Linkages between cultural and scientific indicators of river and stream health

Prepared for

Stakeholders of the
Motueka Integrated Catchment Management Programme

Manaaki Whenua
Landcare Research

TDC Tasman District Council

Tiakina te Taiao

CAWTHRON

November 2008

Linkages between cultural and scientific indicators of river and stream health

Motueka Integrated Catchment Management (Motueka ICM) Programme Report

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EXECUTIVE SUMMARY

There is an increasing need for accurate and reliable information about our environment and also increasing recognition of the need to include different perspectives into monitoring programmes. Maori have a long history of connection with their environment which is reflected in their knowledge, values and world view. The Resource Management Act (RMA 1991) emphasises the importance of the relationship of Maori with their environment and requires that decision makers have particular regard to kaitiakitanga and understand the Maori world view. Cultural indicators help to articulate cultural values, assess the state of the environment from a cultural perspective, and assist with establishing a role for Maori in environmental monitoring. In this report we review the philosophies behind cultural and scientific monitoring of river health and compare the results from the two approaches at sites where corresponding data is available.

Iwi/hapu groups from the Motueka Catchment have adapted a cultural health index developed in the Otago region and applied it at sites throughout the Motueka and Riwaka catchments. The Motueka cultural health index stratifies the landscape into Atua domains (a Maori cultural framework) such as Tangaroa, Tane Mahuta, Haumietiketike, Rongomatane, Tumatauenga and Tawhiri Matea. Attributes covering riverbank condition, riverbed composition, water clarity, water flow, water quality, channel shape, riparian vegetation, catchment vegetation, river modification/use, use of river margins and smell are scored from 1 (poor) to 5 (excellent), with the overall cultural stream health measure calculated as the average of these scores. An assessment of the mahinga kai status and traditional status of the site is also determined, along with a judgement of whether iwi would return to the site.

There was considerable overlap in site selection between the scientific and cultural health monitoring efforts, with the few differences reflecting the differing objectives of each monitoring programme. There was a strong correlation between the cultural stream health measure and the percentage of the catchment above each site in native forest, and also weaker relationships with water clarity, a macroinvertebrate community index (SQMCI), and the concentration of faecal indicator bacteria. These relationships confirm that both types of indicators are successfully capturing aspects of river and stream health. When comparing guidelines associated with the scientific data it was apparent that the cultural stream health assessments were more strict than stream health standards based on scientific data.

The scientific approach is robust and objective and uses methods and equipment that are well tested and reviewed. Scientific methods measure precise changes to river and stream health over time but can be relatively costly and require a high degree of professional expertise and experience. The cultural approach is qualitative, cost effective and based to a high degree on acquiring in-depth knowledge of a local environment (e.g., matauranga Maori, local and historical knowledge). Cultural methods rely on collective skills/knowledge held by tangata whenua and a high degree of consistency in the assessment in order to measure and detect long-term changes to an environment. Scientifically based and culturally-based indicators, along with community-based approaches, potentially provide an enriched understanding of the environment with each offering a slightly different worldview about the health of freshwater systems. With this complementary model, different forms of assessment and monitoring can be used side by side by local government, community, iwi and hapu, and research agencies. No particular group is excluded from working across a range of assessment types although a certain level of expertise and specialist knowledge is required for each.

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Glossary of Maori and scientific terms

Maori terms

Atua	God, deity, supernatural being, Maori spiritual gods
Hapu	sub-tribe, pregnant
Iwi	Tribe, bones
Kaitiaki	guardians or the agent who practices kaitiakitanga
Kaitiakitanga	exercise guardianship or stewardship of the environment and tikanga
Kaumatua	respected elder, knowledgeable person
Kuia	elderly female, respected elder
Kaupapa	Maori cultural framework, Maori philosophy, cultural methods, etc.
Mahinga kai	cultivation sites, gardens, places of food harvest and collection
Maori organisation	iwi or hapu authority, kaitiaki group, marae, or other organisation e.g., incorporation, trust, limited liability company (Ltd)
Mana, mana whenua	prestige, control, authority over an area
Manu	bird, birds
Marae	ceremonial courtyard, social cultural centre, village
Matauranga Maori	Maori knowledge
Mauri	life force, life principle, internal element, metaphysical component of all things, animate and inanimate
Ngahere	forest
Noa	free from tapu, ordinary, unrestricted
Papatipu runanga	Local marae, cultural place, local group or council of an area or place
Puku	centre, stomach, digest, feeling in the gut
Rahui	restrictions, regulation, or temporary sanction
Ritenga	rules, regulations
Rohe	tribal area, boundary
Rongoa	traditional medicines and treatments, cure, heal
Runanga	council, assembly, consultation
Taiao	environment, environmental
Tane Mahuta	God of forests
Tangaroa	God of the sea, marine, water
Tangata whenua	people of the land, having an ancestral link and authority to a given area
Tapu	sacred, ritual prohibition, off-limits
Taonga	something treasured, e.g., treasured flora & fauna species; iconic, highly valued, precious
Te Tau Ihu	tribes *iwi* of the northern part of the South Island (e.g., Ngati Rarua, Te Ati Awa, Ngati Tama, Ngati Koata)
Tikanga	customary values, rules, and practices
Tino rangatiratanga	self determination, authority, sovereignty
Tohu	indicator, standard, mark, to guide
Wahi tapu	sacred site, or place, restricted, spiritual
Wai	water
Wairua	spiritual dimension, spiritual qualities
Wananga	forum, house of learning, institute, discussion and learning forum, workshop
Whanau	extended family, relationships
Whakapapa	ancestral lineage, genealogy
Whenua	land, placenta

Scientific terms and abbreviations

Catchment	Area of land where water drains into a water body
CHI	Cultural Health Index
CSHM	Cultural Stream Health Measure – the stream health component of the CHI
E. coli	a faecal indicator bacteria – indicates faecal pollution at a site
Epistemology	types of learning/knowledge/beliefs
GIS	Geographic Information System
ICM	Integrated Catchment Management
Macroinvertebrate	animals without backbones (e.g., insects, worms, snails, mussels, shrimps, koura) that live in streams and rivers and are visible with the naked eye.
Macrophytes	aquatic plants growing in the river channel
MCI	an index of river health that incorporates just the types of macroinvertebrates found at a site
Periphyton	the layer of algae and other material that grows on river beds
pH	a measure of the acidity of water
RMA	Resource Management Act
SHMAK	Stream Health Monitoring and assessment kit – developed as a simple tool for farmers and community groups to monitor their streams
SOE	State of the Environment
SQMCI	an index of river health that incorporates the numbers and types of macroinvertebrates found at a site.
TDC	Tasman District Council
Turbidity	a measure of the cloudiness of the water – the opposite of water clarity
WHO	World Health Organisation

1 INTRODUCTION

1.1 Aims of monitoring

There is an increasing need for accurate and reliable information about the environment and how it is changing. High quality freshwater is one of New Zealand's most important natural assets and a resource that is at enormous risk. Good management of water resources requires a firm understanding of the effects of adjacent land management on water quantity and quality, the equitable allocation of water for out–of–stream and in–stream uses, and knowledge about potential connections between freshwater and coastal ecosystems. With this information we can make informed decisions about sustainable natural resource management and set environmental, social and economic goals, standards, and policy.

Monitoring enables councils and other groups to:

- Determine the state of water quality throughout an area/region
- Detect long term trends: is the water deteriorating over time, or sustaining its health and condition?
- Determine suitability for uses: is it being sustained for specific purposes/values?
- Check compliance with standards: for example measured for recreation or drinking standards
- Assess adequacy of controls on discharges

1.2 Maori participation in environmental monitoring

There is growing recognition of the value of monitoring programmes that are planned and conducted by local communities (Jollands & Harmsworth 2006; Reed et al. 2008). Maori have been observing and interacting with their environment for centuries. Cultural knowledge and values reflect a long history and relationship that tangata whenua have with a given area, location, catchment, or region and reflect their world view. Cultural values are statements of knowledge, connections to a place, and establish responsibility to a geographic area or resource. They can therefore shape the way Maori think about issues, form the basis for decision-making, find solutions, and are fundamental for determining aspirations, needs and priorities.

The traditional Maori worldview acknowledged a natural order to the universe, built around the living and the non-living, and the central belief was that all parts of the environment were interrelated or interdependent through the domains of Atua or departmental gods. Traditionally, Maori believed that small shifts in the mauri or life force of any part of the environment, for example through use or misuse, would cause shifts in the mauri of immediately related components, which could eventually affect the whole system. All activities and relationships with the environment were governed by mythology, religion, and Maori values. Within this framework spiritual qualities guided resource use through an elaborate system of ritenga or rules, with goals to regulate and sustain the wellbeing of people, communities and natural resources. Guiding values and concepts included *kaitiakitanga, tapu, mauri, rahui, mana, noa,* and *wairua*.

The requirement to introduce more systematic and defensible monitoring methods and standards within national and international frameworks is a relatively recent phenomenon. In New Zealand, the Resource Management Act (RMA 1991) emphasised the importance of the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, wahi tapu, and other taonga (RMA, Section 6). Additionally, all persons involved in managing the use, development, and protection of natural and physical resources, shall have particular regard to kaitiakitanga and the ethic of stewardship (RMA Section 7). Therefore, it is important that decision makers understand the Maori world view and are able to take account of those views in making decisions on plans and applications for resource consent.

To ascertain the iwi/hapu Maori role in monitoring, we use the premise that iwi/hapu have different beliefs, values, and cultural perspectives from mainstream western thinking. A different world-view may change the way people experience, perceive, and interpret their environment and their relationships with other people, and may change the way iwi/hapu approach an issue and the environmental standards they define or find acceptable. In the context of national monitoring and reporting it is important to ask questions such as:

- How do iwi/hapu therefore see their environment changing in time? Define issues? Prioritise work?
- How do iwi/hapu assess and monitor their environment?
- How do iwi/hapu assess change and define environmental health?
- What is iwi/hapu knowledge? What are iwi/hapu/whanau Maori concepts and beliefs?
- How can iwi/hapu knowledge be used to underpin assessment and monitoring?
- How do iwi/hapu make decisions about their environment?
- How do iwi/hapu define what is an ideal relationship with local government, and other agencies?
- What are iwi/hapu environmental and cultural aspirations?

Many of the answers to these questions require an in-depth understanding of iwi and hapu tikanga, knowledge, cultural values, and aspirations. Through values and knowledge Maori groups, such as iwi and hapu, can transfer this assessment (e.g., cultural indicators or nga tohu) into standards, planning, policy, goals, and expectations of river and stream health.

