species has particular ecological requirements and some sought-after species (e.g. pāua) may be stressed by heavy overfishing while nearby stocks (e.g. kina) flourish. Specific management strategies targeted at key cultural species is therefore more likely to deliver the most effective restoration and ongoing protection of cultural health. Nevertheless, State of the Takiwā reporting and ‘site-led’ restoration of cultural health will be best facilitated by calculating an aggregated overall score for the health of each site. The MCHI indicates overall health of each site in two complementary ways: (a) by reporting the average number of species sought for harvest at a given site by all surveyors; and (b) by calculating an average score for each species’ individual cultural health, after weighing the influence of each species from one (most sought after) to five (least sought after).

The number of different species expected and sought for harvest at a particular site is an appropriate modification of what ecological scientists deem as species richness. A place with high species richness has more “biodiversity” and is usually considered to be ecologically healthier. The MCHI considers a site that offers a greater variety of kai to be more “bioculturally diverse” and to contribute more to the community’s cultural wellbeing than one that provides few types of kai. One measure of the current
cultural health of the site is therefore the number of potential species that could flourish there, those which are actively and easily being gathered.

Surveyors are asked to rank the species they seek at a site in order from most sought after to least sought after, up to a maximum of five species. Calculation of an average cultural health for all the species targeted therefore requires a decision about how much one “weighs” (favours) the scores of the top ranked species, compared to the second rank, and so on for the subsequent species. Figure 13 shows some options, regarding weighting of the five species:

- **0% weighting:** The score for species #1 is given just as much weight as the score for Species #5.
- **10% weighting:** Species #2 is discounted by 10% so that its overall influence on average cultural health is 90% of that for Species #1; then, species #3 is 90% as important as species #2 and [90%*90% = 81%] as important as species #1 (and so on to the 5th species, if a full five are sought for harvest at the site).
- **20%, 30%, or 40% weighting:** By the time a 40% discount rate is used between successive ranks for each species, the 5th most important species has hardly any influence on the overall cultural health of the site (ie. the score for the health of species #5 is only 13% as influential as the most sought after species targeted for the area).

![Figure 13. Average cultural health for all five species targeted using different discount scenarios (i.e. deciding the relative weightings of subsequent species).](image)

The effect of the species discount rate to the overall score for site health is shown in Figure 14 for a hypothetical scenario of an uncontaminated site where five species are expected for harvest, each with the following individual health scores:
• Species #1: Ability to get a Feed varied from 0 to 4. All other components fixed at score 4.
• Species #2: All components scored 1.
• Species #3: All components scored 2.
• Species #4: All components scored 3.
• Species #5: All components scored 4.

This scenario depicts an extreme case of increasing health of the least important kai species, so it shows a relatively larger shift in the site’s overall cultural health score than might normally be expected from varying the species discount rates. A 40% discount rate leads to an average cultural health score for the site of 16% if the ability to get a feed of the top-ranked species is zero, but this climbs to 38% if the 5th rank species is considered to be equally important for cultural health as the 1st ranked species (Figure 14).

Our recommendation is thus to weigh successive species at 20%, an intermediate scalar that recognises that some species are considered to be particularly important for each marae and community, while not disregarding the need for a variety of kai species. If necessary, this middle-level weighting can be adjusted later, once a large database of MCHI scores are gathered and matched against the communities’ satisfaction with the degree of restoration achieved. Choice of an intermediate (20%) species discount rate is a pragmatic compromise that will accelerate attention to the most important cultural keystone species first, while driving some multi-species restoration effort in its wake.

Figure 14. The effect of the species discount rate on the overall score for site health. The green line represents our recommended 20% discount rate.
Figure 15 depicts the changes in overall Cultural Health of an uncontaminated site using the 20% discount rate for successively more species being targeted there. In this case we have simulated the effect of varying Ability to get a Feed of the top-ranked species (with Replacement, Taste and Condition, and Habitat Threats and Quality for this species always scoring 4) for each addition of each new species with all individual Cultural Health component scores equalling 3. Again, the Ability to get a Feed score has the main effect on overall site health, especially if it is the only species sought from the site (“1 species” line in Figure 15). However, the health of up to four other additional species dampens the effect of variation in the health of Species #1 (ie. the lines flatten out in Figure 15). When the Ability to get a Feed for Species #1 falls below 3 (the score for the additional species in this scenario), the overall health of the site is raised by the presence of the secondary species. When the Ability to get a Feed for Species #4 reaches 4, the inferior health of the supplementary species drags the overall site score down. With a discount rate of 20% per additional species, the addition of a 5th species has little impact. (The lines for a score with four species and five species are virtually the same in Figure 15). The biggest relative shift in overall Cultural Health occurs by adding a second species, and the least by adding a fifth.

![Figure 15](image.png)

**Figure 15.** The changes in overall Cultural Health of an uncontaminated site using the 20% discount rate for successively more species being targeted.

The long-term trajectory of the site’s Cultural Health scores, along with which species contribute most to the score, will convey a lot about the ecosystem health. Many interviewees lamented the loss of cultural knowledge, as well as the gradual memory loss of what could be harvested from sites when cultural practices are severed. We categorise this as “sinking cultural health baselines,” directly analogous to the
similar phenomenon emphasised by western fisheries managers about fish abundance – the idea that the expectations of current generations fishing in marine ecosystems are gradually sinking regarding what is normal; therefore, there is little awareness of the need to rebuild stocks. If the institution and active management of CPAs succeeds in restoring overall ecological and cultural health, we expect that the number and type of harvest species will rise and diversify, and that this will be scored successfully by the MCHI. Comparisons of the MCHI scores from other CPAs or unmanaged sites from more remote and pristine coastlines where habitat degradation, pollution, and fishing pressure are reduced will also benchmark restoration progress and help kaitiaki set goals. The benchmark scores contributed by experienced gatherers in the MCHI scoring protocol can also be used to set restoration targets.\(^87\)

Scaling of the different components of both an individual species’ and a site’s Cultural Health score has been designed to adapt to sensitive changes, from highly degraded to fully intact cultural health. For the much depleted species, low abundance and lack of accessibility from the shore will most likely correlate with lack of replacement from within the local area, possibly also with poor condition of those animals present and/or threats to their habitat such as invasive species or sedimentation.

Restoration of stocks by such actions as the reduction of harvest pressure is likely to build the *Ability to get a Feed* and *Replacement* scores, so that a rapid trajectory to a more healthy species is expected. The greatest overall contribution to a species’ and site’s cultural health will be to clean up any sewage or toxic pollution, as it affects all species. The East Otago Taiāpure Management Committee has repeatedly submitted to Dunedin City Council to improve sewage treatment along their coast. The Koukourārata community is reforesting parts of their catchment surrounding, which drains into their mātaitai, particularly along stream banks. Political advocacy for reduced pollution and better sewage and storm-water management is one of the lasting indirect effects of the establishment of CPAs.

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\(^{87}\) It may even be possible to roughly estimate what the MCHI score would be like in Marine Reserves by conducting virtual dives like those deployed by *Te Tiaki Mahinga Kai* scientists to estimate pāua catch per unit effort (Richards et al. in prep.). *Taste and Condition* could not be estimated from a no-take area like a Marine Reserve, but collections of the specimens from just outside the reserve could be used to extrapolate what is occurring within it, or the analysis can simulate a range of potential MCHI scores for the reserve area when the *Taste and Condition* score fluxes from 0 to 4.
4. Synthesis & Discussion: Opportunities and constraints for using the MCHI

4.1 Can one toolkit work for different ecosystem types?

Marine ecologists often begin their sampling programs by categorising study areas into major habitat types. Marine systems are commonly divided into soft sediments versus rocky substrates, while water depth and degree of wave exposure are secondary divisions\(^8\). Intermittent flushing of tides and differential mixing of salt and freshwater are environmental factors that also differentiate habitat types. These variables present a challenge to developing a single MCHI that may be applied to a stretch of coast, such as a mātaitai or taïpō, which may encompass a range of habitat types. Furthermore, the biological diversity and composition of kaimoana species may vary considerably among different habitat types. Development of a robust and flexible marine Cultural Health Index is therefore more ecologically complex and potentially more challenging than that done so successfully for stream environments for Ngāi Tahu by Dr Gail Tipa, Laurel Tierney and Dr Colin Townsend\(^9\).

In this report we categorise New Zealand’s in-shore harvest areas into five representative habitat types\(^10\): estuaries, mudflats, soft sediment harbours, rocky shores, and kelp beds. We distinguish kelp beds as particularly distinctive ecological community types, where the primary productivity is driven by the kelp growth, which in turn is regulated by light penetration determined in large part by sediment loads in the water column\(^11\). These five habitat types broadly account for the range of in-shore marine habitat changes along the New Zealand’s coastline.

Limiting the variety of coastal habitats to five distinctly recognisable types allows surveyors to more easily categorise their sampling areas. It may also help validate the competency of the surveyor by cross-checking their records of present kaimoana species against our current understanding of the biological composition of these major habitat types. Scientific studies and historical knowledge together help provide us with a good understanding of the types of kaimoana species to expect within each habitat, as many kaimoana species are usually constrained to certain habitat types. Soft sediment zones, for example, may typically harbour an array of burrowing bivalve species such as tuangi\(^12\), but are unlikely to be home to aggregations of pāua, which typically reside along shallow rocky coastlines where seaweed is abundant. The project’s centralised database has the capacity to efficiently detect records of atypical species, which could lead to follow-up cross-validation to ensure that the data streaming in from the communities makes ecological sense.

An integral component of the MCHI toolkit design was to structure the ‘Key Cultural Indicators’ in such a way that they may be applied to all in-shore marine habitat types, while still addressing the state of ecosystem and cultural health at each. This helps account for changes in species composition at

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\(^8\) For example, Morton, 2004

\(^9\) Tipa & Tierney (2003, 2006); Townsend et al. (2004)


\(^11\) Foster & Schiel (2010); Hepburn et al. (2011), Daniel et al. (in review)

\(^12\) Powell (1979)
different sites while still enabling surveyors to score the cultural health of the five most important species. The surveyors themselves choose which of up to five species to evaluate, giving more voice to each community involved and allowing their primary concerns to be featured in each survey without restriction. In the long term, the actual species chosen will itself be an indirect indicator of cultural health and the overall number targeted is likely to change as the mahinga kai are restored and customary practices are rekindled.

The interviewees emphasised that the presence of sewage precludes harvest and the first priority for cultural restoration interventions. While sewage may not necessarily degrade the ecology of a habitat from a biological perspective\textsuperscript{93}, it certainly has the potential to affect the harvestability of an area, which is of primary concern to Ngāi Tahu and this MCHI. For some, human sewage contamination was an ultimate sign of neglect of care for a site and their community, and deeply offensive for ethical and spiritual reasons. The next major focus for interviewees was the ability for everyone to get a modest feed whenever the tide was out. Many others went on to discuss the fundamental sustainability indicators of whether the stocks were in good condition and whether there was evidence of population recruitment in their area. These and other ‘Key Cultural Indicators’ remain valid across estuarine zones, mudflats, soft sediment harbour zones, rocky shore zones, and kelp beds.

4.2 What was left out of the MCHI?

The design of the toolkit has traded-off general applicability and usability by non-specialists against detailed and more specific indicators in some habitats. For example, some interviewees emphasised the variety of shell remains on a beach, while others discussed the variety of life forms in rock pools. We did not include either of these two tohu because reliable scoring could only be done by a subset of observers and they could only ever be monitored at some habitat types. The wide applicability of the toolkit to various in-shore habitat types is advantageous, allows standardisation across all sampling areas, providing a more efficient, quick, and accessible framework for surveyors to work within – but it does necessarily abandon some local knowledge and detail. Some interviewees talked at length about threats to the cultural and ecological wellbeing of their area. For example, many emphasised that sediment and pollution loads fluxing into the coast from large rivers can degrade the health of inshore stocks and affect the harvestability of the receiving area thereby reducing local fishing success. We concur with many kaitiaki who believe that increased sedimentation triggered by land clearance is probably the most important threat to inshore marine habitats. The initial MCHI trialled with communities from four marae included a semi-quantitative score of the degree of sedimentation occurring in a site, but this was abandoned in the final MCHI toolkit. Sedimentation was dropped partly because it varies so much naturally from place to place, or even within minutes of a tide turning\textsuperscript{94}.

