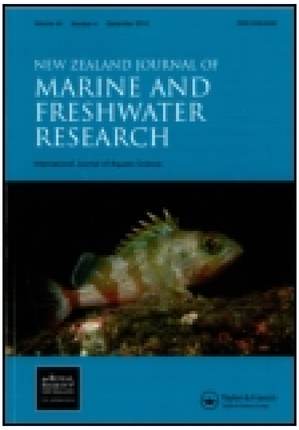

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Linkages between cultural and scientific indicators of river and stream health

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Scientific monitoring of river health is well established and has a significant role to play in environmental assessment by communities, managers and policy makers. Cultural indicators help to articulate cultural values, assess the state of the environment from a cultural perspective and assist with establishing a role for Māori in environmental monitoring. We reviewed the philosophies behind cultural and scientific monitoring of river health and compared the results from the two approaches at 25 sites in the Motueka and Riwaka catchments. Both scientific and cultural indicators suggested a decrease in river health in relation to increased land-use pressure. There were also correlations between the results from the two approaches suggesting cultural indicators could be used in a similar manner as scientific indicators to set environmental benchmarks. Using scientific approaches alongside culturally based monitoring provides a wealth of knowledge to understand better what we mean by river health. The two approaches can be regarded as complementary and reflect two different knowledge systems and perspectives.

Keywords: Cultural health index; Māori; resource management; ecosystem health; mauri

Introduction

The concept of river health incorporates both ecological and human aspects. A healthy river is described as 'an ecosystem that is sustainable and resilient, maintaining its ecological structure and function over time while continuing to meet societal needs and expectations' (Meyer 1997). 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. These values can be intrinsic (e.g. species have a right to exist) or instrumental (e.g. tourism value of trout fishery). Different groups of stakeholders (e.g. farmers, fishers, developers) typically have differing values that reflect their background, needs and aspirations. In New Zealand, Māori people have a unique set of values that are associated with the environment, and resource management agencies have a statutory obligation to recognise the Māori view when managing the use, development, and protection of natural and physical resources (Resource Management Act 1991). The aim of this study is to investigate the linkages between traditional and western philosophies of river health in New Zealand by comparing monitoring approaches and results in a case study of the Motueka and Riwaka rivers (Young et al. 2008).

The standards and guidelines that are set for New Zealand streams, rivers and lakes usually reflect a combination of society needs and values (Reed et al. 2008) and are based on finding a collective balance between stakeholders such as

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industry, community, iwi, government and science. A measure of river health generally requires a comparison with reference or minimally disturbed state (Stoddard et al. 2006). For example, what range of species and habitats could be supported at this site? Guidelines often reflect how the physical, chemical and biological condition of the water and channel meets the needs of people and ecosystems (Niemi & McDonald 2004). For example, how much water can be extracted before life-supporting systems are compromised? What are minimum low flows? What are acceptable limits for turbidity, sediment, algal growth, periphyton, invasive pests and gravel extraction? Common goals and objectives for water quality standards in New Zealand include acceptability for swimming and food gathering (i.e. human health), acceptability for stock drinking and irrigation, and life-supporting capacity. Other objectives for river systems include maintenance of channel capacity to protect human life and property, public access for recreation and landscape aesthetics.

The traditional Māori worldview acknowledges a natural order to the universe, built around the living and the non-living, and the central belief that all parts of the environment are interrelated or interdependent through the domains of Atua or Departmental Gods. Traditionally, Māori believe that small shifts in the mauri or life force of any part of the environment, for example through use or misuse, will cause shifts in the mauri of immediately related components, which could eventually affect the whole system. Within this framework, spiritual qualities guide resource use through an elaborate system of ritenga/kawa, or customary rules, with goals to regulate and sustain the wellbeing of people, communities and natural resources. Guiding values and concepts include kaitiakitanga, tapu, mauri, rahui, mana, noa and wairua (see Table 1 for a glossary of Māori words). In the context of monitoring and management, such values shape the way Māori think about issues, form the basis for decision making and are fundamental for determining aspirations, needs and priorities.