1.3 The need for cultural indicators

Maori groups have been formally developing indicator and monitoring tools mainly in response to the RMA and more latterly as part of the national 1998 MfE environmental indicator programme, through reference groups, forums and related projects. One of those projects was the development of a cultural health index (Tipa & Teirney 2002, 2003, 2006a,b; Townsend et al. 2004) based on earlier work in the Taieri catchment for monitoring freshwater ecosystems (Tipa 1999). The cultural health index has subsequently been explored further in the Motueka and Riwaka catchments and adapted by local iwi/hapu and their pan-iwi regional resource management agency *Tiakina Te Taiao* for their own use and application. This work has been developing in parallel with scientific data collection and monitoring on stream and river sites throughout the Motueka and Riwaka catchments as part of the Motueka Integrated Catchment Management (ICM) programme.

The Motueka iwi cultural indicators project is helping articulate cultural values, the state of the environment from a cultural perspective and how that is changing, and is establishing a role for Maori in environmental monitoring. Monitoring tools such as these also help iwi prioritise, plan, strategise and develop actions for realising goals and aspirations. This can be simply by identifying areas of cultural significance and importance through to a more holistic view of the state of the environment over the whole catchment or over a rohe (tribal area). It can also be by identifying specific projects they are involved in and monitoring progress towards a defined set of goals. Another important goal for iwi environmental monitoring is to build iwi/hapu research capacity, through areas such as research and training, and collectively engaging in project work and field work.

There are an increasing number of reasons why Maori organisations should monitor their own environments and these can be summarised as three main groups.

- An internal driver – to monitor for themselves – and to manage and protect environments with which they have a relationship, and to safeguard and manage natural resources for future generations as part of their own responsibilities and for community wellbeing. These internal drivers come from internal responsibilities such as whakapapa, kaitiakitanga, tikanga – cultural values, community beliefs (e.g., whanau, papatipu runanga, hapu), and from tribal expectations. This type of monitoring may be associated with projects (e.g., restoration, rehabilitation, SOE reports) and measure progress towards desired cultural goals such as enhancement of cultural resources and cultural wellbeing.

- To monitor in response to an issue; this could be more reactionary, to provide meaningful information in response to, for example: contamination, toxic waste, impacts on cultural resources, cultural heritage, water quality, dwindling fish stocks, sewage disposal/outfall, pollution, sustainable management of a species or customary harvest. The reasons for monitoring here are usually to determine or detect change and usually form responsive actions, for example, be alerted to a problem or issue, respond to sudden or deleterious impacts, or detect slow or gradual – sometimes imperceptible – change requiring long-term monitoring strategies. It could also be in response to government regulations or major policy shifts where cultural and scientific information can be used to support a tribal position statement or to develop culturally appropriate management or policy strategies and actions.

- In response to external needs and influences, this could be in relation to legislation (e.g., RMA), the Treaty of Waitangi, best practice, and, for example, in response to central government, local government, or industry initiatives. Examples of these requirements come from national legislation such as the RMA – especially section 35 (i.e. monitoring), industry initiatives and standards such as the Forest Stewardship Council (FSC) (FSC 2001), and initiatives such as the national and regional environmental monitoring programmes and international drivers such as international agreements, conventions, OECD frameworks and requirements (OECD 1993, 1997).

Cultural approaches and techniques can be used to:

- Articulate and increase understanding of cultural values and perspectives
- Identify and determine issues and areas of potential resource – and cultural/political – conflict
- Monitor changes and trends in the cultural health status of a river, stream or catchment
- Identify and prioritise (culturally significant) areas for restoration and enhancement projects
- As a basis for cultural impact assessment and other iwi/hapu planning and policy
- As a basis to resource consent responsibilities and recommendations
- Help build iwi/hapu research capability
- Expand iwi/hapu knowledge and understanding (e.g. integrated knowledge systems)
- Expand science knowledge and understanding (e.g. integrated knowledge systems)
- Help build collaborative research with science agencies and researchers
- Help establish collaborative projects and partnerships that make a difference (in line with iwi needs, aspirations, goals)
- Generate new iwi/hapu research directions
- Inform iwi and hapu policy and planning
- Inform local government policy and planning

- Improve access to science information and knowledge
- Address Maori needs and issues
- Improve iwi/hapu inputs into planning and policy
- Improve iwi/hapu capabilities for decision making and sustainable resource management.

1.4 What is river and stream health?

The concept of river health incorporates both ecological and human aspects. Meyer (1997) describes a healthy river as “an ecosystem that is sustainable and resilient, maintaining its ecological structure and function over time while continuing to meet societal needs and expectations." Therefore, a healthy river system is able to support the range of organisms that have adapted to live there, performs the ecological functions that would be expected, and has the ability to bounce back after disturbance. A healthy river will also supply the goods and services that are valued by people (e.g., GOODS - clean water for drinking, water supply for irrigation/industry, environment for recreation and spiritual renewal; SERVICES - cleansing and detoxifying water, producing fish/shellfish, providing aesthetic pleasure, maintaining water supply, storing and regenerating essential elements). These values can be intrinsic (e.g. species have a right to exist) or instrumental (e.g., tourism value of trout fishery).

Human values will obviously differ among different people and therefore one person’s assessment that a particular river is healthy may not match with another’s assessment. Conflicts can occur between different values and optimising resource use to meet one value may sacrifice other values (e.g. taking all the water from a river for irrigation will compromise its ability to provide spiritual and cultural renewal!!). Through values and knowledge we ascribe – from a range of stakeholders – standards of health that reflect our desired needs, goals, and relationship with water. Often this reflects standards we have set using a number of indicators, guidelines or functions (e.g., local government water quality guidelines, iwi guidelines, community guidelines, industry guidelines, WHO guidelines), and good or bad reflects the uses and expectations we have of rivers and streams to support life, sustain wellbeing, for use and activities, and achieve needs for industry and commerce. These standards are based on factors that support life, health, wellbeing, human values and perceptions of what constitutes healthy and what is not? Each group of stakeholders and users (e.g., farmers, fishers, horticulturalists, developers, iwi) typically have differing values and standards that reflect their values, needs, and aspirations.

A range of indicators can potentially be used to measure river health. Ecological indicators based on the range of species present at a site are a useful tool (e.g., stream invertebrates, fish), along with measurements of water quality and flow. Most ecological indicators used in the past have been based on measurements of the types of species present at a site (Boulton 1999), although new approaches measuring rates of ecological functions are recently gaining popularity (Young et al. 2008). Indicators based on human values/needs are also used, and focus on objectives such as acceptability for swimming, water supply and food gathering. We describe in this report iwi/hapu initiatives for environmental monitoring and indicators from a cultural perspective where the iwi/hapu led monitoring is fundamental to their own requirements and responsibilities. The methods and results are regarded as complementary to other approaches.

1.5 River and stream health standards

To measure river health a reference scale is needed. For example, "What range of species would you expect at this site? How fast would you expect this river to recover after a disturbance of a certain size?" This is relatively easy to determine if you have appropriate reference sites nearby that are not influenced by human activities, but is more difficult if all similar habitats are heavily modified. Another approach to developing a reference scale relates to defining how the physical, chemical and biological condition of the water and channel meets the needs of people and ecosystems. Important objectives for water quality and the broad indicators with which to measure those objectives are listed in Table 1 below:

Table 1: Local Government objectives – showing the objectives to achieve – through standards, ranges, and guidelines – and the role of indicators for identifying whether these objectives are being met

Key Objectives	**Indicators (conventional science based)**
Acceptability for swimming	Clarity Filamentous algae (slime) Disease causing organisms
Acceptability for food gathering	Clarity Filamentous algae (slime) Quality and abundance of food resources Disease-causing organisms (mainly relevant to shellfish) Mauri of water (life force)
Life supporting capacity	Biological condition (abundance and diversity of flora and fauna – invertebrates, fish, birds) Quality and quantity of habitat including water quality parameters such as temperature, dissolved oxygen, extent of stream side plants – riparian, quality spawning habitat for fish, white bait etc, and in-stream substrate (including woody debris)
Acceptability for stock drinking water	Disease causing organisms

Other objectives that are important to councils on behalf of stakeholders include:

- Flood capacity – maintenance of channel capacity to protect human life and property
- Recreation – includes the quality of experience and public access
- Landscape aesthetics
- Resource consents for use or modification of the water resource: e.g., discharge into, allocation/take of water

Management plans and policy are often used to meet these standards and objectives. Effective monitoring using the right set of indicators and monitoring approaches (scientific, community based, cultural) are used to measure progress and trends towards or away from desired stakeholder and legislative goals and objectives.

1.6 Aim of this report

A number of river and stream health monitoring approaches are presently being carried out in the Motueka and Riwaka catchments (Figure 1), and provide an excellent opportunity for iwi/hapu-science collaboration. Iwi/hapu members have been interested in accessing much of the ICM programme science information since its inception and using this information in their own projects, and for planning and policy. Iwi/hapu led research projects have initiated recording, storing, and analysing large amounts of matauranga Maori (local iwi/hapu knowledge) on the Motueka and

Riwaka catchments and other related environments. It is this specific knowledge that is increasingly providing the foundation for indicator development and cultural assessment and monitoring. The combination of scientific and cultural knowledge is providing a more comprehensive and holistic understanding of river and stream health and condition. This report explores the emerging linkages between scientifically based approaches and those that are culturally based and the opportunities this could provide.

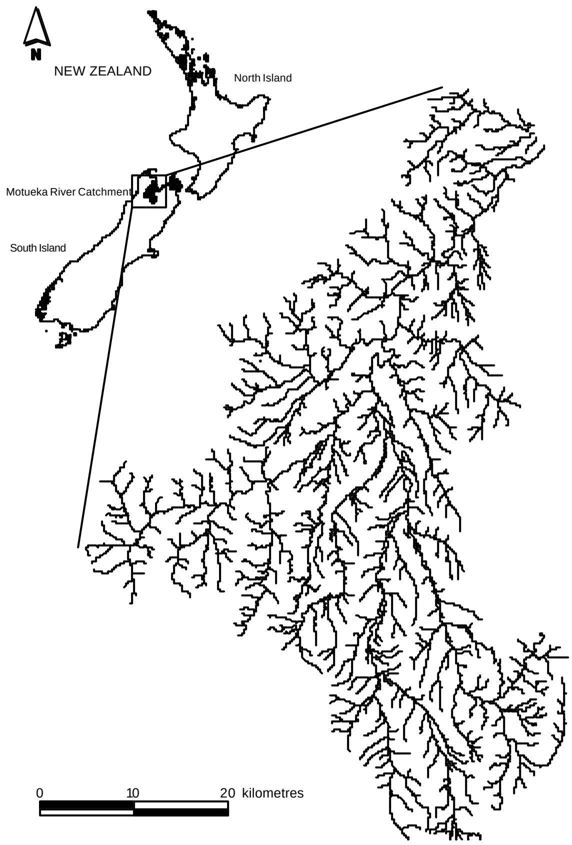

Figure 1: Motueka and Riwaka river catchments.