Some interviewees spoke of traditional uses of seaweeds for rongoa (medicinal uses) and collection of bull kelp in particular for pohā. Opportunity to gather these culturally important materials is an important contribution of some local sites to cultural health of the community. Nevertheless we

\textsuperscript{93} Roberts et al. (2005)
\textsuperscript{94} Pritchard, 2011
eliminated them from consideration from formal scoring of the MCHI because the biomechanics of harvesting plants are so very different from gathering shellfish or free swimming fish. A new and more specialised MCHI subcomponent could be designed later if the communities request it, but in the meantime we have set the issue aside to simplify the MCHI prototype.

More generally, we also excluded variables like sedimentation because they are best classified as “pressure” and “response” variables rather than “state” variables. MCHI is primarily a tool to monitor the current state of the mahinga kai and associated cultural health of the site, not to identify the causes (often pressures) of that current state. Much of the interview kōrero blended pressure and state issues, and some went further to discuss solutions (response). For example, many considered the overarching CPA establishment programme as the most effective response to failed fisheries and marine coastal protection, but none of those commentaries were incorporated into the MCHI itself; i.e. some interviewees believe that having an area under customary management was itself a sign of cultural health and these people said they would be more likely to want to harvest from CPAs because they were more confident that the take would be sustainable. That may well be the case, but governance and management input is in our view not a tangible characteristic of the current state of the stocks themselves. We therefore ignored this as a potential criterion for scoring the MCHI.

Similarly, many interviewees asserted strong convictions of why the ecosystem and cultural health of their mahinga kai were in such a bad state. Many detailed hypotheses, most of which were entirely plausible from marine ecology and environmental science perspectives, were shared (and sometimes debated) by the locals. We very firmly rejected this type of information from inclusion in the MCHI itself because the tool is for monitoring what is happening to mahinga kai, not why. Eventually the kaitiaki will be able to use the long-term database of MCHI measures to test and identify causes for deterioration of cultural health as the first step of identifying optimum interventions to reverse the situation, but its design had to disentangle the two types of knowledge.

Development of this MCHI is one of the latest amongst a gathering number of partnerships between Traditional Ecological Knowledge and science for environmental management. Often the spiritual dimension of the traditional knowledge, in this case the mātauranga of the Ngāi Tahu kaitiaki, clashes strongly with a scientific approach that rests largely on biophysical explanations for how the world works. We have not included overtly metaphysical and spiritual explanations for why management of mahinga kai might or might not be needed, or what will or will not succeed. These exclusions from the design of the MCHI disassociate the tool from fundamental belief aspects of what Fikret Berkes

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95 Environmental managers commonly categorise management options into a Pressure-State-Response framework (Hughes et al. 2004). Pressure identifies what is changing and threatening an area or species; State is the current status of the resource and its resilience or vulnerability; Response is the management action required to counteract the pressures and rebuild the state variables.

96 See Stephenson & Moller (2009) for a synthesis of wide ranging debate of how far such partnerships can go without either the Traditional Knowledge or the science losing its integrity.

97 See Uhlmann & Almstadt (2009) and a reply by Lyver et al. (2009) for consideration of the spiritual dimensions of TEK and effect on partnership with science.
identifies as the three interlinked aspects of Traditional Ecological Knowledge: ‘practice’, ‘knowledge’ and ‘belief’. We fully expect the motivations for use of the toolkit and interpretation of its results to rest in part on spiritual and ethical constructs associated with kaitiakitanga and cultural identity, but these do not affect the scoring rationale or process itself. For example, traditional transfer of breeding stocks of pāua and tuangi included instruction to transport some of the sediment or kelp from the donor site to the release site. Some informants interpreted this in more metaphysical terms as transfer of the mauri (life force) along with the shellfish to assist its establishment in the receiving environment, but we have not considered perception of overarching mauri of the site in the MCHI scoring system.

Some of the interviews included a long list of species that used to be present, so an earlier prototype of the MCHI tested by four communities included the recording of a current species list. We subsequently abandoned collection of the wider species data and instead now just invite the observers to record the top five species they harvested historically and would expect to harvest from the area now or in the future were the site to be restored. This shortens the survey task, opens an opportunity for observers that mainly know about the fishing rather than having wider technical skills in species identification. A predominating component of Western-styled conservation is a focus on “biodiversity”, often measured by a “Species Richness” or a “Diversity Index”. We use the “Cultural Species Richness” as a type of biodiversity index similar to that used by conservation scientists, but in this MCHI case it centres squarely on the variety of foods that are expected or sought from the site, either now or after the site has been restored. This cultural analogue of a biodiversity index may have much wider use in a “biocultural conservation” paradigm, but as far as we can tell, this Ngāi Tahu MCHI will be the first time it is used in any formal indigenous monitoring and management programme.

Overall we were able to capture the general principles described in around 75% of the words coded to tohu from the transcripts (Table 2, Figure 4) and we hope that by dropping some valuable snippets of local knowledge has enabled us to conserve the generalizability and robustness of the scoring system. We have attempted to mitigate this risk by providing supplementary questions relating to more specific attributes in historical benchmark scoring exercises (see Form J in appendix 3). It is recommended that four photos of the reef be taken from the selected assessment point, in each direction, as reference for future assessments. We also provide space for optional written commentaries throughout so that the observers can record more detail for analysis and archiving. The MCHI will therefore act as a vehicle for recording a lot of historical local knowledge, even though those data do not formally enter into the scoring system.

4.3 Standardisation of MCHI scoring to enhance repeatability

The more standardised the actual scoring procedure, the more repeatable the measure will be by surveyors working at different sites or at the same sites in future. The layered approach to scoring

98 Berkes (2008)
99 Bird et al. (2010)
100 See Maffi (2006) for an outline of this new approach to conservation that is more inclusive of the human dimensions of ecosystem health.
individual components of cultural health (guided by the flow charts in Forms D-I in appendix 3) is designed to force more crispness in scoring, say a 2 compared to a 3 for each attribute. The toolkit also requires strict definition of each site. Spatial standardisation provides more direct comparisons of the health of kai species and habitat condition over time.

Despite these precautions the complexity of open marine systems presents a challenging framework and it is inevitable that people will vary in their ability to score cultural health precisely\(^{101}\). Much of the success of the toolkit relies on the competency, knowledge, and experience of the surveyor in relation to the harvest site, as well as the frequency and consistency of the surveys. It is therefore imperative that harvest sites be assessed by individuals familiar with the area (local Tangata Tiaki/Kaitiaki and customary fishers in particular) and that regular training in the smaller details of the scoring system are maintained.

### 4.4 Should the MCHI be considered scientific?

We do not see this toolkit as fully scientific, nor any need for it to justify itself in scientific terms. There is a huge and, in our view, ultimately somewhat futile literature debating the common ground and differences between science and traditional knowledge and especially the labels used for either\(^{102}\). Both are legitimate and valuable knowledge systems in their own right and often are applied to quite different parts of life. Just as there is strong and reliable science, there is strong and reliable traditional knowledge. We have therefore striven to maintain a distinction between scientific rigor and cultural rigor, and to incorporate both into our research process and synthesis. A MCHI developed in a Māori way and based on strong Māori knowledge can legitimately be considered excellent irrespective of whether science considers it rigorous. This is not because we see science and mātauranga as always being equal to the other, or one to always be more powerful than the other in all circumstances and for all types of questions! Indeed, the development of the MCHI is mainly motivated to give voice and effect to cultural knowledge and assist a distinctly Māori community set of goals for their own sake.

Although cultural integrity was our first and overarching design principle, Te Rūnanga o Ngāi Tahu commissioned the development of the MCHI also in part to build trust amongst wider society in Ngāi Tahu ways of managing the inshore ecosystems. It is inevitable that scientific scepticism from many people of whatever ethnicity will lead them to doubt the reliability of the MCHI monitoring methods. We have therefore deliberately designed the tool to be as scientifically defendable and repeatable as possible without losing its primary cultural goals and credentials, and especially without compromising the toolkit’s simplicity and accessibility by requiring expensive measuring instruments or the time and inclination. We rejected several specific indicators that we judged would be too hard to measure

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\(^{101}\) Many commentators confuse ‘precision’ with ‘accuracy’. Science often strives for accuracy, whereas in certain circumstances where indicators are concerned, we are most preoccupied with making the measures precise (relatively consistent and repeatable) rather than an accurate measure of what is actually there.

\(^{102}\) General discussions include: Ingold (2000); Ellis (2005); Stevenson (2005); Agrawal (2009); Dikison (2009); Stephenson & Moller (2009). Specific mātauranga examples from Aotearoa include: Newman & Moller (2005); Don (2010); Lyver & Moller (2010), Moller & Lyver (2010).
repeatedly without a lot of added effort. In practice, Traditional Ecological Knowledge and science are often complementary and can assist each other, as well as offering strong and respectful peer review of the other. The threats and habitat quality indicators accord well with ecological knowledge of marine ecosystem processes, as well as being ‘good common sense’. Similarly, our division of habitat types and the need for a good spread of age classes to demonstrate successful breeding and recruitment are just two examples of the way the design of the MCHI reflects both the interviewee’s knowledge and basic ecological principles. Although the MCHI has been designed primarily from Ngāi Tahu knowledge shared by local Ngāi Tahu experts, and has been created primarily for Ngāi Tahu management, its presents no fundamental challenge to science and scientific inference or methods other than a relaxation of formal measurement.

A fundamental constraint on any scientific use of the MCHI data stems from its use of ‘ordinal’ scores for measuring cultural health. In statistics, ordinal data are ranked along a somewhat arbitrary numeric scale where the exact numeric quantity of a particular value has no significance beyond its ability to establish a ranking over other data points. So if a local pāua population is scored as having a cultural health index of ‘4’ after imposition of a rāhui (restricted access), whereas it was only ‘2’ before the mātaitai Tangata Tiaki/Kaitiaki imposed that rāhui, we should not ever infer that cultural health has now doubled. All we can say is that the health of the pāua is greatly improved and the management intervention has worked because its contribution to cultural health is definitely more than two, and even better than sites scoring a 3. Formally, statistical analysis of ordinal data sets is challenging but can be done rigorously to add scientific credibility to conclusions. We recommend the use of a specialist statistician for preliminary descriptions of pattern and detection of trends once a few years of data are gathered into the MCHI database.

The type of semi-quantified scores used in our MCHI are very much like the “Fuzzy Logic” modelling used by systems engineers to monitor and drive technology. This burgeoning field shows that little loss in reliable knowledge and control of a system stems from the uncertainty in measurements themselves. An obsession with accuracy of measurement in scientific approaches to environmental management is often challenged by traditional Ecological Knowledge holders that place more emphasis on aggregations and responses to what can be considered individually course and scientifically confounded measures.

Observers may be particularly sceptical of the reliability of the historical benchmark scores of the MCHI. Again we stress that the changes wrought over the past 40-50 years to inshore fishing stocks have been huge and the reported changes in the size distribution of the population are logical correlations of

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103 Ordinal scales differ from the ‘interval scales’ that we normally use when counting – the latter are not only ranked in order of size, but also the interval (gap) between the numbers is fixed and measured. So if the MCHI had used an interval scale in the example for pāua restoration after imposition of the rāhui above, we would know that cultural health is twice that before the rāhui, and that the site is exactly one unit better than sites which scored 3.

104 Some of the statistical fishhooks in interpreting these types of data for broad scale sustainability indicator assessments are explored by Hubbard (2009).

105 See Berkes (2008) and Berkes & Kislalioglu (2009).
fisheries decline and overfishing in particular. Descriptions of “bumper to bumper” pāua as are now only seen in deep water patches are graphic and straight forward. Denial of the prior existence of this abundance on rocks within each reach of a wader would go beyond scientific scepticism to cynicism. Nevertheless we urge that the historical benchmark scores are used only very generally as theoretical goals for restoration effort. Natural forces may now preclude attaining such levels again even if improved fisheries management can be achieved.