Table 1 Glossary of Māori words

Māori term	Meaning
Atua	God, deity, supernatural being
Hapu	Sub-tribe, extended family
Iwi	Tribe
Kaitiaki	Guardians or the agent who practices kaitiakitanga
Kaitiakitanga	To exercise guardianship or stewardship of the environment and tikanga
Mahinga kai	Cultivation sites, gardens, places of food harvest and collection
Mana	Prestige
Marae	Social cultural centre, village
Mātauranga Māori	Māori knowledge
Mauri	Life force, metaphysical component of all things
Ngahere	Forest
Noa	Free from tapu, unrestricted
Puku	Stomach, centre
Rahui	Restrictions
Ritenga/Kawa	Rules, guidelines
Ronga	Traditional medicines and treatments, cure, heal
Tangata whenua	People of the land, having an ancestral link and authority to a given area
Tapu	Sacred, off-limits
Taonga	Something treasured, iconic, highly valued
Te Tau Ihu	Tribes of the northern part of the South Island (e.g. Ngāti Rarua, Te Āti Awa, Ngāti Tama, Ngāti Koata)
Tikanga	Customary values, rules, and practices
Wai	Water
Wairua	Spiritual dimension

Māori groups have been developing indicator and monitoring tools through reference groups, forums and related projects (e.g. Townsend et al. 2004; Tipa & Teirney 2006a, 2006b). Key goals of iwi/hapū monitoring in flowing waters typically include a desire to maintain the mauri of rivers and enhance the relationship and connection between iwi/hapū and place; maintain and enhance the customary use of resources in the catchment and revitalise matauranga Māori of cultural resources; improve access; maintain, protect and enhance the diversity and condition of cultural resources/taonga; and maintain and enhance Māori wellbeing.

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). Community-led monitoring programmes involve, educate and empower local communities. Examples of community-scientific monitoring in New Zealand include the Stream Health Monitoring and Assessment Kit (Biggs et al. 1998), the national wetland indicators monitoring handbook (Clarkson et al. 2002), the Waterwatch programme (http://www.lincoln.ac.nz/About-Lincoln-University/outreach/Water-Watch/), WaiCare (http://www.waicare.org.nz/) and EMAP (http://www.emap.rsnz.org/index.php). Community-scientific monitoring often shows strong correlations to scientific monitoring (e.g. Kilroy & Biggs 2002; Larned et al. 2006). Identifying synergies between Māori-community monitoring, and scientific and community-scientific approaches may provide a platform to integrate multiple stakeholder views into resource management and policy development. The overall goal of this study is to introduce a cultural method adapted and refined to monitor river health in northern parts of the South Island, New Zealand, and to discuss linkages between cultural and scientific monitoring approaches and output.

The research presented here was an integral part of the Integrated Catchment Management (ICM) Programme. The ICM research programme began in July 2000 after extensive consultation with end-users, stakeholders and input from two international experts. In particular, Māori research contributed a significant Māori worldview to the programme and enabled alignment of ICM objectives to Māori needs and priorities. Cultural input provided a holistic approach to understanding the Motueka catchment and especially the interconnections between people and the physical, cultural and spiritual environment. The ICM programme with iwi/hapū helped build much needed capacity on both the iwi and science side for the duration of the programme. More details on the research programme can be found in related publications of this special issue and at the programme website: http://icm.landcareresearch.co.nz.