2 CULTURAL AND SCIENTIFIC INDICATORS OF RIVER HEALTH

2.1 Cultural Indicators

A recent project developed by a number of Te Tau Ihu iwi/hapu groups and their resource management agency *Tiakina Te Taiao,* with the help of the ICM programme, has developed a framework assessment method and a suite of cultural indicators (Appendix 1a, b). The cultural assessment framework and indicators are based on the cultural health index (CHI; Tipa & Teirney 2002, 2003, 2006a,b).

The original CHI was developed to provide iwi/hapu with a tool to express their cultural perspectives, values, and past and ongoing relationships with a location or area. It was originally developed, trialled and evaluated in the Taieri and Kakaunui catchments, Otago 1997–2003 (Tipa 1999), and more recently in the Hakatere (Ashburton) River, Canterbury and Tukituki River, Hawke's Bay (2004–2005) to test its applicability to other river types and other iwi (Tipa & Teirney

2006b). It provides a holistic Maori perspective of stream and river health and gives iwi/hapu a tool to express cultural values of stream health and mahinga kai for planning, policy and decision-making. It takes into account a range of cultural indicators including mauri, taonga (flora and fauna) species, and mahinga kai (cultural resources for use and harvest; MfE 1998, Harmsworth and Tipa 2006). The CHI can be aggregated into a score (e.g., A-1/2.9/4.1) that recognises and expresses Maori values, and also as an indicator for planning, policy, and environmental reporting. It can be used for an entire river and stream catchment or a river/stream segment.

Three components make up the numeric index at any given river or stream site:

- establishing the relationship or association by tangata whenua, iwi/hapu (site status)
- evaluating mahinga kai values (mahinga kai measure)
- assessing stream health (stream health measure)

Gail Tipa and Laurel Teirney were invited to the Motueka and Riwaka catchments and ran a training workshop in early 2006. The Nelson-Motueka pan-tribal regional resource management agency, *Tiakina Te Taiao* have modified the original CHI forms into their own structure, descriptions and recording system. They adapted the CHI using a cultural framework which stratifies the landscape into Atua domains (Maori departmental gods – such as Tumatauenga, Tangaroa, and Tane Mahuta), cultural themes, indicators, and descriptors (Figure 2 and Appendix 1a, b). All the information described from field assessment is recorded using maps, aerial photos, and given precise grid coordinates and sometimes located using a Global Positioning System (GPS). A score sheet (Appendix 1a,b) is then filled out by trained iwi members and can be entered into Tiakina Te Taiao’s Geographic Information System (GIS) based at Whakatu marae in Nelson.

Many of the river and stream sites assessed by iwi correspond to sites where freshwater scientific indicators have been measured and recorded. These monitoring methods represent important Maori approaches that enable reporting on the state of the environment and make a valuable contribution to research areas including integrated catchment management, biodiversity, sustainable resource management, and effects based planning.

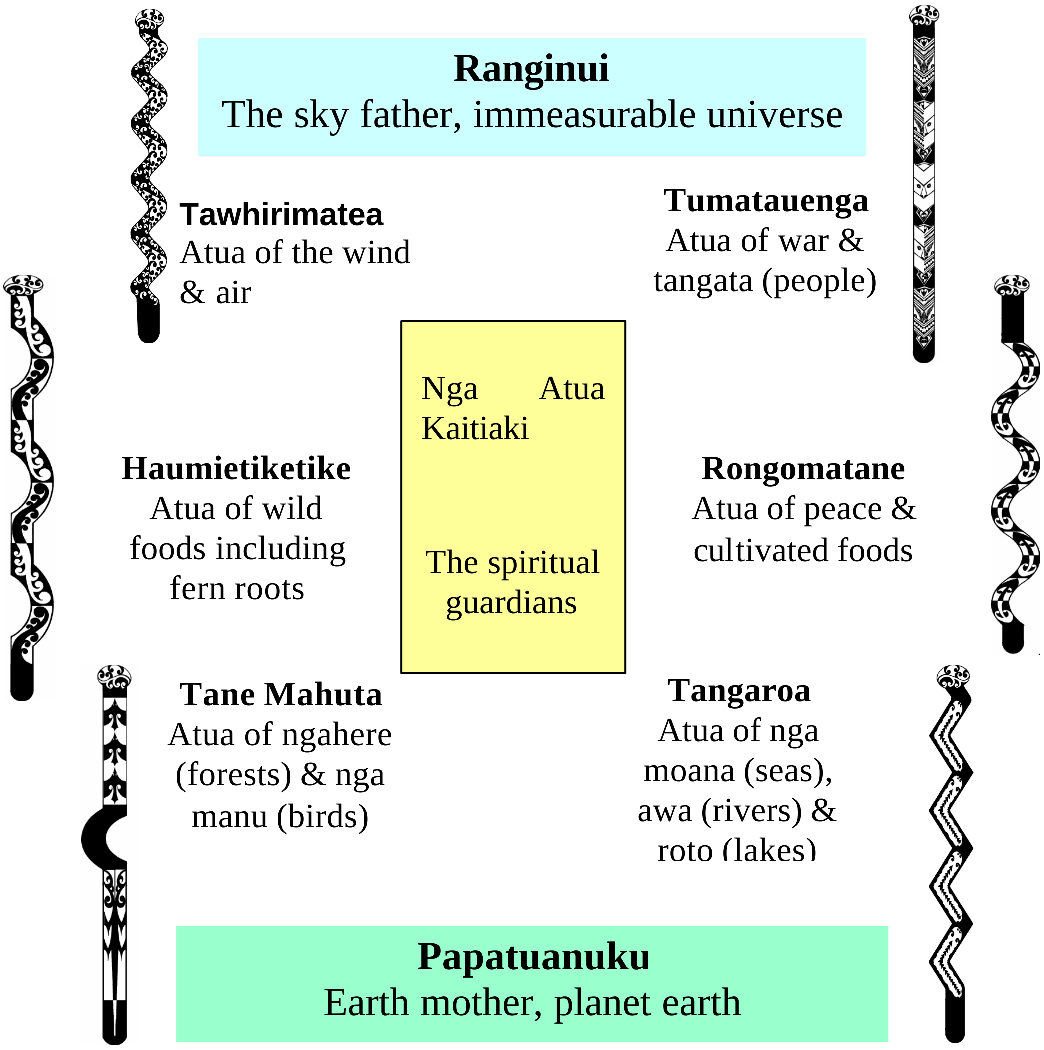

Figure 2: Atua (departmental gods) domain framework Source: Tiakina te Taiao, Dean Walker.

For Maori organisations such as iwi/hapu groups, desired goals, standards and objectives may be different or vary from those of other stakeholders, such as district councils, and could be measured using different monitoring approaches and different sets of indicators. Goals and objectives are also prioritised according to cultural values, aspirations and issues. It is always important to have some type of baseline measure/assessment in each catchment from which to reference changes through time. Iwi/hapu will also be interested in using scientifically based indicators in conjunction with cultural indicators to see if their cultural goals, objectives, and standards (e.g., indicator range), are being met (Table 2). Iwi/hapu standards (represented by indicator ranges, thresholds and guidelines) are often stricter than those defined by councils and other stakeholder groups. Therefore iwi/hapu indicators can be used to identify potential issues/concerns at a site, and subsequently investigated further with scientific indicators to see if there is scientific validity to the concern/issue.

Table 2: Example of Maori iwi/hapu objectives – showing key goals and objectives to achieve – and the role of cultural indicators, within Atua domains (Appendix 1a, b) to measure achievement

Key Goals and objectives	**Cultural indicators**	**Science indicators**
Maintain the mauri of rivers and streams in the catchment	Mauri of water (life force) Tumatauenga Tangaroa Tane Mahuta Haumietiketike and Rongomatane Tawhirimatea Wairuatanga	N/A
Maintain and enhance the relationship and connection between iwi/hapu and place	Tino rangatiratanga Mana Whenua Tumatauenga Tangaroa Tane Mahuta Haumietiketike and Rongomatane Tawhirimatea	N/A
Maintain and enhance the customary use of resources in the catchment and revitalise matauranga Maori of cultural resources	Whakapapa Tumatauenga Tane Mahuta Haumietiketike and Rongomatane	Clarity Filamentous algae (slime) Disease causing organisms
Improve access to cultural resources in the catchment	Tumatauenga Haumietiketike and Rongomatane	Clarity Filamentous algae (slime) Quality and abundance of food resources Disease-causing organisms (mainly relevant to shellfish)
Maintain, protect, and enhance the diversity and condition of cultural resources/taonga (Life supporting capacity) and revitalise matauranga Maori of cultural resources	Mauri of water (life force) Tangaroa Tane Mahuta Haumietiketike and Rongomatane	Condition and Biological condition (abundance and diversity of flora and fauna – invertebrates, fish, birds) Quality and quantity of habitat including water quality parameters such as temperature, dissolved oxygen, extent of stream side plants – riparian, quality spawning habitat for fish, white bait etc, and in-stream substrate (including woody debris)
Maintain and enhance Maori wellbeing	Tumatauenga Rongomatane Overall health–Ora Wairua	Disease causing organisms
Achieve cultural aspirations for water	Tino rangatiratanga Mana whenua Mana moana Kaitiakitanga Wairua and Mauri of water (life force) Tumatauenga Tangaroa Tane Mahuta Haumietiketike and Rongomatane	N/A

2.2 Scientific indicators of water quality and river health

Scientific monitoring has been an important feature of ICM research in the Motueka and Riwaka catchments since October 2000 (Young et al. 2005a) and is an important component of Tasman District Council's (TDC) State of the Environment (SoE) monitoring programme (Young et al. 2005b). The approaches that have been used and the parameters and variables that are measured and recorded are shown in Appendix 2.