4.5 Is the MCHI a Māori toolkit?

There can be no doubt that this toolkit is distinctly Māori and strongly nuanced in the tikanga, kawa and mātauranga of Ngāi Tahu in particular. The basis of scoring and reasons for scoring cultural health reflect core Māori values. The study formally demonstrated many strong differences in emphasis of the Māori compared to other interviewees (for example, Figure 9) and much of the discussion covered issues of identity and mana, and the special responsibilities associated with kaitiakitanga. Our sample size was not big enough to statistically compare the emphases of Ngāi Tahu kaitiaki compared to other Māori, besides, such comparisons are problematical when definitions of whakapapa (genealogy) and an overlay of individual histories of the interviewees are considered. The primary emphasis on two “trump indicators” of cultural health (the importance of clean water and healthy kai and the ability for everyone to get a feed relatively easily at low tide) resonates strongly with Māori emphasis on customary harvesting and manaakitanga. We use the ‘Cultural Species Richness’ as a type of biodiversity index similar to that used by conservation scientists, but in this MCHI case it centres squarely on the variety of foods that are expected or sought from the site, historically, now or after the site has been fully restored. Similarly, mātauranga principles have been used to scale other aspects of the Cultural Health Scoring system, especially in the “Is the population replacing itself?” section. There we follow the traditional Māori management approach of focussing on the presence of mature breeders as the primary determinant of reproductive potential of the population. This reflects the principle, repeated several times in the interviews, that leaving the breeding stock and harvesting young or partly grown selfish and fish is a more sustainable strategy than the current “western” or “scientific” approach to fisheries management that normally only allows harvest of the very big or old animals in the population.

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106 Several of the Māori interviewees had shifted to the Ngāi Tahu rohe earlier in their lives and many became active participants in local Māori community endeavours, including fishing and application of kaitiakitanga.

107 These ‘trump indicators’ are given particular emphasis in the way each score is calculated for each species and site. The scores for the other dimensions of cultural health were multiplied rather than added, so they dominate the overall outcome.

108 McCarthy et al. (subm.) and Scott et al. (in prep.) also use the interview material described here for designing the MCHI to outline the loss of the kaimoana and traditional Ngāi tahu management approaches in more detail; Dick et al. (in press) underscores many of the same values and consequences of loss of the inshore fish stocks on Māori communities in North island.

109 See Moller & Lyver (2011) for the underlying principles and the way was often applied throughout Aotearoa.
4.6 Will the MCHI reliably detect changes in cultural health?

We contend that inshore stocks are so depleted compared to former levels that even a semi-quantitative scale can more than adequately capture the difference between now and then, and guide broad scale restoration of a system that is obviously degraded. The toolkit will mainly be used for long term monitoring by communities that are staying put and which are in this for the long haul. Often the same people will be doing the repeated monitoring at fixed sites, so all that is required is a “relative index” of stocks. Wildlife managers distinguish “relative” and “absolute” abundance measures. The actual number of fish residing in an area as measured per square metre, or per plant, or per cubic metre of water are all examples of an absolute measure of abundance. These typically require a lot of expensive effort and usually a formal scientific survey to obtain confident estimates of absolute abundance. But often all that is needed is a “relative index” of abundance where the number of fish seen in a given time frame, or the time taken to get a feed is used as a type of proxy for the full scientific count\(^{110}\). If the same observers are doing such relative scores regularly at the same sites and in a consistent way, they can be very powerful semi-quantitative measures of changing stock abundance. The Rakiura Māori tītī harvesters have kept diaries of muttonbirding success, some since the 1930s, and careful analysis of the diaries corroborates the same rate of population change as detected by five other more short-term population estimators using more formal scientific methods\(^{111}\).

We should be on guard about comparing the relative indices scored by different observers at the same place because of individual idiosyncrasies of each observer and the subjective nature of the scoring system. Similarly, care is needed to compare the score of the same observer for two different places because differences in say seaweed cover or colour at each site might make the pāua harder to see at one of the places\(^{112}\). We should be even more on guard when trying to compare the scores of different observers at different sites because all these potential interference effects could multiply to mislead us.

The main way to reduce the risk of being misled is to gather as many repeated measures by the same team of observers as possible, to form a large team so that a consensus on the stock levels will eventually emerge, and to keep the system going as long as possible. There is strength in gathering lots of numbers from lots of observers to tell a complete story. Ensuring that all surveyors receive an initial toolkit training period and are guided and supervised by an experienced local MCHI monitoring leader (such as Toitū Te Whenua staff) will reduce inconsistency in the way the MCHI is scored. The MCHI has been designed to be as sensitive as possible, especially by focussing on the top ranked species sought from a given site (Figures 7-8). A moderate weighting system has been devised so that up to four other

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\(^{110}\) See Moller et al. (2004) for an overview of the use of catch rates as an index of stock levels, and Richards et al. (in prep.) for those principles applied to pāua in CPAs.

\(^{111}\) Clucas (2011); Clucas et al. (2012).

\(^{112}\) Statisticians and ecologists often have more confidence in ‘repeated measures’ at the same sites in successive periods done by the same observer for reliable detection of trends. As the database archive accumulates, the MCHI should allow increasingly reliable inference by these repeated measures – the key need is to not extend interpretations beyond the limits of the technique, especially in the initial years when data are sparse.
species are considered, and these will to some extent dampen rates of change in the MCHI unless they are restored at the same rate by the management interventions of the kaitiaki.

This combination of (i) large scale change in stocks being monitored, the (ii) long term and (iii) mass nature of the data gathering, together with (iv) a relatively sensitive scoring system leaves us confident that the MCHI will reliably monitor changes in cultural health.

A component of the “Environmental Precautionary Principle” and its analogue, the “Cultural Precautionary Principle”\(^ {113} \) add a further safety margin for restoration guided by simple and semi-quantitative measures like the MCHI. These precautions have been incorporated into how the MCHI is scored in two ways: Firstly we have assumed that if the subtidal and offshore reefs are depleted, so too will the near-shore ones. In fact added fishing pressure from the shore may mean that much more healthy stocks are protected in the deeper water and that these may rapidly reseed the accessible stocks should conditions improve. Stated another way, the situation may not always be as bad as first appears from the shoreline, but at least the kaitiaki will be warned about the risk. Secondly, the way that the “Is the population replacing itself?” component of the MCHI is scored ignores the possibility that recruitment is sporadic and perhaps is provided by areas outside the monitoring site or CPA. A measure of environmental and cultural safety is thereby incorporated by scaling the alerts to a minimum requirement that the stocks are replacing themselves now and from within the same area. Some species, like kōura for example, mix over huge areas and the young ones entering a CPA are almost certainly not produced on that same site\(^ {114} \). Nevertheless the underlying safety margin used is that the harvesting area should at least be providing as many young to disperse into the surrounding “metapopulation” as are needed to replace what is gathered by the people.

4.7 Putting the MCHI into practice

Kaitiaki and Te Tiaki Mahinga Kai researchers will now collaborate with Toitū Te Whenua staff to thoroughly field-test MCHI scoring, site assessments, data collection, and follow-up initiatives to ensure that the toolkit meets the needs of Ngāi Tahu communities. Ideally, each community shall form a MCHI committee (e.g. the mātaitai or taiāpure committee in those areas), to select quality monitors, review results of site assessments and plan follow-up activities to improve their environment’s health. This committee, which would be inclusive to all interested community members, would ensure that the MCHI process is guided by the community collectively, rather than a few individuals. Some overall considerations for setting up a robust design of the overall surveying programme is given in the MCHI Instructions in Appendix 3.

We recommend that the MCHI be thoroughly reviewed and if necessary modified as soon as around 100 individual MCHI surveys have been reported. It is important that a wide variety of surveyors, habitats and locations are used for these tests so that the final design can be bedded down as soon as possible. Adjustment of the way the overall aggregated site MCHI is calculated can follow later to fine-tune its

\(^ {113} \) Akins et al. (in prep.)
\(^ {114} \) Morton & Miller (1973), Morton (2005).
sensitivity\textsuperscript{115}, but it is important that the methods used to score each component part of the MCHI are fixed as soon as they are checked to be fully workable for all participants in the monitoring programme.

The selection of the monitoring sites will obviously be based on the objectives the community set for the monitoring (e.g. the monitoring a particular activity at a given site versus a ‘State of the Takiwā’ snapshot of the entire rohemoana) and local knowledge of traditional fishing grounds and so on. Some questions to consider for the selection of sites include:

- Should only fixed sites be selected based on mātauranga or local knowledge or should some random sites be identified in a stratified way also?
- Should replicate sites be surveyed? This may add more robustness and defendability to the data but it will decrease the rapidness of the tool.
- Should ‘control sites’ be surveyed?
- Should sites cover a comprehensive coverage of all habitat types or all strata?

Some questions to consider for the selection of potential surveyors include:

- How are the surveyors chosen?
- Who will select the surveyors?
- Are there certain qualifications and/or selection criteria that the surveyor must meet?

The very best surveyors should have a historical relationship with the site, preferably having harvested in this site for several years. If the MCHI is to maintain the confidence of the community and be considered reliable, surveyors should also be a well-respected individual in the community, with familiarity of the community’s local harvest areas as well as familiarity with the community’s key concerns and standard harvest experiences. They should have an understanding of the predominant species harvested in the assessment sites. Most of all they need to be practising harvesters, or in the case of people filling in an historical benchmark survey, to have been active harvesters back then. The MCHI cannot be reliably scored by someone who is not or was not in the water regularly and observing the abundance and health of the stocks and habitat as they were gathering.

Communities also need to consider how surveys will be conducted. The MCHI can be implemented at different levels of intensity. The surveys can be conducted from memory as a passive, perception-type survey (using the last time the surveyors fished the site for example), the surveyors can fish (using the appropriate customary methods preferably or more contemporary methods may be appropriate too) and then complete the forms and coupled with this fishing the surveys may also incorporate the work of science providers (surveying population numbers, water testing or flesh testing for contaminants) to assist with completing the MCHI. Each community must figure out what methodologies will work best for them. Whatever way the MCHI is implemented this must repeated each time.

\textsuperscript{115} A similar retrospective adjustment was made to the way the Ngāi Tahu Stream Cultural Health Index is calculated.
Several questions should be considered too regarding the frequency, consistency, and accuracy of site assessments, to ensure correct and most beneficial use of the toolkit. Such questions include:

- How often will each site be surveyed?
- How many surveyors will conduct each site assessment?
- How will surveyors ensure that they are assessing the site from the exact same location each time?
- Will individual observers score the MCHI independently of each other?\(^\text{116}\)
- How will the community ensure that surveying is frequent and consistent?

Surveying needs to be frequent enough and over a long enough period of time to detect real change as opposed to short term fluctuations\(^\text{117}\). While the frequency and duration of the surveying depends on each site, community capacity, the methods used and the mātauranga for when sites should be fished, we hope that communities survey on a quarterly basis (every three months), for a minimum of 10 years. The more records the better.

The initial phase of these assessments is the most crucial, in order to create a standardised and maintained system and to create a firm baseline of the site’s health in all seasons and conditions. Thus, we recommend that, for the first year, increased support, time and energy is invested into the assessments, to accurately conduct multiple and frequent assessments at all key sites of interest to the local community. Future less frequent measures of the MCHI can then be more firmly benchmarked against the current state of the mahinga kai to determine whether cultural health is declining, being maintained or are restoring.

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\(^{116}\) Statistical confidence in the results comes from lots of different people making up their own mind about how healthy a site now is (or was in the past if an historical benchmark survey is being recorded). We anticipate that groups of kaitiaki will visit sites at the same time and encourage that at first they trial the methods and discuss the results so they become confident that they are all scoring the MCHI in about the same way. However, after that trial period the scores must be derived independently of one another if each person’s testimony is going to be given equal weight. Statisticians refer to this as gathering “independent” data and ensure that it happens to avoid “pseudo-replication”.