Materials and methods

Site selection

The study was conducted in the Motueka and Riwaka catchments in the upper South Island of New Zealand. The Motueka drains a catchment area of 2200 km^2 and flows in a northerly direction for 110 km from the headwaters to the sea. Mean annual rainfall ranges from <1000 mm/year on the eastern side of the catchment to 3500 mm/year on the western side. Median discharge at the bottom of the catchment is about 47 m^3/s with a mean annual low flow of about 13 m^3/s. Land use is varied and includes native forest in the southern and western headwaters, plantation forest across much of the eastern and central part of the catchment, and pastoral farming and horticulture along the valley floors. The Motueka catchment is geologically complex with a mix of ultramafic and sedimentary rock in the southeastern headwaters, a complex array of sedimentary rocks underlying the western tributaries, a band of granitic rock (Separation Point Granite) down the western centre of the catchment and a large band of alluvial gravel and clay (Moutere Gravels) down the eastern centre of the catchment (Young et al. 2005b). The catchment is sparsely populated with a total population of around 12,000, most of whom live in the town of Motueka near the river mouth. Six iwi—Ngāti Rārua, Ngāti Tama, Te Āti Awa, Ngāti Koata, Ngāti Apa and Ngāti Kuia—claim tangata whenua status over at least part of the Motueka and Riwaka catchments.

Study sites were chosen separately for the two monitoring approaches. Scientific monitoring sites were chosen to include a variety of dominant land uses (e.g. forestry, pastoral, native and horticulture) and a range of geological types (e.g. Moutere gravel, ultramafic, granite, karst). Sites ranged from 6% to 100% native vegetation cover in upstream catchments. Site selection for the cultural health monitoring was conducted with knowledge of the existing network of scientific monitoring sites and a final selection based on strong cultural interest or cultural issues, such as culturally significant sites (e.g. mahinga kai, taonga species), or sites where iwi/hapū had concerns about potential environmental impacts (e.g. impacts of land use, contaminants, effluent). Twenty-five sites overlap within the two monitoring networks, allowing comparison of the results throughout the catchments (Fig. 1).

Cultural monitoring and indicators

Iwi/hapū groups from the Motueka Catchment adapted a cultural health index (CHI) first developed in the Otago region (Townsend et al. 2004; Tipa & Teirney 2006a, b), and applied and tested it at sites throughout the Motueka and Riwaka catchments from 2006 to 2009. The monitoring assessment framework was organised into a cultural framework made