Water quality is measured by taking direct measurements at specific sampling sites, or collecting samples and sending them to a laboratory for analysis. A robust strategy for selecting sites is required and standard methods and equipment are used to measure and record data.

The monitoring network consists of 23 sites from the upper catchment to the coast and has a large number of river and stream sites, on a range of landuses and rock types. Data collection for the monitoring was carried out every month in the first year from October 2000 and then subsequently sampled quarterly by TDC as part of their SoE monitoring programme. The TDC also has records of water quality at sites in other river catchments throughout the district. The network was developed to provide information on the relationships – cause and effect – between landuse and freshwater health and to detect changes in health over time. In addition it has been important to look at the relationship of river health with vegetation cover, land use and geology (Young et al 2005a). TDC also continues to monitor river health using invertebrates on an annual basis at approximately 15 sites in the catchment.

3 COMPARISON OF THE TWO APPROACHES

Cultural and scientific approaches to river health assessment are very different, as shown in Table 3 – the epistemologies they are founded on, their underlying methodology, their purpose, what they record and measure, and how that information is analysed and interpreted. They have enormous potential though for articulating two worldviews (perspectives) of river and stream health together, and on which to base future goals, objectives, defined standards, and policy.

For iwi and hapu this cultural assessment is fundamental for identifying changes in catchment condition and health (river and stream health) especially in areas regarded as culturally significant. This allows iwi and hapu to prioritise and target areas defined as culturally significant for restoration and enhancement and allows them to monitor change in cultural resources and resource condition throughout the catchment during the year or in subsequent years (e.g., monitoring sites every year or five years).

Table 3: Comparative features of scientific and cultural approaches

Feature	Scientific indicators	Cultural indicators
Worldview	Western -science	Te ao Maori (indigenous)
Knowledge	Based on science principles and paradigms	Based on matauranga Maori and local knowledge
Purpose and goals	To identify and define river and stream health from a western perspective, detect changes, and whether defined standards and goals are being met and sustained	To identify and define river and stream health from a Maori cultural perspective, alert need for scientific monitoring
Methods	Scientific, detailed protocols documented and equipment calibrated	Kaupapa Maori. Calibration of operators.
Site selection	Robust sampling strategy based on river characteristics (e.g. River Environment Classification - REC), specific targeted monitoring at key sites	Culturally significant sites and comparative sites
Site	Site specific, minimal area (50-100 m)	Over whole area, whole reach-length of stream or river, sub-catchment
Sampling area	Specific sampling within a river or stream (50-100 m)	Includes assessing river and surrounding upper and lower catchment area
Training	Science degrees or courses, professionalism and precision	Cultural training for consistency and standards
Templates	Science parameters and variables – standard western science framework	Maori frameworks e.g., Atua domains
Information recorded and stored	Quantitative, objective – directly measured	Qualitative, subjective – directly observed and assessed
Assessment	Based on independent objective data. Accuracy and precision very important	Based on Maori values and aspirations
Field Records	Parameters, variables, databases on computer, spreadsheets, graphs	Cultural knowledge, Cultural scoresheet, data, overall assessment at each site
Storage	Documents, GIS, reports	Documents, GIS, reports
Analysis	Scientific indices, ranges, guidelines	Cultural health index assessment and scores
Applications	Measure baselines, environmental change, standards, goals, policy	Measure trends and change for cultural health and environmental goals, policy
Outcomes	Healthy rivers and streams based on science and western standards	Healthy rivers and streams based on cultural goals and standards
Reporting	Detailed reports, info on websites, presentations to community and conferences	Kanohi te kanohi (face to face) advice, Hui, Reports, consent submissions, website

3.1 Strengths and weaknesses of each approach

Several strengths and weaknesses are evident in each approach. These are summarised below in Table 4.

Table 4: Strengths and weaknesses evident in each approach

Cultural approach		**Scientific approach**	
Strengths	*Weaknesses*	*Strengths*	*Weaknesses*
Holistic Subjective, qualitative monitoring	Holistic Subjective, qualitative monitoring	Objective, quantitative monitoring	Objective, quantitative monitoring
	Difficult to obtain baseline information without repeated historical assessments	Can measure baselines and trends from key indicators	
Can measure change	Needs to be consistent to measure change and trends	Can measure change, and is repeatable and objective	Needs high degree of skill for interpretation
Professional expertise, knowledge and skills required	Requires high degree of iwi/hapu capacity to be effective – collective approach	Professional expertise, knowledge, and skills required – limited to few people	Requires high degree of training to be proficient and skilled
Focussed at understanding larger areas, whole areas, e.g. sub-catchments, rivers	Generalised	Specific	Located in small defined areas, sites, e.g. stream reach, river segment
Cost-effective and relies on low budget materials and assessment forms. Staff time could be costly over several days	Not always consistent depends on collective training and skills	Highly repeatable and standardised across sites	High cost and often requires expensive equipment and materials
Meaningful and can be standardised with training	Relies on having a high degree of knowledge (local, Maori, etc.) at each site	Meaningful and standardised	Relies on a high degree of scientific knowledge for monitoring methods/standards and interpretation – restricts number of people involved to just experts
Indicators dependant on each other, need to be used and assessed together – holistic, whole picture	Indicators dependant on each other, linked, need to be used together	Each indicator can be measured and used independently	Each indicator independent, not linked for whole picture – singular
Focussed on goals and outcomes		Focused on in-stream and in-river measurement	
Articulates a Maori perspective and values		Articulates a scientific perspective	
Can measure state of health from a Maori perspective		Can measure progress towards wider stakeholder objectives	
Identifies issues of cultural significance		Identifies water health issues at an early stage	

In summary the scientific approach is robust and objective and based largely on direct measurement. The science methods are well tested and reviewed. They require a high amount of professional expertise and experience. They can detect and measure precise changes to river and stream health over time.

The cultural approach is qualitative (e.g. observational), cost effective and based to a high degree on acquiring in-depth knowledge of a local environment (e.g., matauranga Maori, local and historical knowledge). They rely on collective skills and consistency in the assessment method. Consistent cultural methods and application can measure and detect long-term changes to an environment, such as a catchment, over time.

3.2 Comparison of results from the two approaches

3.2.1 Site selections

The scientific monitoring network in the Motueka and Riwaka catchments was designed to cover sites that represented a variety of land use (forestry, pastoral, native, and horticulture) and geological (Moutere gravel, ultramafic, granite, karst) types, as well as sites on major tributaries and along the mainstem of the river. Site selection for the cultural health monitoring was conducted with knowledge of the existing network of water quality monitoring sites in the Motueka/Riwaka catchments, but was also aimed at sites with particular cultural interest and sites where iwi/hapu have concerns about potential impacts. Therefore, only 14 sites have both scientific and cultural stream health data available (Figure 3, Appendix 3). Cultural health information has been collected at 11 additional sites, including culturally important sites such as Waiatua at Puketawai, Motueka River at the rivermouth and Riwaka at Moss Bush. Iwi/hapu have concerns about the potential impacts of a timber treatment yard near Kohatu therefore sites upstream and downstream of the processing yard were chosen (Motueka at North Road, Motueka at Kohatu). Similarly, concerns regarding the sewage treatment system for Tapawera led to a site being chosen on the Motueka River at Tapawera. Scientific information has been collected at 10 additional sites, including a triplet of small neighbouring streams at Kikiwa that drain contrasting land use types, a stream draining a horticultural area (Little Sydney), and some significant tributaries (Baton, Stanley Brook and Motupiko at Quinneys).

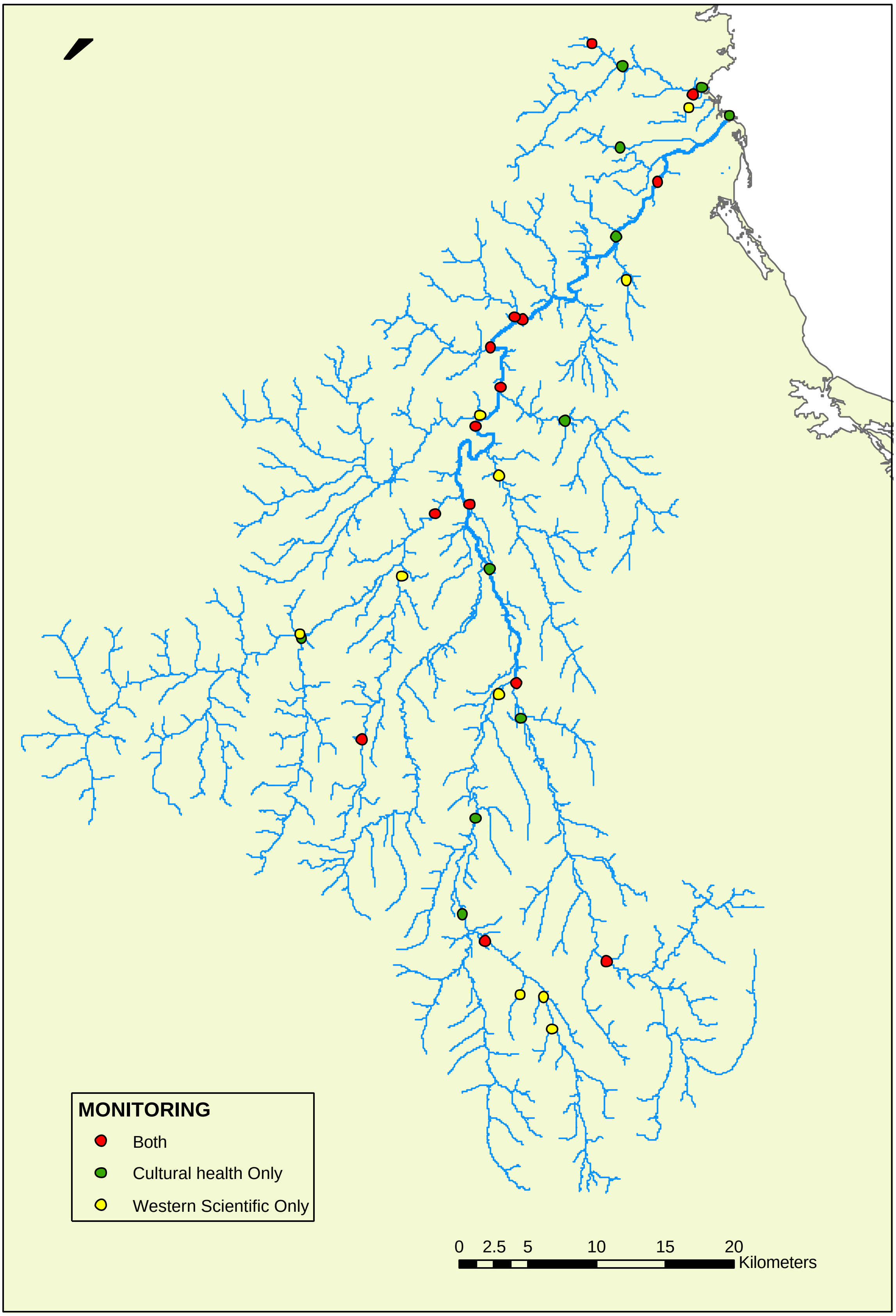

Figure 3 Map of the Motueka Catchment showing monitoring sites and the type of monitoring undertaken at each site.