\(^{117}\) See Abbot and Guijt (1998) and Wagner (2005) for examples of how short term variation can trip up interpretation and management.
Figure 16. Changing emphases in a long-term MCHI monitoring plan

Site assessment is only the first step towards a successful MCHI. What one does with the data will determine how the site’s cultural health will improve in the future. Thus, several questions need to be considered, to ensure the findings’ recommendations are fruitful, that the data are reviewed, and that actions are in place to improve the site’s health. Such questions include:

- How and when will the data be reviewed?
- If the assessment findings provide obvious red-flags or failures, what will the community do to improve these? Follow-up actions can be facilitated easier in CPAs than outside in ‘open’ fisheries.
- How will the findings be properly archived?
- How will the findings be conveyed to Government agencies, other interested parties, partners, and funders?
- Will there be a dialogue between the community and traditional knowledge gathered from the site assessments and scientific surveys also conducted in the area? If so, when and how? How can these improve overall assessment of the site’s health, and which collaborators will be involved? How will culturally sensitive material be safeguarded?

Once 3-5 years of repeated assessments are in place at each site, we recommend conducting a review of the estimated variance in indicators as well as a formal statistical “power analysis” to measure the probability of detecting a decline in cultural health given the communities current level of monitoring.
using the MCHI. We cannot confirm the sensitivity of the scales, nor estimate their temporal and spatial variance until the MCHI monitoring programme is well underway. Thus, until these conditions are measured we cannot advise on the ability to monitor trends. It may therefore be valuable to review the toolkit’s design as well as each site’s findings every four to five years, to monitor trends and adjust sampling effort to ensure that the kaitiaki are aware of threats and can adjust their management intensity.

4.8 Will the marine Cultural Health Index toolkit make a real difference?

This project aimed to develop an MCHI toolkit to help Ngāi Tahu monitor the health of their Mātaitai, Taiāpure and other harvest areas in order to make informed management decisions for their mahinga kai. Of paramount importance for the success of this project was the establishment of a working relationship amongst research members, Ngāi Tahu and community groups. To help analyse the relative success of the project thus far, we gauge the performance of the project so far against a set of seven criteria for success identified in an international review of toolkits designed for community-based monitoring. Only one of the 15 internationally reported studies fulfilled all seven criteria – a toolkit that works with communities in the Pacific and Indian Ocean on locally-managed marine areas. We summarize below how the development of the Ngāi Tahu MCHI toolkit already meets the first five criteria, and argue that it is also very likely to meet the remaining two once it is fully operationalized.

1) Does the community contribute to indicator selection and are the selected indicators locally relevant?

The indicator list and subsequent development of the monitoring toolkit was entirely derived from local knowledge. The 100 informants involved in this study were all located near potential and culturally important monitoring sites. Each interviewee proclaimed a vested interest in the state of in-shore local fisheries and it was obvious from the often animated and passionate kōrero that they keenly care about their local environment and how better to manage it. While the majority of informants in this study were of Ngāi Tahu Māori descent, a diverse range of community members were approached in order to obtain a more comprehensive variety of indicators relevant to both traditional Māori knowledge and local knowledge. Both Ngāi Tahu taiāpure and many of their mātaitai are managed on a cross-cultural

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118 This review was done Landesberg (2012), a student in the Te Tiaki Mahinga Kāi research team.
partnership basis to incorporate the knowledge and elicit collaboration with the locals and other cultures, so it is appropriate that some non-Māori informants were included.

2) Were trade-offs between scientific rigor and simple monitoring methods for non-trained scientists acknowledged?

Parts of this report, and especially the preceding section of discussion, reflect our wish to maintain a distinction between science and mātauranga (Traditional Ecological Knowledge). This report is probably much fuller than most users of the MCHI will wish to read, but we considered it necessary to record the rationale of the MCHI design to allow the debate about its uses and constraints to be open and rigorous.

3) Is the information gained shared transparently among all community members and does the community feel ownership over the monitoring process?

The research team has engaged in multiple meetings with Ngāi Tahu to discuss the scope and direction of the project. The development of the toolkit was envisioned by Ngāi Tahu as a tool to be used in conjunction with other environmental assessment methods for Ngāi Tahu use, including some ecological surveys deployed by trained community members. Ngāi Tahu has complete ownership of the MCHI toolkit, its regularity of use, and its monitoring scheme. There may be some aspects of cultural knowledge at a few sites that must be protected from public disclosure and the surveyors may have shared that information only on the condition that is kept safe and accessed only by cultural experts and managers on an as-needs basis. Nevertheless it is expected that virtually all the data gathered will be actively used to guide restoration of cultural health and that at least some of this must be shared if external agencies and other parties are indeed going to take heed of the information and help the restoration effort.

4) Is the information gained from the monitoring used and are the objectives for the monitoring achievable with the funding available and within the set time frame?

These questions cannot be fully addressed until the later stages of this project once a monitoring framework has been implemented. The answer will depend on whether surveyors continue operating on a voluntary basis, whether communities successfully apply for funding should it be needed, and which strategies each community pursues regarding follow-up methods of their site assessment results. Although it is too early to say for sure that the MCHI will be taken up, we expect that it will indeed be used in a lot of communities and for a long time. Partly our confidence stems from the participatory and detailed way that it has been generated, so that there will presumably be a strong sense of ownership of their own tool that they co-created with the scientists.

5) Are the rights over the natural resource/area clear and has the community the opportunity to manage these resources/areas?

As a result of the ‘Sealord Deal’, the Treaty of Waitangi Fisheries Claims Settlement Act 1992, customary fishing regulations were developed to recognise and provide for customary non-commercial fishing rights. The subsequent establishment of CPAs within the Ngāi Tahu Whanui Takiwā give Ngāi Tahu a
greater voice in the management of their traditional harvest areas\textsuperscript{120} and rapid spread of the mātaitai in particular suggest that this will occur throughout most Te Wai Pounamu coastal regions (Figure 1).

Taiāpure differ from mātaitai mainly by allowing commercial fishing. Both nominate local experts that advise the Minister responsible for Fisheries on fishing rules to control all types of fishing within the local area. Such rules include the management of customary food gathering in line with local sustainable management practices, among others. The reserve managers may also issue customary food gathering authorizations\textsuperscript{121}, as well as request temporary harvest bans in accordance with the section s186B Temporary Closure provisions of the Fisheries Act (1996). Therefore the legislative warrants are in place to follow-through actions indicated as needed by the MCHI. Nevertheless most of the CPA work in a cross-cultural and deep community partnership model, so we expect the MCHI to be mainly contributing to a community consensus building function rather than justifying new rules that are wholly imposed on a local community.

Local marae act as meeting places, learning centres and parliaments for group decision making about local area management. A strong local infrastructure supported from central iwi level stands behind local kaitiakitanga. We therefore expect the MCHI to be just one ingredient of an overall toolbox for culturally and community directed restoration of inshore fisheries.

6) Are costs and benefits outlined clearly to the communities and do the benefits outweigh the costs?

Aside from an initial investment of funds by Ngāi Tahu to allow the University of Otago research team to develop this toolkit, the financial costs of field testing and refinement and especially on-going monitoring are relatively small. No expensive dive gear, scientific equipment, or scientific procedures are required except when using the toolkit in tandem with scientific surveys. Costs should remain minimal, and may only include transportation, time, and printing of documents. After the initial survey is completed by each surveyor at each site, the time necessary to conduct repeat surveys will be considerably reduced. The first survey will take approximately 1 hour to conduct; all repeat surveys should take approximately 20-30 minutes to conduct. The community monitoring for learning how to restore marine ecosystem health is in essence a “Participatory Action Research” and culturally embedded ‘Citizen’s Science’ exercise that has now become more structured and faster through the application of the MCHI toolkit\textsuperscript{122}.

The benefits of regularly using this toolkit include but are not limited to a rapid and repeatable health assessment of locally important marine harvest sites; the encouragement of community level

\textsuperscript{120} Te Rūnanga o Ngāi Tahu (2007)

\textsuperscript{121} Ministry for Primary Industries (2009)

\textsuperscript{122} Participatory Action Research frameworks resonate well with Māori community approaches to co-management of research and the ‘practice’ component of Traditional Ecological knowledge (Moller et al. 2009). Citizen’s Science is rapidly rising as a reliable tool for environmental monitoring around the world (Hand 2010), and this MCHI and the whole Ngāi Tahu State of the Takiwā programme is a remarkable and inspiring example of the same principles in action.
participation in resource assessment, monitoring, and management; the ability for individuals at the community level to see local assessment results benchmarked against a summary of results from elsewhere in the Ngāi Tahu takiwā; the implementation of adaptive co-management strategies (learning by doing); and the guidance of stock restoration efforts as mātaitai and taiāpure test the effectiveness of new fishing rules.

7) **Does the toolkit ensure that monitoring occurs after the initial setup phase?**

Success of long-term monitoring ultimately depends on the commitment and decisions of each community involved, and that in turn will be determined by whether the MCHI provides benefits and empowers kaitiakitanga. Solid iwi-level support mechanisms have been put in place by Toitū Te Whenua to support community action and application of kaitiakitanga. Two fulltime workers maintain regular hui and support networks, training programmes and close relationships with the customary fisheries managers throughout the Ngāi Tahu takiwā. The central role of data collation and summary in a Ngāi Tahu central database also future-proofs maintenance of the data streams and provision of feedback to the participating communities of the very best kind – the provision of summaries of the data to demonstrate the value of the monitoring for guiding the real restoration work. A long-term Ngāi Tahu commitment to a unified network of CPAs has already put more of New Zealand’s inshore fisheries under customary fisheries protection measures in a decade than is currently protected by the Marine Reserve network. The MCHI toolkit is therefore integrated into a widespread and reasonably well resourced and long term management framework, and so there is little danger of it languishing unused in the community storeroom!

Finally, the main reason for our confidence that the toolkit will be used comes from listening to over 150 hours of passionate testimony by 100 locals and the grief that they feel for the current state of some of the mahinga kai. They want to restore local stocks for all sorts of cultural identity and spiritual reasons and many are extremely frustrated with the current health of the mahinga kai. Many expressed broad scale scepticism that “western” fisheries science could adequately protect their heritage and eagerly anticipated arrival of a non-technical tool to claim back local monitoring and management to put right a deeply troubling situation: the degradation of their mahinga kai and its cultural consequences.

*Mō tātou, ā, mō ngā uri a muri ake nei*

*For us and our children after us*
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6 Appendix