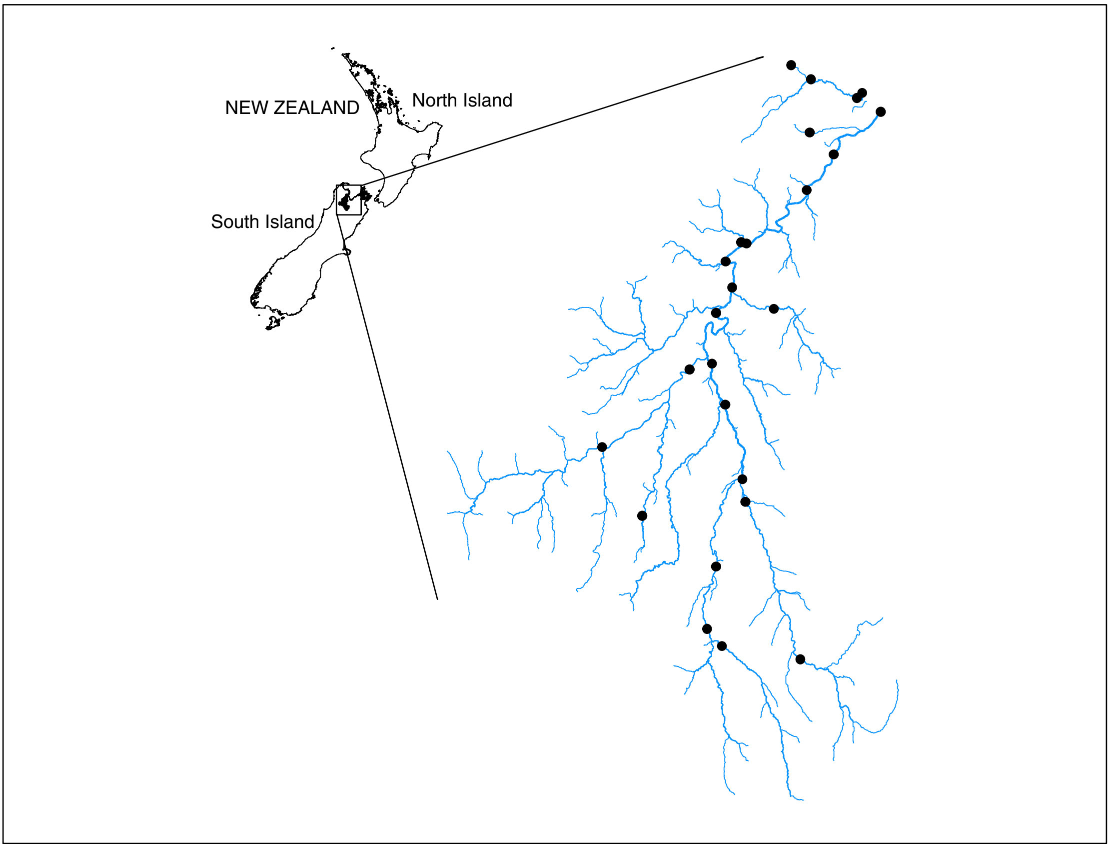

Figure 1 Location of 25 study sites in the Motueka and Riwaka river catchments, South Island, New Zealand.

up of Atua domains (Ngā Atua Kaitiaki) and a number of key indicators were selected (Table 2). Note all the Atua (deities) sit within Ranginui and Papatūānuku (from the traditional Māori belief system), as they are the children of the two primordial parents.

The range of cultural indicators were scored from 1 (poor) to 5 (excellent), with an overall cultural stream health measure (CSHM) calculated as the average of specific scores. Assessments of the mahinga kai status and traditional status of the sites were also undertaken. The CHI can be summarised in an aggregate score (e.g. A-1/2.9/4.1) that provides a holistic Māori perspective of stream and river health for planning, policy and decision-making. Three components make up the numeric index at any given river or stream site: establishing the relationship or association by tangata whenua, iwi/hapū (site status), evaluating mahinga kai values (mahinga kai measure) and assessing stream health (stream health measure). The method can be applied to an entire river and stream catchment, but was used to assess a river/stream segment in this study.

Scientific monitoring

Scientific monitoring has been conducted in the Motueka and Riwaka catchments since 2000

Table 2 Cultural monitoring assessment framework with key indicators organised into Atua domains.

Atua domains	
Ranginui (sky father, immeasurable universe)	Key indicators
Tangaroa (sea, coast, waterways)	Riverbank condition*[1]
	Sediment on riverbed*[1]
	Water clarity*[1]
	Water flow*[1]
	Water quality*[1]
	Shape and form of river*[1]
	Insect life (method, no. & species)
	Fish (method, no. & species)
Tāne mahuta (forests, birds, animals)	Riparian vegetation*[1]
	Catchment vegetation*[1]
	Bird life (method, no. & species)
	Ngahere/taonga (no. & species)
	Pest plants/animals (no. & species)
Haumia tiketike (wild foods)	Mahinga kai (no. & species)
	Traditional mahinga kai site*[2]
Rongomatāne (crops, peace, harvested resources)	Contemporary mahinga kai site*[2]
	Rongōa (no. & species)
Tūmatauenga (human made/human activities and conflicts/war)	Use of river*[1]
	Use of river margins*[1]
	Access to river*[2]
	Cultural site (descriptive)
Tāwhirimātea (air, wind)	Smell of river*[1]
	Weather*
Ora—Overall health	Feeling in puku*
Papatuānuku (earth mother, planet earth)	

*Indicators are assigned a score from 1 to 5. Scores are averaged to calculate a Cultural Stream Health Measure[1] and Mahinga kai score[2].

(Young et al. 2005a, b; Young & Collier 2009) and is an important component of Tasman District Council's (TDC) State of the Environment monitoring programme. Standard methods and equipment were used to measure and analyse key parameters (Table 3), including physicochemical parameters, dissolved nutrients and *E. coli* (APHA 2005) and macroinvertebrates (Stark 1998; Stark et al. 2001). Data collection occurred quarterly during base flows for all parameters except macroinvertebrates, which were sampled annually in summer. Values were averaged from 2006 to 2009 inclusive.