3.2.2 Correlations among cultural and scientific indicators

The stream health component of the cultural health indicator (subsequently referred to as the cultural stream health measure or CSHM) was significantly correlated with all of its component scores. There was a very close correlation between the CSHM and the 'puku' score ($r = 0.95$) indicating that the single score based on the 'feeling in the puku' about the site was similar to the more robust CSHM involving scoring on separate components relating to the health of the site. There was also a relationship between the CSHM and the mahinga kai score ($r = 0.72$), although mahinga kai scores were generally lower at each site than the corresponding CSHM score (Figure 4).

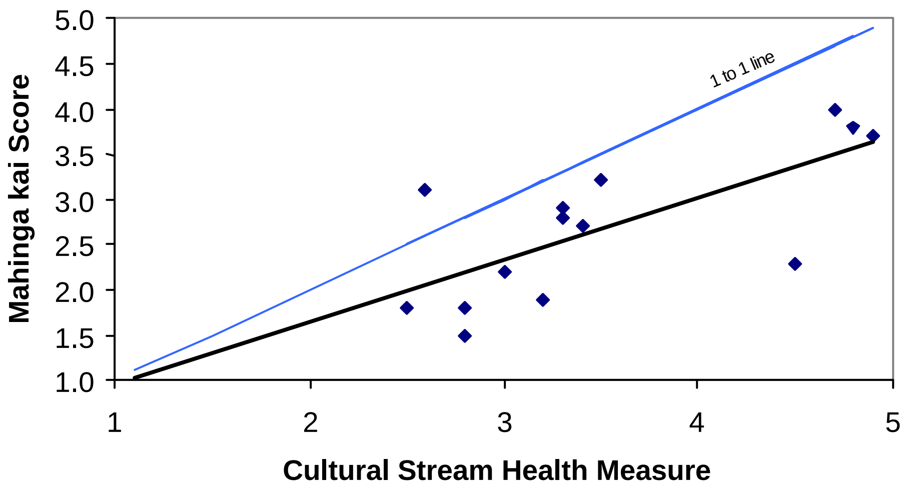

Figure 4: Relationship between the cultural stream health measure and the mahina kai score.

When compared against western scientific indicators, the CSHM score was correlated with the percentage of native vegetation in the catchment upstream of each site (Figure 5). There were also weak relationships between the CSHM and water clarity, the concentration of *E. coli*, and the semi quantitative version of the macroinvertebrate community index (SQMCI; Figure 5), although these were not quite statistically significant at the $p<0.05$ level. In contrast to Townsend et al. (2004) we found no significant relationship between the CSHM and the presence-absence version of the MCI ($r = 0.30$). This was somewhat surprising since the MCI and SQMCI are often closely correlated (Stark 1998), however, this was not observed with this dataset ($r = 0.32$). There was also no evidence of any relationship between the CSHM and median nutrient concentrations or periphyton score.

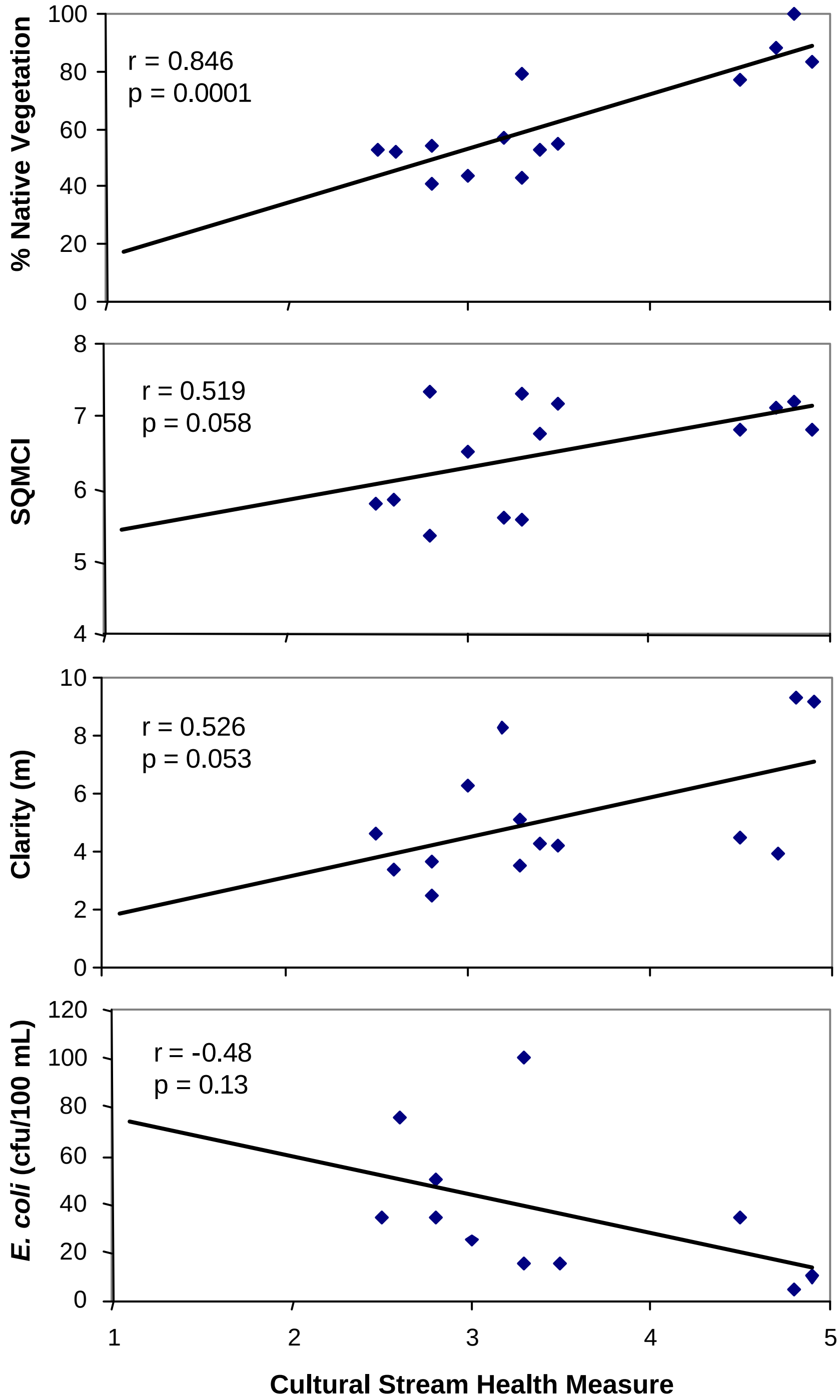

Figure 5: Relationship between cultural stream health measure and % native vegetation in the catchment upstream, the semi-quantitative version of the macroinvertebrate community index (SQMCI), water clarity, and concentration of faecal indicator bacteria (*E. coli*)..

3.2.3 Patterns in indicator responses throughout the Motueka Catchment

Sites in the southern and western headwaters of the Motueka Catchment were given relatively high cultural stream health measure scores, whereas sites in the lower river generally scored poorly. The site in the Dove, an eastern tributary, was also scored poorly, along with relatively low scores in the upper Sherry River, mid reaches of the Motupiko River, and the Motueka River upstream of the confluence with the Wangapeka (Figure 6). A relatively similar pattern was seen with scores from the SQMCI, with high scores in the southern and western headwaters and low scores in tributaries near the river mouth (Figure 7). Low SQMCI scores were also evident in the Waiwhero Stream, another eastern tributary (Figure 7). In contrast to the cultural health indicator, the lower reaches of the Motueka mainstem had satisfactory SQMCI scores (Figure 7).