6.1 Appendix 1 - Glossary

Table 4. Māori terms, plant and animal names

<table>
<thead>
<tr>
<th>Key Kupu</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Aotearoa</td>
<td>New Zealand</td>
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<tr>
<td>Hapū</td>
<td>Sub-tribe; kinship group</td>
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<tr>
<td>Hui</td>
<td>Meeting; to gather or congregate</td>
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<tr>
<td>Iwi</td>
<td>Tribe</td>
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<tr>
<td>Kai</td>
<td>Food</td>
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<tr>
<td>Kaimoana</td>
<td>Seafood</td>
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<tr>
<td>Kaitiaki</td>
<td>Custodian; guardian; minder; keeper</td>
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<tr>
<td>Kaitiakitanga</td>
<td>Guardianship</td>
</tr>
<tr>
<td>Karakia</td>
<td>Prayer; to recite ritual chants</td>
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<tr>
<td>Kaumātua</td>
<td>Respected elder</td>
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<tr>
<td>Kōrero</td>
<td>Discussion</td>
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<tr>
<td>Kōura</td>
<td>Crayfish; rock lobster; Jasus edwardsii</td>
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<tr>
<td>Kutai</td>
<td>Greenlip mussel; Perna Canalicula</td>
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<tr>
<td>Mahinga kai</td>
<td>The practice of customary food gathering, the places where food is collected and the resources themselves</td>
</tr>
<tr>
<td>Mana</td>
<td>Prestige; authority; spiritual power; control; status</td>
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<tr>
<td>Manaaki</td>
<td>Support; take care of; provide hospitality to people</td>
</tr>
<tr>
<td>Manaakitanga</td>
<td>Hospitality, especially shown to visitors</td>
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<tr>
<td>Māori</td>
<td>Native/indigenous people of New Zealand</td>
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<tr>
<td>Marae</td>
<td>Traditional Māori meeting place</td>
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<tr>
<td><strong>Mātaitai</strong></td>
<td>An identified traditional fishing ground which has special status under the Fisheries Act 1996 to protect customary fishing rights and values</td>
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<tr>
<td><strong>Mātauranga</strong></td>
<td>Māori knowledge</td>
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<tr>
<td><strong>Mauri</strong></td>
<td>Life force; spiritual essence</td>
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<tr>
<td><strong>Moana</strong></td>
<td>Sea; ocean; large lake</td>
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<tr>
<td><strong>Moki</strong></td>
<td>Blue-grey and silver fish of shallow coastal waters; Latridopsis ciliaris</td>
</tr>
<tr>
<td><strong>Mokopuna</strong></td>
<td>Grandchildren</td>
</tr>
<tr>
<td><strong>Pākehā</strong></td>
<td>Person of non-Māori or more generally European descent</td>
</tr>
<tr>
<td><strong>Papatūānuku</strong></td>
<td>Earth mother and wife of Rangi-nui (Sky Father)</td>
</tr>
<tr>
<td><strong>Pātiki</strong></td>
<td>Flounder; flatfish; Rhombosolea spp.</td>
</tr>
<tr>
<td><strong>Pāua</strong></td>
<td>Abalone; Haliotis spp.</td>
</tr>
<tr>
<td><strong>Rāhui</strong></td>
<td>To put in place a temporary prohibition, restriction or harvest ban</td>
</tr>
<tr>
<td><strong>Rangatiratanga</strong></td>
<td>Chieftainship; right to exercise authority; self-determination</td>
</tr>
<tr>
<td><strong>Rāwaru</strong></td>
<td>Blue cod; Parapercis colias</td>
</tr>
<tr>
<td><strong>Reo</strong></td>
<td>Language; dialect; speech</td>
</tr>
<tr>
<td><strong>Rohe</strong></td>
<td>Tribal area, tribal territory</td>
</tr>
<tr>
<td><strong>Rohe Moana</strong></td>
<td>A coastal or marine area over which an iwi or a hapu exercises its mana and its kaitiakitanga</td>
</tr>
<tr>
<td><strong>Rongoa</strong></td>
<td>Medicinal plant</td>
</tr>
<tr>
<td><strong>Taiāpure</strong></td>
<td>Areas that are given species status to recognise rangatiratanga (as Taiāpure-local fisheries).</td>
</tr>
<tr>
<td><strong>Takiwa</strong></td>
<td>Tribal district synonymous with rohe.</td>
</tr>
<tr>
<td><strong>Tangata</strong></td>
<td>Person</td>
</tr>
<tr>
<td><strong>Tangata Kaitiaki</strong></td>
<td>Individuals or groups who can authorise customary fishing within their rohe moana, in accordance with tikanga Māori.</td>
</tr>
<tr>
<td><strong>Tangata Manaaki</strong></td>
<td>Support and caring for the people</td>
</tr>
<tr>
<td><strong>Tangata Whenua</strong></td>
<td>People of the land</td>
</tr>
<tr>
<td><strong>Tangi</strong></td>
<td>Funeral</td>
</tr>
<tr>
<td><strong>Taonga</strong></td>
<td>Treasure; property; possessions</td>
</tr>
<tr>
<td><strong>Tarakihi</strong></td>
<td>Silver marine fish; Nemadactylus macropterus</td>
</tr>
<tr>
<td><strong>Te Reo</strong></td>
<td>Māori language</td>
</tr>
</tbody>
</table>

Te Tiaki Mahinga Kai · New Zealand · Ngāi Tahu Marine Cultural Health Index
<table>
<thead>
<tr>
<th>Tikanga</th>
<th>Correct procedures; custom; cultural protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tio</td>
<td>Oyster; Tiostrea lutaria</td>
</tr>
<tr>
<td>Titī</td>
<td>Sooty shearwater; Mutton bird; Puffinus griseus</td>
</tr>
<tr>
<td>Tohu</td>
<td>Environmental indicator</td>
</tr>
<tr>
<td>Tuaki; Tuangi</td>
<td>Endemic bivalve; Austrovenus stutchburyi. Known commonly as cockes.</td>
</tr>
<tr>
<td>Tuna</td>
<td>Eel; Anguilla spp.</td>
</tr>
<tr>
<td>Waiata</td>
<td>Traditional Māori songs; chant; psalm</td>
</tr>
<tr>
<td>Whānau</td>
<td>Family</td>
</tr>
<tr>
<td>Whānui</td>
<td>Be broad; extensive; wide</td>
</tr>
</tbody>
</table>
### 6.2 Appendix 2 – Indicator list

Table 5. Description of each of the top 30 indicators as ranked using ‘total words coded’ and ‘number of interviewees mentioning each indicator’.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
<th>Total words coded</th>
<th>Number of interviewees mentioning indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>General abundance of kai (is there enough to get a feed?)</td>
<td>A high abundance of one or more taonga species (enough to consistently get a feed) usually harvested in the area, is an indicator of good ecosystem health. Many interviewees complain of a general decrease of kai abundance during the course of their lifetimes.</td>
<td>13402</td>
<td>56</td>
</tr>
<tr>
<td>Taste and condition of kai.</td>
<td>The condition of various kai species, especially shellfish, is an indicator of overall ecosystem health. Condition is determined by taste, presence of worms / parasites, and for shellfish, a high flesh to shell ratio indicates good ecosystem health.</td>
<td>5302</td>
<td>34</td>
</tr>
<tr>
<td>Age / size structure of kai (are there breeding stock and a healthy range of sizes?)</td>
<td>Lots of large individuals within a species indicate a healthy breeding stock and greater chance of population stability, while a good distribution of sizes indicate a healthy kai population. Many interviews talk of a significant reduction of large kai individuals over the past 40 years.</td>
<td>4735</td>
<td>35</td>
</tr>
<tr>
<td>Recruitment (is the kai replacing itself?)</td>
<td>Regular recruitment indicates a healthy population. A large number of juveniles mean a greater chance of population stability.</td>
<td>4608</td>
<td>19</td>
</tr>
<tr>
<td>Pāua numbers</td>
<td>Pāua came through as the most discussed single species among interviewees. 23 interviewees also consider pāua as an indicator species, reflecting the health of their ecosystem. There were several accounts by interviewees of pāua depletion, having to travel further to gather pāua and a loss of large individuals.</td>
<td>4295</td>
<td>23</td>
</tr>
<tr>
<td>Harvest success (how long does it take to get a feed of kai?)</td>
<td>The length of time it takes to gather/fish/harvest kaimoana is an indicator of ecosystem health. Interviewees complain of having to wait much longer to gather a feed than in previous years.</td>
<td>4049</td>
<td>30</td>
</tr>
<tr>
<td>Pollution - sewage</td>
<td>The presence of sewage indicates that an area is not suitable for harvest. Interviewees typically use smell or a visual inspection of the water ways to assess a harvest area for sewage contamination. Some interviewees also look for signs of nearby swage outlets and septic tanks before deciding whether to harvest an area.</td>
<td>3731</td>
<td>32</td>
</tr>
<tr>
<td>Presence and absence of kai (have the fish disappeared?)</td>
<td>The absence of a once regularly harvested species from a site indicates either poor ecosystem health or overfishing.</td>
<td>3528</td>
<td>29</td>
</tr>
<tr>
<td>Category</td>
<td>Description</td>
<td>Code</td>
<td>Rank</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>Sedimentation</td>
<td>High levels of sedimentation, siltation and gravel deposition affects the harvestability of an area. In particular, interviewees alluded to high smothering sediment loads reducing the available habitat for shellfish growth, fouling up reefs and blocking light for kelp growth. Interviewees state that sediment loads are affected by swell, wind, erosion, dredging and may be carried down by rivers.</td>
<td>3473</td>
<td>23</td>
</tr>
<tr>
<td>State of nearby river</td>
<td>Rivers have the potential to transport pollutants from the land to mahinga kai areas. The health of a nearby river (as determined by its smell, colour, clarity and type of surrounding land use) is an important indicator of mahinga kai health in the receiving area.</td>
<td>3064</td>
<td>24</td>
</tr>
<tr>
<td>Finfish numbers</td>
<td>A high abundance and diversity of finfish indicates a healthy ecosystem. Interviewees state how finfish numbers have depleted in certain areas.</td>
<td>2976</td>
<td>27</td>
</tr>
<tr>
<td>Water - quality / clarity</td>
<td>Murky, discoloured or smelly water deters several interviewees from harvesting an area.</td>
<td>2502</td>
<td>26</td>
</tr>
<tr>
<td>Species diversity</td>
<td>Interviewees complain of reduced biodiversity, particularly of species of finfish in certain harvest areas. They attribute the reduction of biodiversity to overfishing and adverse climate changes.</td>
<td>2373</td>
<td>26</td>
</tr>
<tr>
<td>Presence of dolphins</td>
<td>The presence of dolphins in certain areas may indicate a healthy finfish population. Some interviewees claim that regular dolphin sightings in an area usually means a healthy and abundant hunting ground.</td>
<td>2188</td>
<td>10</td>
</tr>
<tr>
<td>Algal bloom</td>
<td>Eight interviewees described algal blooms as potential threats to the health of in-shore harvest areas. Some recall accounts of blooms 'wiping out' whole pāua and salmon populations.</td>
<td>2148</td>
<td>8</td>
</tr>
<tr>
<td>Invasive species</td>
<td>Invasive marine species have the potential to outcompete local species for resources and change the ecology of areas, thus potentially affecting the harvestability of an area.</td>
<td>1814</td>
<td>13</td>
</tr>
<tr>
<td>Intertidal access</td>
<td>The ability to consistently gather a feed at low tide is an indicator of good ecosystem and harvestability health. Several interviewees describe how they must now travel further out to sea, or now require expensive dive gear to harvest kai.</td>
<td>1636</td>
<td>16</td>
</tr>
<tr>
<td>Kōura (crayfish) numbers</td>
<td>High crayfish abundance indicates a healthy and well managed habitat. Interviewees talk of severe depletion of crayfish numbers during the 1970s, but recent observations suggest that crayfish numbers are in recovery.</td>
<td>1370</td>
<td>16</td>
</tr>
<tr>
<td>Seaweed</td>
<td>The health, condition, and biomass of seaweed, especially kelp, is an indicator of ecosystem health and productivity (for areas where kelp usually resides).</td>
<td>1236</td>
<td>14</td>
</tr>
<tr>
<td>Growth rate</td>
<td>Stunted growth has been observed for pāua in certain areas. Stunted growth deters some interviewees from harvesting these areas is indicates 'some sort of</td>
<td>1136</td>
<td>8</td>
</tr>
<tr>
<td>Fishing pressure trends</td>
<td>A change in fishing pressure in a particular area over a time-scale of years gives an indication of the amount of harvestable kai left in that area. When the number of fishing vessels drops off in an area, it usually means local resources have dried up.</td>
<td>1125</td>
<td>7</td>
</tr>
<tr>
<td>Pātiki (flounder) numbers</td>
<td>13 interviewees use the abundance of pātiki as a gauge for ecosystem health. A reduction in pātiki numbers is usually attributed to either overfishing.</td>
<td>1097</td>
<td>13</td>
</tr>
<tr>
<td>Tidal flow / flushing</td>
<td>Stagnant water or poor tidal flushing potentially indicates an unhealthy ecosystem due to 'sludge' build up.</td>
<td>1041</td>
<td>8</td>
</tr>
<tr>
<td>Abundance / variety of shells on beach</td>
<td>A greater variety and abundance of shells washed up on sandy beaches may indicate a healthier ecosystem.</td>
<td>1031</td>
<td>5</td>
</tr>
<tr>
<td>Red cod numbers</td>
<td>Interviewees talk of the disappearance of red cod from many harvesting sites, especially those north of Otago over the last 30 years. They see the reduction in red cod numbers as an indication of climate change, water temperature change and/or over fishing.</td>
<td>977</td>
<td>11</td>
</tr>
<tr>
<td>Pollution - man made rubbish</td>
<td>The amount of litter along a beach indicates the level of community appreciation for their local marine resource.</td>
<td>926</td>
<td>9</td>
</tr>
<tr>
<td>Community health through harvest</td>
<td>The ability to regularly harvest an area is an indication of both ecological and community health and wellbeing.</td>
<td>836</td>
<td>4</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>An overabundance of some green algae, in particular blue-green algal blooms or sea lettuce indicates high rates of eutrophication.</td>
<td>827</td>
<td>9</td>
</tr>
<tr>
<td>River mouth</td>
<td>Greasy' thick water, foam and slime present in nearby river mouths are indicators of an unhealthy river and may act as a harvesting deterrent.</td>
<td>820</td>
<td>6</td>
</tr>
<tr>
<td>Water - temperature</td>
<td>Some interviewees attribute a change in water temperature to the disappearance of particular species from harvest areas, including red cod.</td>
<td>631</td>
<td>9</td>
</tr>
</tbody>
</table>
Ngāi Tahu

Marine Cultural Health Index

2013 Manual
# Table of Contents

1.0 INTRODUCTION  

1.1 SETTING UP A MARINE CULTURAL HEALTH MONITORING PROGRAMME  
  Deciding on goals  
  Marine Cultural Health Index or scientific surveys?  
  Where should we monitor?  
  How many sites should we monitor and how often?  
  How many people do we involve?  
  Surveyor Training  
  How should the field surveys be conducted?  
  How long will this take?  
  How big should each survey site be?  
  What do we do with the data afterwards?  
  Who gets to see the data later?  