Results

Cultural and scientific philosophies

Epistemologies, purpose, methodologies and indicators differ greatly between cultural and scientific monitoring approaches (Table 4), although, it is important to note that no group is excluded from working across the range of assessment types. Cultural methods are qualitative and subjective based solely on observations, but do incorporate collective in-depth cultural and environmental experience and knowledge by local communities (e.g. mātauranga Māori, local and historical

Table 3 Guidelines for freshwater science indicators measured as part of State of the Environment monitoring in Motueka and Riwaka catchments.

Value	Key parameters measured	Guidelines
Life-supporting capacity	Dissolved oxygen (DO)	Healthy: $>80\%$ saturation or >6.5 mg/l daily minimum
	Macroinvertebrate community index (MCI) Semi-quantitative macroinvertebrate index (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)
	pH	Excellent: 7–8 Satisfactory: 6–7 or 8–9 Unsatisfactory: <6 or >9
	Dissolved reactive phosphorus (DRP)	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 (DIN)	Excellent: <0.07 g N/m^3 Satisfactory: 0.07–0.44 g N/m^3 Unsatisfactory: >0.44 g N/m^3
Acceptability for swimming or drinking water	Turbidity	Excellent: <0.5 NTU Satisfactory: 0.5–5 NTU Unsatisfactory: >5 NTU
	Escherichia coli (E. coli)	Contact recreation limits <260 cfu/100 ml (acceptable) 260–550 cfu/100 ml (alert) >550 cfu/100 ml (action)

Table 4 Complementary monitoring approaches in the study of river and stream health (adapted from Harmsworth 2002).

Monitoring approach	Skill requirements	Examples
Māori knowledge or culturally based		
Cultural impact assessment; iwi monitoring of cultural-heritage sites; iwi monitoring of contaminated sites; cultural health index; Māori wetland, ngahere and estuarine indicators; culturally based environmental indicators	Require in-depth Māori knowledge and understanding of particular environments and issues; understanding of Māori values, goals, and aspirations; good for problem definition	Māori values; cultural sites, mahinga kai, pā, kainga; cultural history; taonga lists; te mauri; uses and preparation of taonga; land management, development issues; cultural information systems; culturally based assessments of river and stream health; coastal survey and monitoring of marine environments
Community–scientific based		
Stream Health Monitoring and Assessment Kit; 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; good for problem definition.	Stream and river condition; community based indicators; community values; community coastal surveys; non technical assessments; school monitoring programmes
Professionally based		
Scientific or technical assessments; 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; may be expensive and/or time-consuming; good for providing insight to solutions	Water/sediment quality; biological sampling including fish, macroinvertebrates, macrophytes, riparian vegetation, ecosystem processes; bacterial counts, pathogens; geographic information systems; satellite imagery; hydrology; groundwater survey; archaeological survey

knowledge). Hence cultural indicators provide a holistic assessment of river health. Cultural methods rely on collective skills and consistency in the assessment method, which means a high degree of training and calibration among different monitoring personnel is needed in order to record, measure and detect long-term changes and trends in a local environment. However, observational techniques are comparatively cost-effective, requiring limited technical equipment or analysis. Cultural monitoring methods are good for identifying issues and defining a problem. Cultural monitoring programmes have a range of goals that encompass both the health of the waterway and the health of the community.

Scientific monitoring or technical assessment is considered more robust than cultural monitoring because it is uses methods and equipment that are well tested and peer reviewed. Scientific indicators are objective and quantifiable based largely on direct measurement, which often involves costly equipment and analysis. Hence, scientific methods can measure precise changes in river and stream health over time but generally require a high degree of professional expertise and experience to interpret the data. Indicators often measure specific components of stream health so a holistic assessment requires multiple indicators. The main aim of scientific monitoring is to assess the impact of human activities on the health of waterways and their ability to provide goods and services. Scientific monitoring may also identify the causes of a problem and thus provide insight into potential solutions (Table 4).