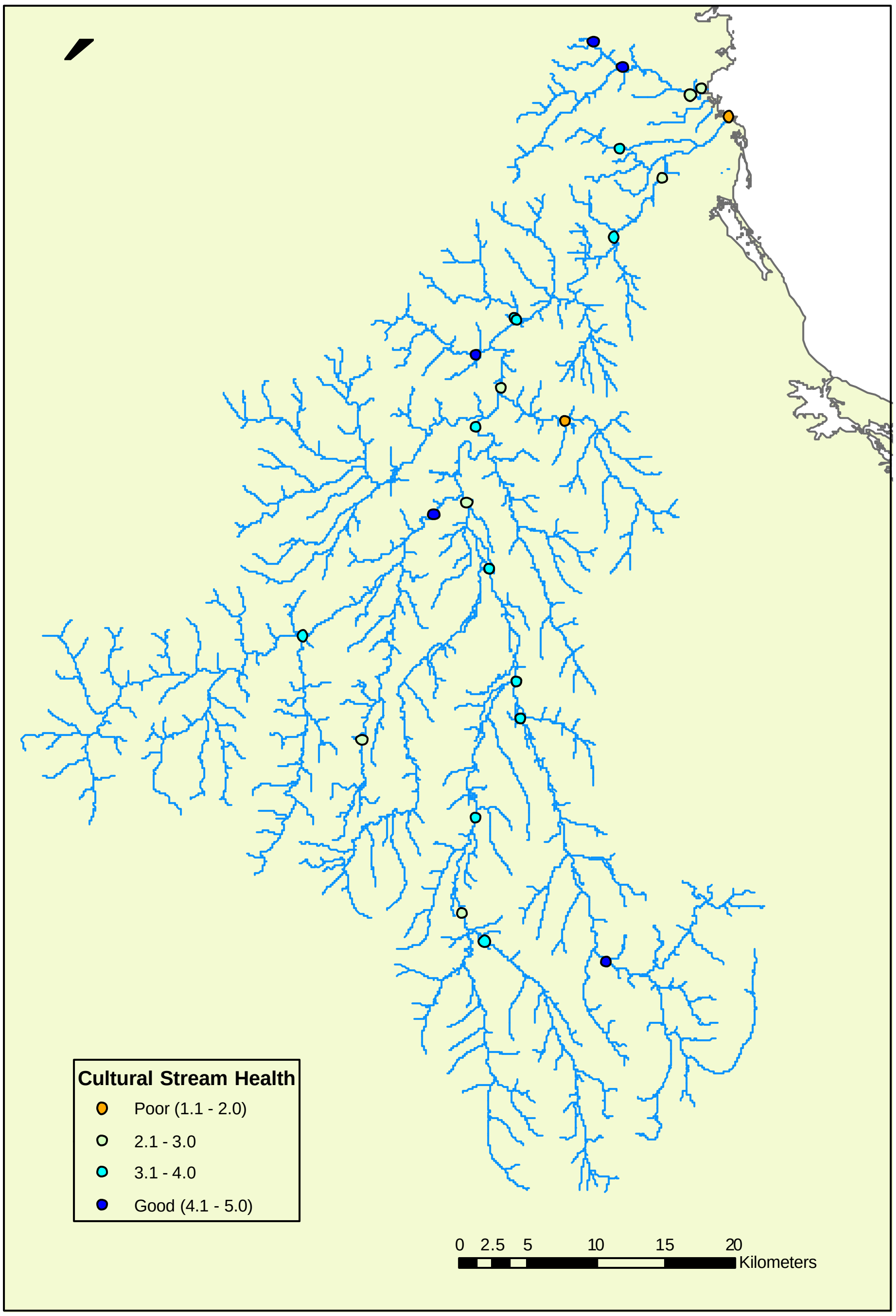

Figure 6: Map showing the distribution of cultural health scores throughout the Motueka Catchment.

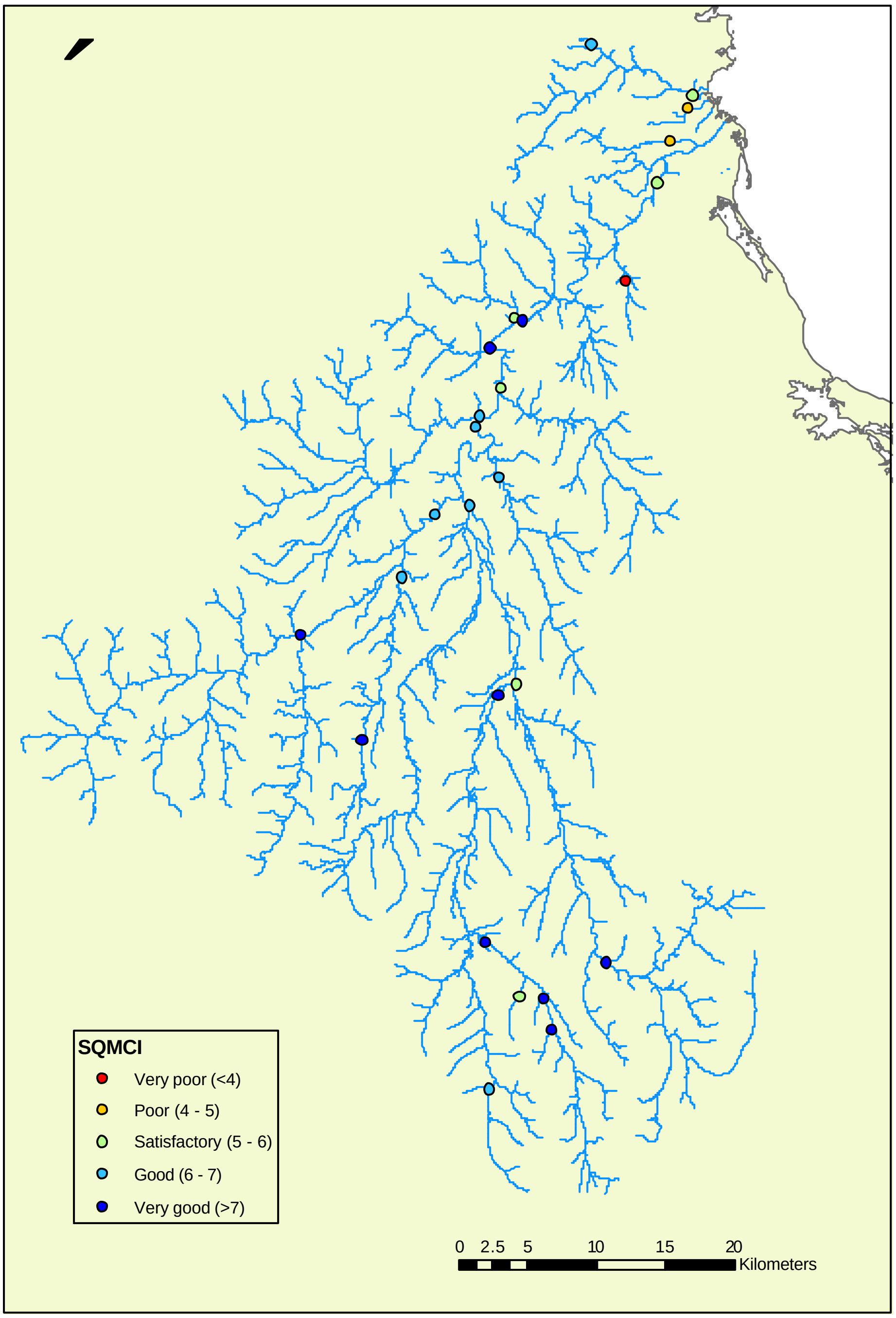

Figure 7: Map showing the distribution of scores from the semi-quantitative version of the macroinvertebrate community index (SQMCI) throughout the Motueka Catchment.

4 DISCUSSION

4.1 Shared learning

Collaborative research has been carried out within the ICM research programme with a wide range of stakeholder and community groups. The research has highlighted the importance of understanding other groups and stakeholder perspectives and values at the regional, catchment, and local level. For science researchers the collaborative process has been essential for understanding indigenous concepts and values, knowledge, and frameworks, and to determine the relevance of biophysical and social research for Maori. The shared learning has enabled the researchers to recognise and respect the status and authority of indigenous Maori (tangata whenua) and their representatives and constituencies. Working with Maori in ICM research has therefore taught ICM researchers a great deal about working in another cultural dimension, seeing the world from a different perspective, one that uses different concepts, approaches, and frameworks. Shared learning therefore provides a pathway for a more complete understanding of catchment ecosystems and processes – using a broader knowledge base that now includes indigenous knowledge and values. Effective collaboration through a variety of ICM-iwi/hapu projects subsequently improves access and uptake of science and technical information to Maori groups and improves the relevance of science to iwi/hapu.

Establishing the right learning environment has therefore been an integral part of ICM for increasing multi-stakeholder engagement and building meaningful relationships, particularly with iwi and hapu.. As research is carried out and lessons are learnt, knowledge from the programme has been regularly documented and evaluated. Specific collaborative projects, such as the "cultural indicators project", are examples of this commitment to shared learning from different world views, expand and produce new knowledge, and directly build capacity for iwi/hapu groups and researchers alike. The Motueka ICM research with Maori is being used to recognise and utilise indigenous knowledge,, better align science research to iwi and hapu issues and priorities (i.e. making it more relevant), identify specific iwi and hapu information needs, determine best modes of information transfer, develop opportunities for participatory research, and increase the bicultural knowledge base (mainstream science and cultural) on which understanding and decisions are made and therefore improve capabilities for decision-making to achieve sustainable management of natural resources.

4.2 Complementary aspects of the approaches

Scientifically based and culturally-based indicators, along with community-based approaches, provide a complementary model of how assessment, monitoring and indicators could be used in future to provide a fuller understanding of the changes in the environment from different world-views (Table 6). Epistemologies, methodologies, purpose, and indicators, on which each is based are different. Together they provide an enriched understanding of the environment and each offer a slightly different worldview in terms of making an assessment about the health of freshwater systems. With this complementary model, different forms of assessment and monitoring can be used side by side by local government, community, iwi and hapu, and research agencies. No particular group is excluded from working across a range of assessment types in each column, except that a certain level of expertise and specialist knowledge is required for each. The three main categories are explained below:

Column 1 (left)
Maori assessment and monitoring based on Maori knowledge (matauranga Maori) and Maori values requires in-depth cultural understanding, conceptual frameworks, and culturally based expertise and skill. These are usually carried out using Maori frameworks and methods.

Table 6: Complementary assessment/monitoring approaches (adapted from Harmsworth 2002)

Maori knowledge or culturally based	Community–scientific based	Professionally based – including scientific or technical assessments
Cultural impact assessment (CIA) Iwi monitoring of cultural-heritage sites Iwi monitoring of contaminated sites Cultural health index Maori wetland, ngahere and estuarine indicators Culturally based environmental indicators Require in-depth Maori knowledge and understanding of particular environments and issues Understanding of Maori values, goals, and aspirations. Examples: • Maori values • Cultural sites, Mahinga kai, pa, kainga • Cultural history • Taonga lists • Te Mauri • Knowledge on uses and preparation of taonga • Land management, development issues • Cultural information systems, GIS Could include culturally based assessments for river and stream water quality Coastal survey and monitoring of marine environs.	SHMAK Waterway Self Assessment Form Community based environmental performance indicators Amateur surveys Require moderate levels of technical input and skill but scientifically robust and part-value based. Cost effective, relatively simple and short duration. Examples: • Stream and river condition and health • Community based indicators • Community values • Community coastal surveys • Non technical assessments • School monitoring programmes	River and stream water quality monitoring methods Coastal survey and monitoring Archaeological survey Scientific environmental indicators Laboratory analysis Require higher levels of technical input and skill, robust sampling strategies, analysis and interpretation, expensive. May be time-consuming. Examples: • Chemistry, water quality, nutrients • Hydrology • Water table modeling • Botanical mapping, classification of plants • pH • Bacterial counts, pathogens • Giardia, Cryptosporidium • GIS applications • Satellite imagery • Studies of fish, macroinvertebrates, macrophytes. • Archaeological survey

Frameworks may include Atua domains, whakapapa, kaupapa Maori, or other Maori worldviews. Analysis and interpretation from these types of assessments and monitoring should be carried out by tangata whenua. Examples include the use of a number of cultural monitoring approaches and indicators such as the Cultural Health Index (CHI; Tipa & Teirney 2006a,b, 2003, 2002; Tipa, 1999), Maori wetland indicators (Harmsworth 2002), cultural impact assessments (CIA; Walker et al. 2003, 2004), and other forms of iwi and hapu monitoring and assessment in a range of environments from terrestrial (Papatuanuku, Tane Mahuta) to the marine (Tangaroa, Hinemoana). These forms of assessment require comprehensive training and being largely qualitative require consistency across the collective, especially when applying methods. Information can be used in planning, policy, projects, and for environmental and cultural reporting, such as SOE reports. Generally iwi/hapu researchers, kaitiaki groups, and Maori scientists and researchers are working in this category.