2.0 SCORING INSTRUCTIONS  
  Assessment of benchmark state  
  Filling out the forms  
  Submission  

Te Rūnanga o Ngāi Tahu 2013
1.0 Introduction

This Marine Cultural Health Index (MCHI) will help monitor and guide management of the Ngāi Tahu rohe moana. Thank you for contributing your time and knowledge. For more information regarding the MCHI monitoring toolkit, please refer to the full-length report entitled, Development of a New Zealand Marine Cultural Health Index (MCHI) to assist sustainable management of mahinga kai.

1.1 Setting up a Marine Cultural Health Monitoring programme

A mixture of community monitoring using the MCHI and scientific surveys will allow you to better protect and restore your rohe moana and provide food for your whānau and manuhiri.

First up, decide on your goals!

How much and where you should monitor depends on what you and your whānui want to achieve.

- Many of you may want to restore the kai in your most important gathering sites
- If you have established Customary Protection Areas (CPAs) like tairāpure, mātaitai, and rāhui, you may want to check cultural health in these areas and track whether your new management rules are accomplishing what they set out to do
- Maybe you want your nohoanga sites to be monitored
- Perhaps a new threat (e.g. pipeline discharge) has arrived and you would like to track its impact on the surrounding area
- You may plan a ki uta ki tae approach, matching your marine cultural health monitoring on the coast to key inland monitoring, using other State of the Takiwā tools, upstream from where the water enters your estuary
- Or, if you want to monitor the overall health of your coastal area, you’ll need to consistently monitor specific sites throughout your rohe

How about getting together to form a community team, rank your priorities, and assess your available time, money and volunteers, to tackle your most important goals?

Should we use the Marine Cultural Health Index or science surveys?

The MCHI allows everyone to contribute: young and old, divers and those who prefer drier ground, Māori and Pākehā. If some of your community’s elders, who remember what your sites used to look like, fill in the MCHI forms, you can begin setting targets for restoration.

However, many people who make decisions about the marine and coastal environment will have more faith in scientific surveys than our MCHI and State of the Takiwā monitoring. Additionally, there are some parts of marine systems that are too hard to monitor effectively with the MCHI monitoring toolkit. So, it would be great if you set up some simple scientific surveys – they don’t need to be rocket science – to run alongside the MCHI monitoring system, so they can be benchmarked against one another. Contact Joe Wakefield from Toitū Te Whenua if you want to do some science. He’ll help connect you to a science support team.
The rest of this document will focus on establishing the best possible MCHI monitoring programme.

**Where should we monitor using the MCHI?**

Please choose a site (or better yet, several sites) on your coast or estuary where you wish to report past and present cultural and environmental health. Go where your goals dictate. Presumably, your community will usually choose to monitor at traditional kai gathering sites, but sometimes it will be worth adding other sites as well, to help you figure out why your ecosystems are changing. Use your local knowledge.

For example, if you want to guide your CPA regulations, set up monitoring sites in each of the main habitat types in your mātaitai or tāiāpure, then choose a few examples of some habitats outside the mātaitai or tāiāpure. That way you can compare what happens when your community imposes a rāhui in the mātaitai, for example, with what’s happening outside.

If your goal is to monitor the impact of a new discharge, choose some MCHI sites right next to the pipe, as well as others far away in similar habitats.

If you are concentrating on a particular estuary or harbour, spread your monitoring sites between the top and the bottom of the area, to reflect the ecological changes at each end.

If you want to monitor what’s happening throughout your rohe, spread your MCHI monitoring sites evenly throughout your entire rohe, a good distance apart. You might nominate a couple of sites in each estuary, harbour, sandy beach, or rocky shore. The Rolls Royce model would be to maintain a baseline matrix of monitoring throughout your area, and then top it up with more specific monitoring at particular sites when a new problem or opportunity arises (like the arrival of that new dairy farm).

**How many sites should we monitor and how often?**

The more sites you monitor and the more times you go back to track changes, the better! But be realistic, and mould the size of the sampling programme to your resources and the urgency of your management needs. The MCHI works best for monitoring shifts in cultural health by consistent and repetitive sampling over several years. Always try to get a “before” versus “after” picture of changes, by scoring the MCHI consistently at the exact same sites, using the exact same effort (fishing gear, time, number of people, etc.).

**How many people do we involve?**

Again, the more the merrier! However, having your most experienced customary fishers or Tangata Tiaki/Kaitiaki would obviously be beneficial. The MCHI is a bit subjective, so we can gain more confidence in the scores’ trends, or how they vary from one place to the next, by receiving scores from several people. By all means, compare notes with each other when you are first training to score the sites, but after that, it is important that each surveyor completes his/her own scoring. No peeking at your neighbour’s scores, even if you all go out together to share a kai after you’ve completed the survey!
Training to get everyone on the same page

The MCHI is a bit subjective, so we expect each surveyor to score it slightly differently. Ultimately, that doesn’t matter too much, provided each person stays consistent in his/her own standards, and that we receive scores from lots of people with lots of repeated samples. That being said, the more your surveyors can score consistently and similarly, the more reliable the MCHI will be. We thus urge your community to run a training session to explain the rules and the need to following them. Talk to Toitu Te Whenua to arrange for an experienced MCHI surveyor to show you the ropes. Whenever new volunteers come on board, make sure an experienced member of your team accompanies them on their first expeditions.

How should the field surveys be conducted?

The MCHI can be implemented at different intensity levels. You can fill in the forms from your memory (using the last time you fished, for example) or you can fish (preferably using customary methods, but more contemporary methods may be appropriate as well). While completing the forms, you may want to conduct some more formal science as well (surveying population numbers, water testing, or flesh testing). Toitu Te Whenua can help facilitate this scientific input.

How long will this take?

We reckon we need 10 minutes from you at the very start, for you to fill in the Surveyor Information Form (Form A). Then, when your community goes to a site for the first time, you will need to spend another 5-10 minutes to record its general characteristics (Form B). If several members from your community are monitoring the same site, only one of you needs to fill in the Site Characteristics Form for that place.

Your community might decide to establish a map of the whole rohe where your sites have been established. You could then give each site a name, and delegate these initial site descriptions to various members of your community, to share the burden.

From then on, each surveyor needs to spend 20-30 minutes filling in the scoring sheets every time he/she visits each site. The time spent at each site will of course vary, depending on whether or not you fish prior to filling in the forms.

How big should each survey site be?

Each survey site should span 50 m x 20 m. The site should stretch 25 m to either side of the surveyor along the shoreline, as well as 20 m into the ocean or estuary from the high-tide mark. If you wish to survey a larger area than this, feel free! You will just need to divide the area into multiple sites of this dimension to do so, and conduct separate surveys for each plot.
What do we do with the data afterwards?

We suggest that a member of your community is delegated as the survey coordinator. This community coordinator can collect each survey, check that the scores are complete and legible, and enter the results into your own database (e.g. an Excel spreadsheet) and/or send the forms to Toitū Te Whenua for entry into the Ngāi Tahu State of the Takiwā database. The community coordinator can then keep one copy on hand in your community, as well as one copy with the central database, for the purposes of synthesising and analysing all data collected.

You can work with Toitū Te Whenua to receive periodic summaries of how you are progressing and what the MCHI is telling you about the health of your rohe moana. We recommend that you request annual reports about your rohe moana health, so that you can track your continued progress and inspire community members to continue surveying.

Who gets to see the data later?

The data will belong to your community. For any centralised data, Toitū Te Whenua will control access to the database to ensure that it is only used to assist kaitiakitanga of your area. However, you can access it at any time, and ask any questions about the health of your rohe moana. Simply get in touch with Toitū Te Whenua.

2.0 Instructions for scoring the Ngāi Tahu Marine Cultural Health Index 2013

If you haven’t contributed an MCHI score before, we ask you to first take a few minutes to fill in the Surveyor Information Form (Form A). This tells us about your personal details and relationship to the area, so that we can better interpret the MCHI scores you provide. You’ll only ever have to fill this in once.

The first time your community assesses a site, someone from your community needs to take a few minutes to complete a Site Characteristics Form (Form B) for each nominated MCHI survey site. If you are on your own, establishing the site for the first time, please fill this out yourself when you get to the site. However, if a group is visiting the site, only one of you needs to fill out the form. This form asks you to allocate a name for the site. Once this form is submitted to the Ngāi Tahu State of the Takiwā database, your site will be given a Site ID code. For all repeat visits, surveyors just need to record the site name and ID code to link their new observations to the same place. You will only need to fill out the Site Characteristics Form once.

Now that the introductory work is complete, it’s time to begin the survey.

Make sure you first assess the benchmark state of the site. Pick a year!

A benchmark survey provides the ability to record past cultural and environmental health of the site. It may also act as a target for your community’s restoration goals. To complete the survey for the Benchmark State, mentally place yourself at this site during the earliest year you can accurately remember. Now, go through all of the MCHI Scoresheets (Forms C-J) for this Benchmark State.
Remember to check off “Benchmark Survey” on the top of each form, to differentiate these scores from those of a “Current State Survey.” You can provide more than one benchmark, if you have had a long association with the site (e.g. 1970s, 1980s, 1990s).

After you have completed a Benchmark Survey for the site (you only need to do this once), you can now do the same thing for the site’s current state. You will fill out the same forms (Forms C-J) to monitor the current cultural and environmental health of the site, plus two additional forms (Forms K & L).

Here’s what to expect, when filling out the forms.

First, fill out the **MCHI Site Survey Form (Form C)**. This form will give context to the scoresheets, by providing current information about the location and time of the survey. You will need to fill out this form each time you survey a site. It should take 1-2 minutes.

You will then need to fill in the **MCHI Scoresheets (Forms D-L)**. [Note: You can record your scores for Forms D-L directly on Form J if you wish to save paper.] The entire survey will probably take you around 20-30 minutes per site, once you get the hang of it. It would be best if you were at the site when you filled in the MCHI scoresheets. Obviously you will be, if you fished the site prior to filling in the forms.

The first section of the MCHI Scoresheets concerns **Key Cultural Indicators (Forms D-G)**. These include the health of kai species (taste, condition, growth and replacement), the ability to get a feed, and the safety of the food. These forms are created like a “choose your own adventure” maze. Start at the top and work your way down, answering each “yes” or “no” question. If your answer leads to a dead-end, stop there and record the score.

Within the Key Cultural Indicators, Form D is site-specific, so record your score for the site at the bottom of the form. Forms E-G are species-specific. You may pick up to 5 of what you think are the most important species at this site. Record a score for each of the species you choose at the bottom of each form. **Prioritise your species (1-5) in order of importance!**

The second section of the MCHI Scoresheets concerns **Habitat Threats & Quality Indicators (Forms H & I)**. These indicators include water quality and sedimentation, as well as invasive and provision species. These two forms give multiple-choice questions, with 6-7 options each. Circle your answer, and transfer the score to the right-hand side of the sheet. Once you have filled out the entire page, add up your scores on the right-hand side and follow the mathematical instructions to tally your final results for this section. [Note: You’ll have to round your score to the nearest whole number if your initial score includes decimal numbers.]