Community-scientific based monitoring bridges the aims and goals of cultural and scientific monitoring by fostering a connection between communities and waterways whilst assessing the impact of human activities on river health. Community-based monitoring and indicators are usually based on or derived from simplified and meaningful scientific knowledge and concepts. Indicators include both qualitative and quantitative approaches but usually use inexpensive equipment and simple assessment methods that require lower levels of training than scientific or Māori indicators. However, they may not provide sufficient definition to identify the causes of problems or find a solution.

Cultural and scientific indicators of stream health

CSHM scores ranged from 1.9 to 4.9 and were significantly correlated with all of its component scores. CSHM scores were strongly correlated with the 'feeling in the puku' score (Pearson's correlation: $R = 0.90$, $P < 0.01$) indicating the subjective summary site score was similar to the more robust CSHM. There was also a relationship between the CSHM and the mahinga kai score ($R = 0.47$, $P = 0.05$), although mahinga kai scores were generally lower at each site than the corresponding CSHM score. CSHM scores were strongly associated with percentage native vegetation in the catchment ($R = 0.75$, $P < 0.01$, Fig. 2A). CSHM was also correlated with the semi-quantitative macroinvertebrate community index (SQMCI; $R = 0.66$, $P < 0.01$, Fig. 2B) and MCI ($R = 0.53$, $P < 0.01$, Fig. 2C).

The MCI ranged from 72 to 138 and was correlated with percentage native vegetation ($R = 0.66$, $P < 0.01$, Fig. 3A), the semi-quantitative MCI ($R = 0.7$, $P < 0.01$, Fig. 3B) and *E. coli* ($R = -0.49$, $P = 0.02$, Fig. 3C). Semi-quantitative MCI scores ranged from 3.7 to 7.3, and were also correlated with percentage native vegetation ($R = 0.57$, $P = 0.04$). Other scientific indicators showed no significant correlations among metrics or relationship with land use.

River and stream health standards

The stream health of the greater Motueka and Riwaka catchments based on scientific guidelines is generally healthy to satisfactory (Fig. 4). Indicators suggest a range of guideline sensitivities with 25 out of 25 sites having healthy dissolved oxygen and *E. coli* levels, through to only seven out of 25 sites having excellent turbidity levels. In contrast, cultural indicators suggest less than a quarter of sites are healthy when values are assigned to guidelines where <2 is unsatisfactory, 2–4 is satisfactory and >4 is healthy (Fig. 4). The cultural 'feeling in the puku' assessment resulted in the least number of sites classified as healthy ($n = 4$) and the greatest number of sites having unsatisfactory stream health ($n = 4$).

Discussion

Linkages between indicators and stream health assessment

This research suggests that both scientific and cultural assessments are successfully capturing aspects of river and stream health, although results are generated from different perspectives and applications. Both the CSHM and macroinvertebrate metrics (MCI and SQMCI) had a strong relationship with percentage catchment in native vegetation, which is often used as a predictive measure of human impact on river systems (e.g. Young et al. 2005b; Death & Collier 2009). There was also a relationship between the CSHM and macroinvertebrate metrics. As such, existing river and stream