Column 2 (middle)

Community-based assessments, monitoring and indicators are usually based on or derived from simplified and meaningful scientific knowledge and concepts. These require limited to moderate scientific/technical measurement, or use semi-specialised techniques where indicators can be measured by community groups, non governmental organisations (NGO), industry groups, Maori organisations such as kaitiaki groups, regional and district councils, and researchers. Monitoring approaches use indicators that are cost effective, using more inexpensive field equipment than in scientific approaches. Community assessments and monitoring require a basic level of training and skill, and experience in recording, collecting and interpreting information. Assessments, monitoring and indicators in this category provide useful information to communities, local government, research agencies, and iwi and can be used to effectively monitor an environment over the long term by the community and can be used to develop planning and policy. Community-scientific monitoring is based on both qualitative and quantitative approaches but usually uses simpler assessment methods that require lower levels of training than scientific or Maori. It is therefore more cost effective than scientific monitoring but often not as objective or quantitative as in scientific approaches (Column 3). Examples include the SHMAK kit (NIWA 1998), the waterway self-assessment form (Polglase & Death 1998), and the national wetland indicators monitoring handbook (Clarkson et al. 2002 http://www.wetlandtrust.org.nz/).

Column 3 (right)

More objective scientific assessment usually requires specialist scientific knowledge, techniques, and often specialist equipment. It may include collection, measurement, and analyses of information such as water quality parameters (e.g. Appendix 2; pH, temperature, dissolved oxygen, turbidity, visibility, nutrients, flow, ammonia, nitrogen, phosphorus), contaminants, bacteria, micro-organisms, pathogens, biological material, toxic material, agrichemicals, heavy metals, algae, macroinvertebrates, nutrient modelling, sediment surveys. Specialist science skills are used to design robust sampling strategies and then collect, measure, record data and analyse and interpret the information. Examples of this category include much of the science being carried out in the ICM programme (Basher 2003) and especially the water health monitoring (Young et al. 2005a). Information from these types of research and assessments is of high level interest to regional and district councils, other research agencies, and iwi/hapu. Typically scientists, Maori and community groups with advanced scientific training will be working in this category.

4.3 Use existing scientific standards to guide interpretation of CHI scores

Although scientific and cultural indicators come from different perspectives, we have demonstrated that they are both successfully capturing aspects of river and stream health. Existing river and stream health standards based on science data could be used to align, articulate and define iwi /hapu values through interpretation of the CHI scores, although there is no suggestion that the two approaches should produce identical conclusions. Our results indicate that there is a relationship between the cultural stream health measure and % catchment in native forest, and possibly water clarity, SQMCI, and the concentration of *E. coli*. Standards for water clarity (for swimming), and *E. coli* concentrations are available (ANZECC 2000; MfE/MoH 2003) and guidelines for interpretation of SQMCI scores are also available (Stark 1998).

The most notable feature when comparing these standards with the cultural stream health measurements is the apparent mismatch between the scales of assessment. The cultural stream health assessments appear to be stricter and impose higher environmental standards than the stream health standards based on scientific data. For example, using the SQMCI, values greater than 6 are considered to represent excellent ecosystem health. Whereas, the regression line between SQMCI and CSHM indicates that a SQMCI value of 6 is equivalent to a cultural stream health score of only 2.3 (Figure 5) – some way from what would be considered excellent condition using the CSHM. We did not have any sites with CSHM scores below 2.5, or SQMCI values below 5.3, therefore it is problematic to extrapolate beyond the range covered. However, assuming that extrapolation was possible and the relationship was linear throughout the range, then a SQMCI value of 5 (which discriminates between sites of good and fair health) would be equivalent to a CSHM score of <1, which is not possible. Similarly, the water clarity guideline for swimming (1.6 m, ANZECC 2000) corresponds to a negative CSHM score if the observed relationship is extrapolated beyond the range covered with data. Ideally, we need to gather more comparative data from low quality sites to better understand the relationship between cultural and scientific assessments.

The relationship between CSHM and MCI that was observed by Townsend et al. (2004) for sites in the Taieri and Kakaunui rivers were more closely aligned with each other. For example, a MCI score of 120 (which distinguishes between clean water and possible mild pollution) was equivalent to a CSHM score of 4.1, a MCI score of 100 (which distinguishes between possible mild pollution and probable moderate pollution) was equivalent to a CSHM score of 2.9, and an MCI score of 80 (which distinguishes between probable moderate pollution and probable severe pollution) was equivalent to a CSHM score of 1.6 (Figure 8). This relationship gives some guidance as to how the CSHM could be interpreted, with scores below 2 indicating poor stream health, scores between 2 & 3 indicating some concerns, score between 3 & 4 indicating possible mild pollution, and scores above 4 representing good stream health. However, the interpretation of the scores is likely to vary among different iwi depending on the thinking/beliefs/values of the monitoring team.

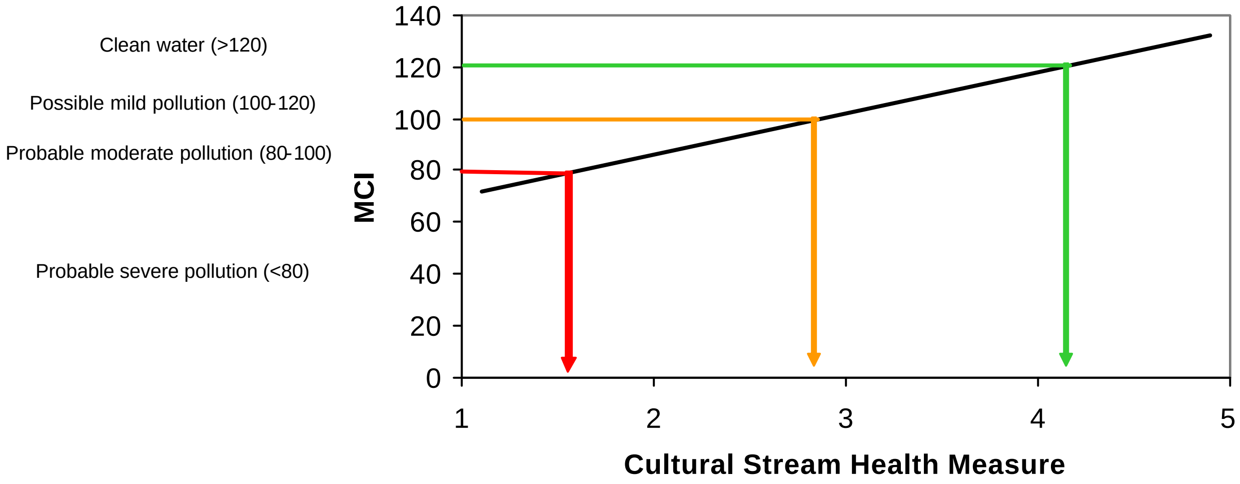

Figure 8: Guidelines for interpreting MCI values and equivalent cultural stream health measures – based on relationship between MCI & CSHM observed by Townsend et al. (2004).

5 CONCLUSIONS

We conclude that the use of scientific approaches and culturally based monitoring and indicators provide a wealth of knowledge to better understand river and stream health and the changing state of freshwater ecosystem health. The two approaches can be regarded as complementary and reflect two different knowledge systems and perspectives.

It is important to continue using monitoring approaches side by side to provide a more complete holistic understanding of human values, uses, perceptions and attitudes. These values (priorities and preferences) are transformed into differing environmental aspirations, policy, standards and guidelines which dictate resource use and management and can illustrate reasons for conflict. They therefore provide an indication through assessment, to human values, perception, belief which is shown in behaviour when issues arise during resource management conflict.

This research shows that it is very important that scientific monitoring approaches and indicators are not just compared to cultural approaches and indicators to show weaknesses and fallacies, but used side by side to illustrate different perspectives and articulate differing sets of values and human desires (Reed et al. 2008). The scientific indicators were more objective and directly measured at each site, while the cultural indicators were largely qualitative and relied on consistent iwi training and shared cultural knowledge.

6 USEFUL LINKS

The ICM programme
http://icm.landcareresearch.co.nz/

http://icm.landcareresearch.co.nz/research/theme.asp?theme_id=2 (Freshwater)

Maori and ICM

Indigenous knowledge and values (Landcare Research website)

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Appendix 1a: Motueka Iwi Indicators form – Freshwater/Wai

<table>
<tr><td colspan="2">Name of Waterway:</td><td colspan="3">Landholder: DoC, Public, Private, Other</td></tr>
<tr><td colspan="2">Catchment:</td><td colspan="3" rowspan="2">Adjacent landuse: 1 Pasture 2 Horticulture
3 Native 4 Exotic forest 5 Scrub 6 Residential
7 Commercial 8 Industrial 9 Recreational
(circle as appropriate)</td></tr>
<tr><td colspan="2">Site Number:</td></tr>
<tr><td colspan="2">Date:</td><td colspan="3">Site Status: A Traditional B Non Traditional</td></tr>
<tr><td colspan="2">Time:</td><td colspan="3">Mahinga Kai: 1 Present 2 Absent</td></tr>
<tr><td colspan="2">Coordinates:</td><td colspan="3">Future: 1 Will return to manage 2 Wouldn’t return</td></tr>
<tr><td>Name:</td><td></td><td></td><td></td><td></td></tr>
<tr><td>TANGAROA</td><td>Rating 1-5</td><td>Rating 1-5</td><td>Rating 1-5</td><td>Comments</td></tr>
<tr><td>1. Riverbank Condition</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2. Sediment on Riverbed</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3. Water Clarity</td><td></td><td></td><td></td><td></td></tr>
<tr><td>4. Water Flow</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5. Water Quality</td><td></td><td></td><td></td><td></td></tr>
<tr><td>6. Shape and Form of River</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7. Insect Life (method, no. & species)</td><td colspan="4"></td></tr>
<tr><td>8. Fish (method, no. & species)</td><td colspan="4"></td></tr>
<tr><td>TANE MAHUTA</td><td>Rating 1-5</td><td>Rating 1-5</td><td>Rating 1-5</td><td>Comments</td></tr>
<tr><td>9. Riparian Vegetation</td><td></td><td></td><td></td><td></td></tr>
<tr><td>10. Catchment Vegetation</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11. Bird Life (method, no. & species)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>12. Ngahere/Taonga</td><td colspan="4"></td></tr>
</table>