Now transfer your scores from Forms D-L to **Form J: Survey Results**. All answers are given a score between 0-4. Scores 0-2 are considered Red Alerts. Something is severely problematic, and the site needs large and/or urgent restoration efforts to improve towards a healthy state. Score 3 is considered an Amber Alert; while much of the site is healthy, or the urgency of the dangers is less, it is still in danger and needs both caution and action. Score 4 is Green, signalling a generally healthy site.
The third section only needs to be filled out if you are completing a Current Survey. Please refer to **Comparison Questions (Form K)**, to answer questions relating to comparisons between the past and present; and **Overall Assessment (Form L)**, to answer questions that will guide future actions to manage the site. This is also your opportunity to write down any remaining thoughts that you feel weren’t addressed in the survey questions.

All done. Submit the forms!

Staple together the MCHI Forms. Remember, if you also completed a Benchmark Survey, you’ll need to have two bundles (one package of forms for the Benchmark Survey and one for the Current State Survey).

Submit your completed forms to your community representative. He/she will then keep a copy in the community and may also wish to send another copy to Toitū Te Whenua for entry into the **State of the Takiwā** database. Either way the data on the forms will be entered into an electronic database for analysis and safe-keeping.

____________________________________________________

*Mō tātou, ā, mō ngā uri a muri ake nei*

For us and our children after us
Surveyor Information | Form A

Personal Details

Full name _____________________________________________  Today’s date (DD/MM/YYYY) ________________

Street address ______________________________________  Email address ______________________________________  Phone No. ________________

☐ Yes, I would like a report of my scores to be sent via email once they are entered into the State of the Takiwā database.

Year of birth ______  No. of children ___  Profession ________________________________  Name of local marae ____________________________

Ethnicity:  ☐ Ngāi Tahu  ☐ Other Maori  ☐ Pākeha/European  ☐ Other (please specify) ________________________________

How did you become an MCHI surveyor?  ☐ Volunteered  ☐ Approached. If approached, by whom? ________________________________

Relationship to Area

Name of the general area you are referring to in the below questions: ________________________________

What is your current relationship with the area? (Tick as many as apply)

☐ Active harvesting  ☐ Receiving species of kai from others  ☐ Living  ☐ Visiting  ☐ Tangata Tiaki  ☐ Other (please specify) ________________________________

List up to two (2) previous relationships with the area, indicating the time period to which you refer. (Tick as many as apply)

Years: ______  ☐ Active harvesting  ☐ Receiving species of kai from others  ☐ Living  ☐ Visiting  ☐ Tangata Tiaki  ☐ Other (please specify) ________________________________

Years: ______  ☐ Active harvesting  ☐ Receiving species of kai from others  ☐ Living  ☐ Visiting  ☐ Tangata Tiaki  ☐ Other (please specify) ________________________________

When did you first harvest in this area? __________  When did you last harvest in this area? __________

How often did you harvest in this area this past year? __________  How often did you harvest in this area five (5) years ago? __________

How often did you harvest in this area ten (10) years ago? __________

Who taught you how to harvest on this site?

☐ My parents  ☐ Aunts/uncles  ☐ Grandparents  ☐ Community members  ☐ Self-taught  ☐ Other (please specify) ________________________________

Is this site important to you and/or your family? Why or why not? ____________________________________________________________

Ngāi Tahu Marine Cultural Health Index
Site Characteristics | Form B

Today’s date (DD/MM/YYYY) ____________  Surveyor Name(s) _________________________  Name of survey site _________________________

Please indicate site location with an X on an attached map.

Site description ____________________________________________  GPS reading (if available) ____________

What type of habitat is this site?

☐ Soft sediment. The intertidal area is mostly soft underfoot.  If possible, please indicate specifics: ☐ Estuary  ☐ Mud-flat  ☐ Soft-sediment harbour

☐ Rocky shore. The intertidal area is mostly hard underfoot.  If possible, please indicate specifics: ☐ Bedrock  ☐ Mostly stones  ☐ Mostly pebbles

☐ Kelp forest. The intertidal area is mostly made up of large kelp.

☐ Other (please specify) _________________________

Do you have any historic photos of this site?  ☐ Yes.  ☐ No.  If yes, please attach them to this form.

If this site is an estuary, name the river(s) feeding it: ____________________________

Other inflowing rivers or streams within 500m of the site:

Name ___________________________  Distance from site ______  Type: ☐ Small intermittent creek  ☐ Constantly flowing creek or small stream  ☐ Stream  ☐ River

Name ___________________________  Distance from site ______  Type: ☐ Small intermittent creek  ☐ Constantly flowing creek or small stream  ☐ Stream  ☐ River

Name ___________________________  Distance from site ______  Type: ☐ Small intermittent creek  ☐ Constantly flowing creek or small stream  ☐ Stream  ☐ River

Site management:  ☐ Mātaitai  ☐ Taiāpure  ☐ S186b closure (Rāhui)  ☐ Fisheries Regulatory Closure  ☐ Marine Reserve  ☐ Marine Park

☐ Other (Such as Statutory Acknowledgement from Ngāi Tahu Settlement). Please specify ____________

Surrounding land use (within 500 m):  ☐ Agricultural  ☐ City  ☐ Small settlement  ☐ Forestry  ☐ Other (please specify) ____________

What is the discharge from surrounding land (within 500 m)?

☐ Treated sewage  ☐ Untreated sewage  ☐ Septic tanks  ☐ No discharge  ☐ Stormwater discharge  ☐ Industrial  ☐ Other (please specify) ____________
Site Characteristics | Form B

What is the proximity of this site to the closest road?  □ Drive to site  □ 100 m  □ 500 m  □ 1 km  □ 5 km or more

How easy is it to access this site?  □ Walk  □ Scramble  □ Boat  □ ATV  □ Ordinary car

Has there been any major construction, development, or other manmade changes at this site in recent years? (If so, please list specifics and years.)
____________________________________________________________________________________________________
____________________________________________________________________________________________________

Have there been any natural disasters (ie. floods, earthquakes, tsunamis, etc.) at or near this site in recent years? (If so, please list specifics and years.)
____________________________________________________________________________________________________
____________________________________________________________________________________________________

Are there any current or recent restoration efforts taking place at this site?
____________________________________________________________________________________________________
____________________________________________________________________________________________________

Is there anything particularly unique or special about the biology of this site? If so, what?
____________________________________________________________________________________________________
____________________________________________________________________________________________________

Is there anything particularly unique or special about the cultural values of this site? If so, what?
____________________________________________________________________________________________________
____________________________________________________________________________________________________

Why has this site been chosen for MCHI monitoring?
____________________________________________________________________________________________________
____________________________________________________________________________________________________

Ngāi Tahu Marine Cultural Health Index
MCHI Site Survey | Form C

Surveyor name(s) _____________________________

Name of survey site _____________________________

What kind of survey is this?
☐ Benchmark state
☐ Current state

What year(s) does it pertain to? _________

Date of survey (DD/MM/YYYY) ____________

Hour _________  ☐ AM  ☐ PM

Weather Centre

Tide at time of survey:  ☐ Low  ☐ Rising  ☐ High  ☐ Falling  ☐ N/A

TEMPERATURE

___° Celsius (or use thermometer)

Hot       25° C or more
Warm      20° C
Mild      15° C
Cool       10° C
Cold       5° C
Freezing  0° C or less

WIND

☐ None  ☐ Minimal  ☐ Light  ☐ Stiff or breezy  ☐ Gusty  ☐ Strong

If there was wind, indicate which direction by circling on the diagram below:

MOON

Circle the current lunar cycle.
☐ N/A

Ngāi Tahu Marine Cultural Health Index
Cloudiness: □ Clear sky □ Mainly clear □ Streaky □ Partly cloudy □ Heavy □ Breaking □ Overcast
Precipitation: □ None □ Mist or fog □ Drizzle □ Light □ Moderate □ Heavy □ Hail □ Snow

Any extra comments on weather? ____________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

Have there been any storms at this site within the past week? □ Yes □ No
Note: Large storms can create lots of sediment in the water column.

At what water depth is your kai moana, in this survey site? (Check all that apply.)
□ 0-1 m □ 2-5 m □ 6-10 m □ 11-20 m □ 21+ m

Did you take any photos? □ Yes. □ No. If yes, please attach photos to this form.

Which direction does each photo face?
Photo 1: __________  Photo 2: __________  Photo 3: __________  Photo 4: __________

Is there any other information you would like to provide about the current state of the site, that you feel would be beneficial for the understanding of the survey?
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

Ngāi Tahu Marine Cultural Health Index
FORM D: IS THE FOOD SAFE TO EAT?

Can you smell or see evidence of sewage now?

**NO**

- RED ALERT = 0 points
  - It is certain that dangerous contamination is currently taking place.

**YES**

Do nearby sewage or toxin discharges sometimes contaminate the site?
(This relies on local knowledge and/or repeated visits to site.)

**NO**

**YES**

- RED ALERT = 1 point
  - It is certain that dangerous contamination takes place regularly.

Is an algal bloom or human rubbish present?

**NO**

**YES**

- RED ALERT = 2 points
  - Lower-level risk of contamination is currently taking place.

Is there a stream, river, or pipe discharging water within 500 metres (from a heavily farmed catchment, urban, or industrial area) that smells or looks bad?

**NO**

**YES**

GREEN = 4 pts.
- No obvious sign of contamination.

OVERALL ASSESSMENT

___ points. GREEN | AMBER | RED

NOTE: If this is a benchmark survey, remember to do it again for the current state!
FORM E: IS THE KAI REPLACING ITSELF?

| Species #1: | ____________________ |
| Species #2: | ____________________ |
| Species #3: | ____________________ |
| Species #4: | ____________________ |
| Species #5: | ____________________ |

Is so little of this species left here that you cannot estimate the age/size range of the stocks?

- **YES**

- **NO**
  - RED ALERT = 0 points
  - The population is extinct or virtually extinct at this site.

Are there any breeders present at all? (You can see at least some large breeders.)

- **YES**

- **NO**
  - RED ALERT = 1 point
  - The population is not replacing itself from within the area.

Are there also some young/small fish present? (You can see both breeders and young at least occasionally.)

- **YES**

- **NO**
  - RED ALERT = 2 points
  - Some breeding but little recruitment is happening; population is unlikely to be replacing itself from within the area.

Can you see a lot of breeders and a lot of young/small fish?

- **YES**
  - GREEN = 4 pts.
  - Strong breeding and recruitment is happening from within the area.

- **NO**
  - AMBER ALERT = 3 points
  - Breeding or recruitment may be reduced. Population may not be fully replacing itself from within the area.

**OVERALL ASSESSMENT**

| Species #1 = ____ points. | GREEN | AMBER | RED |
| Species #2 = ____ points. | GREEN | AMBER | RED |
| Species #3 = ____ points. | GREEN | AMBER | RED |
| Species #4 = ____ points. | GREEN | AMBER | RED |
| Species #5 = ____ points. | GREEN | AMBER | RED |

NOTE: If this is a benchmark survey, remember to do it again for the current state!
If your species is *sedentary* (e.g. most shellfish), fill out this form. If your species is free-swimming, fill out Form F2 instead.

### Key Cultural Indicator

**CAN YOU GET A FEED EASILY ENOUGH?**

*Form F1: Sedentary animals*

- **Species #1:**
- **Species #2:**
- **Species #3:**
- **Species #4:**
- **Species #5:**

#### Is the species still present at all?

- **YES**
- **NO**

#### Can you get a *small feed* here in a reasonable time, provided you use contemporary gear or methods (*e.g. free-diving, UBA, pots or dredges off a boat*)?

- **YES**
- **NO**

#### Can you get an *adequate feed* here in a reasonable time, provided you use contemporary gear or methods (*e.g. free-diving, UBA, pots or dredges off a boat*)?

- **YES**
- **NO**

#### Can you get an adequate feed in a reasonable time, by using customary gear or methods (*e.g. hand-gathering or wading in up to your waist at low tide*)?

- **YES**
- **NO**

---

**GREEN = 4 pts.**

*Everyone can quickly and regularly gather enough of this species for kai here.*

---

**OVERALL ASSESSMENT**

<table>
<thead>
<tr>
<th>Species</th>
<th>Points</th>
<th>Color</th>
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<tbody>
<tr>
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**GREEN | AMBER | RED**

**NOTE:** If this is a benchmark survey, remember to do it again for the current state!
Key Cultural Indicator
CAN YOU GET A FEED EASILY ENOUGH?

Form F2: Free-swimming animals
Species #1: __________________________
Species #2: __________________________
Species #3: __________________________
Species #4: __________________________
Species #5: __________________________

Is the species still present at all?

YES

Can you at least occasionally catch enough for a feed here in a reasonable time, provided you use contemporary gear or methods (e.g. free-diving, UBA, or nets or pots off a boat, or were equipped with nets or special gear on shore)?

NO

RED ALERT = 0 points
Something (probably habitat degradation, sedimentation, or overfishing) has driven this population extinct.

YES

Can you always catch enough for a feed here in a reasonable time, provided you use contemporary gear or methods (e.g. free-diving, UBA, or nets or pots off a boat, or were equipped with nets or special gear on shore)?

NO

RED ALERT = 1 point
The species is present but stocks are severely depleted; thus, the species is functionally extinct. People will not try to fish here, even if they have a boat or can dive.

YES

Can you catch enough for a feed in a reasonable time, using customary methods (e.g. simple line or rod from the shore or off a boat, or by spear, in case of flounder)?

NO

RED ALERT = 2 points
People will fish here occasionally if they have a boat or special gear, or can dive, but are unlikely to ever fish here from shore.

YES

GREEN = 4 pts.
Everyone can quickly and regularly gather enough of this species for kai here.

OVERALL ASSESSMENT

Species #1 = _____ points. GREEN | AMBER | RED
Species #2 = _____ points. GREEN | AMBER | RED
Species #3 = _____ points. GREEN | AMBER | RED
Species #4 = _____ points. GREEN | AMBER | RED
Species #5 = _____ points. GREEN | AMBER | RED

NOTE: If this is a benchmark survey, remember to do it again for the current state!
Key Cultural Indicator

FORM G: TASTE & CONDITION OF KAI

Species #1: ____________________
Species #2: ____________________
Species #3: ____________________
Species #4: ____________________
Species #5: ____________________

Is so little of this species left here that you cannot estimate the taste and condition of the stocks?

NO

YES

Is this species often infected by worms and other parasites, or does it have blotchy discolouration, signs of damage, or deformations?

NO

YES

Do you reject more than a third of what you catch because of poor condition?
(For example, little flesh in shell, thin for given size, etc. Don’t count rejects simply because they are too small.)

NO

YES

Is this species always tasty?

YES

NO

GREEN = 4 pts.
Everyone can consistently gather safe and tasty species for kai here.

RED ALERT = 0 points
The stocks are severely unhealthy or stressed, and are most likely in poor condition. They may or may not be safe to eat.

RED ALERT = 1 point
The stocks are severely stressed or starving, and are unlikely to be reproducing or growing well. They probably won’t taste good.

RED ALERT = 2 points
The stocks are lightly stressed but the population as a whole may be producing and growing well. The majority taste good.

AMBER ALERT = 3 points
People might gather this species occasionally but are likely to prefer another species or site.

OVERALL ASSESSMENT

Species #1 = ____ points.  GREEN | AMBER | RED
Species #2 = ____ points.  GREEN | AMBER | RED
Species #3 = ____ points.  GREEN | AMBER | RED
Species #4 = ____ points.  GREEN | AMBER | RED
Species #5 = ____ points.  GREEN | AMBER | RED

NOTE: If this is a benchmark survey, remember to do it again for the current state!
1. Does poor water quality often prevent you from gathering species for kai at this site?

- ☐ N/S Not sure
- ☐ 0 Nearly always
- ☐ 1 Often
- ☐ 2 Sometimes
- ☐ 3 Occasionally
- ☐ 4 Never

2. If you are surveying a site with sand or mud on its bottom (usually an estuary, harbour, or lagoon, not a surf beach), is there a smelly black layer of sediment near the surface of the sand or mud?

- ☐ N/A No rocks or vegetation present. Can’t tell if site is silting up.
- ☐ N/S Not sure
- ☐ 0 Blanketed. Most rocks & vegetation are affected.
- ☐ 1 Lots of rocks & vegetation are affected.
- ☐ 2 Some rocks & vegetation are affected.
- ☐ 3 A few rocks & vegetation are affected.
- ☐ 4 No effects of silt or scum are visible.

3a. Are there signs that the site is currently being affected by sediment? (For example, are any rocks, kelp, or seaweeds often partly covered in silt or sand? Are grazers concentrated on outcrops that are nearly inundated with sand or silt?)

- ☐ N/A No rocks or vegetation present. Can’t tell if site is silting up.
- ☐ N/S Not sure
- ☐ 0 Blanketed. Most rocks & vegetation are affected.
- ☐ 1 Lots of rocks & vegetation are affected.
- ☐ 2 Some rocks & vegetation are affected.
- ☐ 3 A few rocks & vegetation are affected.
- ☐ 4 No effects of silt or scum are visible.

3b. If you have noticed silting up at this site, please describe the evidence:
______________________________________________________________
_______________________________________________________________________

NOTE: If this is a benchmark survey, remember to do it again for the current state!

Ngāi Tahu Marine Cultural Health Index
FORM I: HABITAT THREATS & QUALITY INDICATORS 2
Invasive & provision species

Date ____________________________
Site ____________________________
Surveyor’s Name __________________

Benchmark Survey □  □
Current State Survey □  □

4a. Are new plants or animals taking over the site? *(Invasive species)*

- □ N/S Not sure
- □ 0 Blanketed. It is/they are everywhere.
- □ 1 Lots of large patches
- □ 2 Some large or small patches
- □ 3 A few small patches
- □ 4 None

4b. If some are present, which species are they? ____________________________

5. How much seaweed or sea grass is at the site? *(Note: Please ignore seaweed mats washed up on shore.)*

- □ N/S Not sure
- □ 0 None
- □ 1 A few small patches
- □ 2 Some large or small patches
- □ 3 Lots of large patches
- □ 4 Blanketed. It’s everywhere.

6. Is there a thick layer of bright green ‘sea lettuce’ *(Ulva)*, or a brown or green slimy thread-like alga covering much of the site?

- □ N/S Not sure
- □ 0 Blanketed. It is/they are everywhere.
- □ 1 Lots of large patches
- □ 2 Some large or small patches
- □ 3 A few small patches
- □ 4 None

SCORE

Q4: ______
Q5: ______
Q6: ______

TOTAL: ______ (P)

How many questions scored (0-3)? ______ (Q)

P ÷ Q = ______ (R)

TOTAL SCORE OF HABITAT THREATS & QUALITY INDICATORS

O (total score of previous page) ______ + R (total score of this page) ______ = ______

Ngāi Tahu Marine Cultural Health Index
### Key Cultural Indicators

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### Habitat Threats & Quality Indicators

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Ngāi Tahu Marine Cultural Health Index
Only complete this section if you are completing a **Current Survey**. If you are completing a Benchmark Survey, skip to **Form L: Overall Assessment**.

1. The **water clarity** of the current state is _________ than the benchmark state.
   - [ ] Not applicable  
   - [ ] Not sure  
   - [ ] Definitely less clear  
   - [ ] Probably less clear  
   - [ ] About the same  
   - [ ] Probably clearer  
   - [ ] Definitely clearer  

2. The **amount of rock, reef, or kai beds** that are currently free of siltation are _________ than the benchmark state.
   - [ ] Not applicable  
   - [ ] Not sure  
   - [ ] Definitely less  
   - [ ] Probably less  
   - [ ] About the same  
   - [ ] Probably more  
   - [ ] Definitely more  

3. The **amount of kelp, seaweed, or sea grass** here now is _________ than in the benchmark state.
   - [ ] Not applicable  
   - [ ] Not sure  
   - [ ] Definitely less  
   - [ ] Probably less  
   - [ ] About the same  
   - [ ] Probably more  
   - [ ] Definitely more  

4. The current **harvest pressure** on the site is _________ than the benchmark state.
   - [ ] Not applicable  
   - [ ] Not sure  
   - [ ] Definitely more  
   - [ ] Probably more  
   - [ ] About the same  
   - [ ] Probably less  
   - [ ] Definitely less  

5. The **variety and abundance of animals and plants in rock pools** currently is _________ than the benchmark state.
   - [ ] Not applicable  
   - [ ] Not sure  
   - [ ] Definitely less  
   - [ ] Probably less  
   - [ ] About the same  
   - [ ] Probably more  
   - [ ] Definitely more  

6. The **amount of bush and scrub** surrounding the site, or in the catchment of any streams flowing into the estuary or sea within 500 m of the site now is _________ than the benchmark state.
   - [ ] Not applicable  
   - [ ] Not sure  
   - [ ] Definitely less  
   - [ ] Probably less  
   - [ ] About the same  
   - [ ] Probably more  
   - [ ] Definitely more  

7. The amount of **town or industrial development** surrounding the site or in the catchment of any streams flowing into the estuary or sea within 500 m of this site now is _________ than the benchmark state.
   - [ ] Not applicable  
   - [ ] Not sure  
   - [ ] Definitely more developed  
   - [ ] Probably more developed  
   - [ ] About the same  
   - [ ] Probably less developed  
   - [ ] Definitely less developed  

---

Ngāi Tahu Marine Cultural Health Index  
1/2
Please list any **species that used to be present** in the benchmark years that are no longer present at this site: __________________________________________________________

If you have the time, please describe the **main changes** you have noticed to the *kai*, the sea, and the surrounding environment since the time of your benchmark comparison. (If you have provided more than one benchmark, use the most historic.)

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
FORM L: Overall Assessment

Date ______________________________
Site ______________________________
Surveyor’s Name ____________________

☐ Current State Survey

---

Qualitative Assessments

Would you return to gather kai from this site, if it remains in its current state? (Or similarly, would you have returned here during the benchmark state, if you are conducting a benchmark survey?)

☐ N/S  ☐ 0  ☐ 1  ☐ 2  ☐ 3  ☐ 4
Not sure  No  Very unlikely  Possibly  Probably  For sure

If not, why not? ____________________________________________

---

Rank the current cultural importance for this site, for gathering in your local community.

☐ N/S  ☐ 0  ☐ 1  ☐ 2  ☐ 3  ☐ 4
Not sure  Unimportant  Slightly important  Important  Very important  Extremely important

Please tell us in a few words why it is important or not: ____________________________________________

---

What actions are required to improve the health of this site? ________________________________________

______________________________________________

Is there anything else you would like to add? ______________________________________________________

______________________________________________

---

Please attach further pages or reference materials, if required.

---

Thank you for participating in the Ngāi Tahu Marine Cultural Health Index!

To get a more thorough analysis of these scores, when weighted based on urgency and priority, contact Toitū Te Whenua to have the data entered into the State of the Takiwā database.

Ngāi Tahu Marine Cultural Health Index
### MCHI Scoring and Analysis Sheet

<table>
<thead>
<tr>
<th>Target Species Name</th>
<th>Form D</th>
<th>Form E</th>
<th>Forms F1 and F2</th>
<th>Form G</th>
<th>Species Scoring</th>
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<td>4</td>
<td>133% 192 100%</td>
</tr>
</tbody>
</table>

### Overall Site Scoring

<table>
<thead>
<tr>
<th>Cultural species richness of site</th>
<th>Total combined score for all species</th>
<th>Cultural health of site (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>192.0</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Reference notes on scoring site health

<table>
<thead>
<tr>
<th>Relative importance of each species</th>
<th>Weighted average for increasing number of species</th>
<th>Cultural Health (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>192.0</td>
<td>100%</td>
</tr>
<tr>
<td>80%</td>
<td>192.0</td>
<td>100%</td>
</tr>
<tr>
<td>64%</td>
<td>192.0</td>
<td>100%</td>
</tr>
<tr>
<td>51%</td>
<td>192.0</td>
<td>100%</td>
</tr>
<tr>
<td>41%</td>
<td>192.0</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Reference notes on scoring fishing effort

<table>
<thead>
<tr>
<th>Ability to get a feed easily</th>
<th>Cultural Health (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>12%</td>
</tr>
<tr>
<td>1</td>
<td>20%</td>
</tr>
<tr>
<td>2</td>
<td>27%</td>
</tr>
<tr>
<td>3</td>
<td>35%</td>
</tr>
<tr>
<td>4</td>
<td>42%</td>
</tr>
</tbody>
</table>