13. Pest plants/animals				
HAUMIE TIKETIKE and RONGO MATANE				
14. Mahinga Kai (no. & species)				
15. Rongoa (no. & species)				
TUMATAUENGA	Rating 1-5	Rating 1-5	Rating 1-5	Comments
16. Use of River				
17. Use of River Margins				
18. Access to River				
19. Cultural Site	(Yes/No) Type			
TAWHIRI MATEA	Rating 1-5	Rating 1-5	Rating 1-5	Comments
20. Smell of River				
21. Weather				
OVERALL HEALTH – ORA	Rating 1-5	Rating 1-5	Rating 2-5	Comments
22. Feeling in puku				

Attachments:

Photos: Y/N

Map: Y/N

Drawings: Y/N

Comments/Recommendations:
Map and or Drawings (use additional paper if required):

Appendix 1b. Notes for Motueka Iwi Indicators form

Indicator	Examples for rating 1 to 5, Questions to assist in decision making, Notes on sampling methods
TANGAROA	
1. Riverbank Condition	1 ~ Human induced erosion / modification 5 ~ No human induced erosion / modification
2. Sediment on Riverbed	1 ~ Covered in slime / mud / sand / sediment / weed 5 ~ Clear of slime / mud / sand / sediment / weed
3. Water Clarity	1 ~ Water is badly discoloured 5 ~ Water is clear
4. Water Flow	1 ~ The flow sounds dead / monotone 5 ~ The flow sounds alive / many tones
5. Water Quality	Q ~ Would you drink the water, eat fish from it, swim in it? 1 ~ Appears polluted by foam, oil, slime, weed etc. No way would I drink it! 5 ~ No pollution evident. Water is more than suited to drinking.
6. Shape and Form of River	Q ~ Are there a variety of habitats, pools, riffles and rapids? 1 ~ Little or no current, uniform depth. 5 ~ Current and depth varies, a variety of different flow related habitats.
7. Insect Life	Outline sampling method i.e. Observation over 10 minutes of flying insects i.e. Lifted 5 rocks and noted insects' present in-stream. Note species and numbers.
8. Fish Species	Outline sampling method i.e. Electric fishing, spotlighting, netting etc. Note species and numbers.
TANE MAHUTA	
9. Riparian Vegetation	Q ~ Is there vegetation present within 20m of a stream or 50m of a river. And does it shade the waterway? 1 ~ Little or no riparian vegetation – neither exotic or native 5 ~ Complete cover of mainly native vegetation
10. Catchment Vegetation	Q ~ What is the mix of Pasture, Horticulture, Native, Exotic Forestry, Other? 1 ~ Only one or two types of exotic vegetation 5 ~ Wide variety of native or native/exotic vegetation
11. Bird Life (Manu)	Outline sampling method i.e. Observation over sampling time i.e. Observation over 10 minutes. Note species and relative numbers. Is the bird song weak or strong?
12. Ngahere Taonga	Note main plant species. Are there opportunities for timber, fruit, or fibre harvest? Are trees seeding? Do plants have special characteristics/properties? Do areas include rocks/stone that has been used for cultural use? e.g. pakohe (argillite).
13. Pest plants/animals	Note species and negative effects. Has any control taken place? If so has it been successful?
HAUMIE/RONGO	
14. Mahinga Kai	Note plant, animal, fish, bird species. Are they harvestable both in quality and quantity?
15. Rongoä	Note plant species. Are they harvestable both in quality and quantity?

TUMATAUENGA	
16. Use of River	Q ~ Is the river being used well? 1 ~ Gravel extraction is excessive, few opportunities for recreation / cultural use, fish passage is poor, vehicles are driving in river 5 ~ Gravel extraction is light or non existent, opportunities for recreation / cultural use abundant, fish passage not artificially blocked, vehicles do not have access to water
17. Use of River Margins	Q ~ Do stock have unfettered access to waterway? Is the dumping of rubbish occurring? Do Council river works maintain the mauri and wairua? 1 ~ River margins are heavily modified or overused. 5 ~ River margins are lightly modified or lightly used.
18. Access to River	Q ~ What is the legal and physical access to the river like? 1 ~ Poor legal and/or physical access 5 ~ Good legal and/or physical access
19. Cultural Site Note site type	Q ~ If the site is an archaeological /cultural site how has it been looked after? Note modifications, destruction, erosion, etc. 1 ~ Cultural site has been poorly looked after 5 ~ Cultural site has been well looked after
TAWHIRI MATEA	
20. Smell of River	Q ~ Does the river have a natural or unnatural smell? 1 ~ River has an offensive or unnatural odour 5 ~ River has a natural smell
21. Weather	1 ~ Wet and cold 2.5 ~ Overcast and mild 5 ~ Sunny and overcast
ORA/WAIRUA/MAURI	**OVERALL HEALTH**
22. Feeling in puku	1 ~ Overall gut feeling about the site is poor 5 ~ Overall gut feeling about the site is excellent
23. CHI score (Motueka)	Calculated from the average score of components 1, 2, 3, 4, 5, 6, 9, 10, 16, 17, and 20.
24. CHI score (Ngäi Tahu)	Calculated from the average score of components 2, 3, 5, 6, 9, 10, 16, and 17.

- Photos Include direction taken
- Map Include scale, north arrow, river, fences, roads, notable trees and other features
- Drawings Include drawings of any artefacts found and note destination of artefacts/köiwi
- Comments/Recommendations for improvement/Ideas for additional indicators/Action points

Appendix 2: Freshwater science indicators that are typically measured for State of the Environment monitoring

Key parameters measured	**Range (guidelines)**
Dissolved oxygen DO (% Saturation or mg/L) Many species can not tolerate low dissolved oxygen concentrations	Daily minimum of >80% saturation or >6.5 mg/l is healthy. Can get large daily changes – minimum will occur at dawn.
Temperature (°C) Warm water temperatures are a problem for many species Measured as spot readings or preferably with a logger that records temperature continuously.	Temperature halfway between daily mean and maximum of <20°C is healthy. Temperature shall not be changed by more than 3°C Excellent <20°C Satisfactory 20-24°C Poor >24°C
Baseflow Water Clarity (m) Underwater visibility Affects fish feeding and plant growth and also an indicator of sediment inputs and sediment deposition on the riverbed.	Excellent: >5 m Satisfactory: 1.6–5 m Unsatisfactory: <1.6 m Depends on catchment geology – some rivers are naturally turbid
Turbidity (NTU) Closely linked with water clarity. Restricts plant growth, fish feeding and an indicator of sediment inputs and deposition.	Excellent: <0.5 NTU Satisfactory: 0.5-5 NTU Unsatisfactory: >5 NTU
pH (acidity-alkalinity) Affects plants and fish	~6-9 (maintain health) Shall not be changed by >0.5 Excellent: 7-8 Satisfactory: 6-7 or 8-9 Unsatisfactory, unhealthy: <6 or >9
Dissolved reactive phosphorus (g P/m^3) Promotes algal blooms if phosphorus is limiting algal growth	Excellent: <0.005 g P/m^3 Satisfactory: 0.005-0.01 g P/m^3 Unsatisfactory: >0.01 g P/m^3
Dissolved inorganic nitrogen (g N/m^3) Promotes algal blooms if nitrogen is limiting algal growth	Excellent: <0.07 g N/m^3 Satisfactory: 0.07-0.44 g N/m^3 Unsatisfactory: >0.44 g N/m^3
Flow Some organisms prefer fast deep water while others prefer slow shallow water	Minimum flow set to match historical minimum or to protect % of habitat for particular species that would be available during average annual low flows.
Escherichia coli (*E. coli*) no. /100ml Indicator of faecal contamination of water by humans or stock. Relevant to suitability for human drinking water, contact recreation and stock drinking	Contact recreation limits <260 cfu/100ml (acceptable) 260-550 cfu/100ml (alert) >550 cfu/100ml (action)
Periphyton Important food resource, but blooms can cause water quality problems, affect aesthetic values and restrict habitat availability	Periphyton scores based on types and cover of periphyton >8 Excellent <8 Unsatisfactory
Stream invertebrates Measures include richness, diversity and presence/absence of sensitive indicator species (MCI. SQMCI)	Healthy stream (MCI>120; SQMCI>6) Mild pollution (MCI 100-120; SQMCI 5-6) Moderate pollution (MCI 80-100; SQMCI 4-5) Poor –severe pollution (MCI<80; SQMCI<4)

Appendix 3: List of sites showing types of monitoring data available

Site	CHI	Western Scientific
Motueka @ Hinetai	Yes	Yes
Motueka @ Woodstock	Yes	Yes
Wangapeka @ Walter Peak	Yes	Yes
Motupiko @ Christies	Yes	Yes
Sherry @ Cave	Yes	Yes
Motueka @ Gorge	Yes	Yes
Motueka d/s Graham	Yes	Yes
Motueka @ Woodmans	Yes	Yes
Riwaka @ Source	Yes	Yes
Riwaka @ Hickmotts	Yes	Yes
Motueka @ Kohatu	Yes	Yes
Motueka @ McLeans	Yes	Yes
Graham River @ Pokororo	Yes	Yes
Pearse	Yes	Yes
Motueka @ Mouth	Yes	No
Upper Brooklyn	Yes	No
Dart u/s Wangapeka	Yes	No
Motueka @ North Road	Yes	No
Motupiko @ Korere	Yes	No
Motueka @ Tapawera	Yes	No
Dove @ Dovedale	Yes	No
Motupiko @ Atapo	Yes	No
Motueka @ Alexanders	Yes	No
Waiatua @ Puketawai	Yes	No
Riwaka @ Moss Reserve	Yes	No
Graham Stream @ Kikiwa	No	Yes
Hunters Stream @ Kikiwa	No	Yes
Kikiwa Stream @ Kikiwa	No	Yes
Little Sydney @ Factory Road	No	Yes
Sherry @ Blue Rock	No	Yes
Stanleybrook @ Barkers	No	Yes
Waiwhero @ Cemetry	No	Yes
Wangapeka u/s Dart	No	Yes
Baton @ Ford	No	Yes
Motupiko @ Quinneys	No	Yes