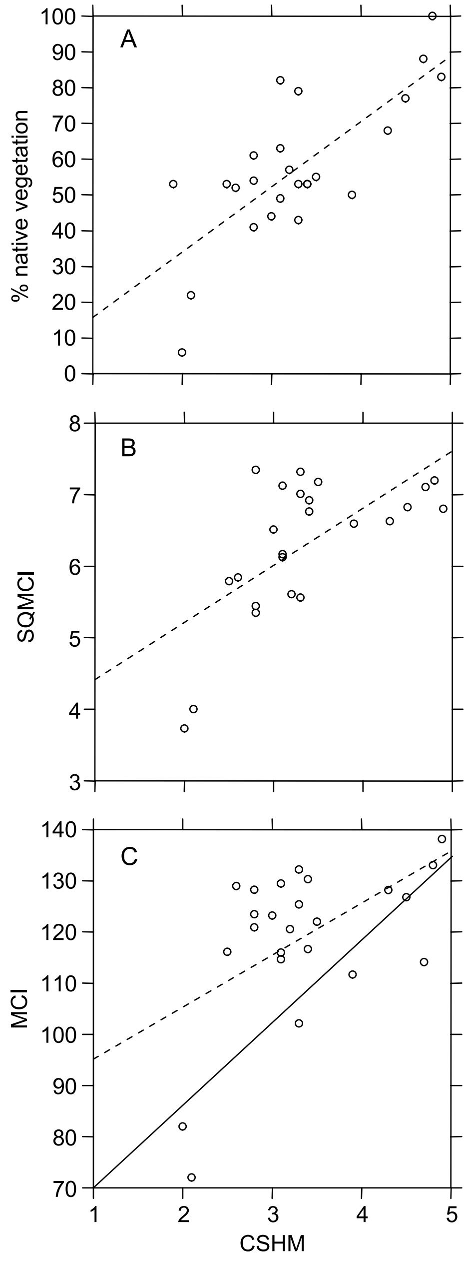

Figure 2 Relationship between the cultural stream health measure (CSHM) and **A,** percentage native vegetation in the catchment, **B,** semi-quantitative macroinvertebrate community index (SQMCI) and **C,** macroinvertebrate community index (MCI). Dotted line shows line of best fit. Solid line shows line of best fit observed by Townsend et al. (2004).

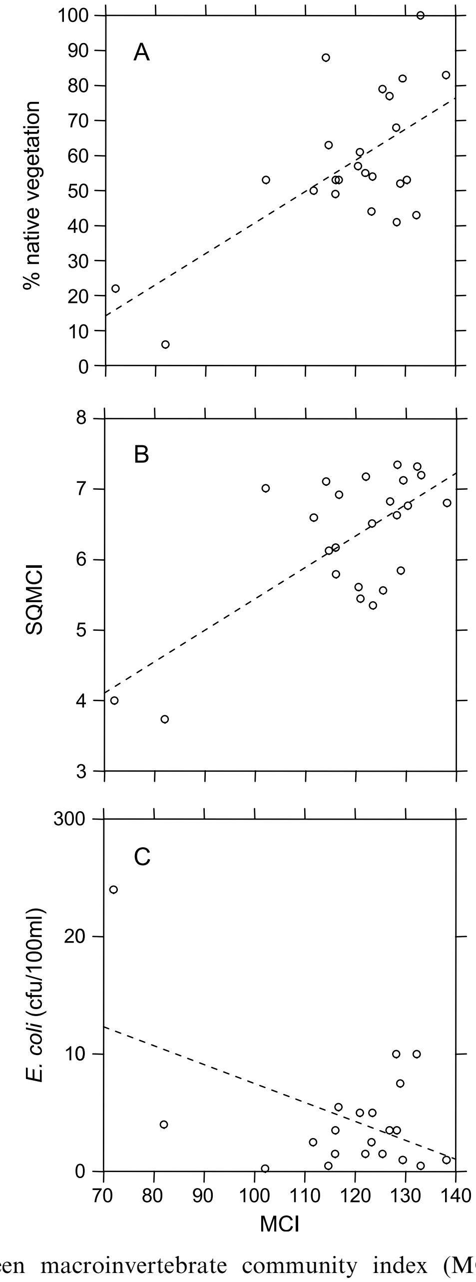

Figure 3 Relationship between macroinvertebrate community index (MCI) and **A,** percentage native vegetation in the catchment, **B,** semi-quantitative macroinvertebrate community index (SQMCI) and **C,** *E. coli*. Dotted line shows line of best fit.

health standards based on science data could be used to align, articulate and define iwi/hapū values through interpretation of the CSHM scores, although there is no suggestion that the two approaches should produce identical conclusions.

In previous studies in the Taieri and Kakaunui rivers, south of the South Island, a

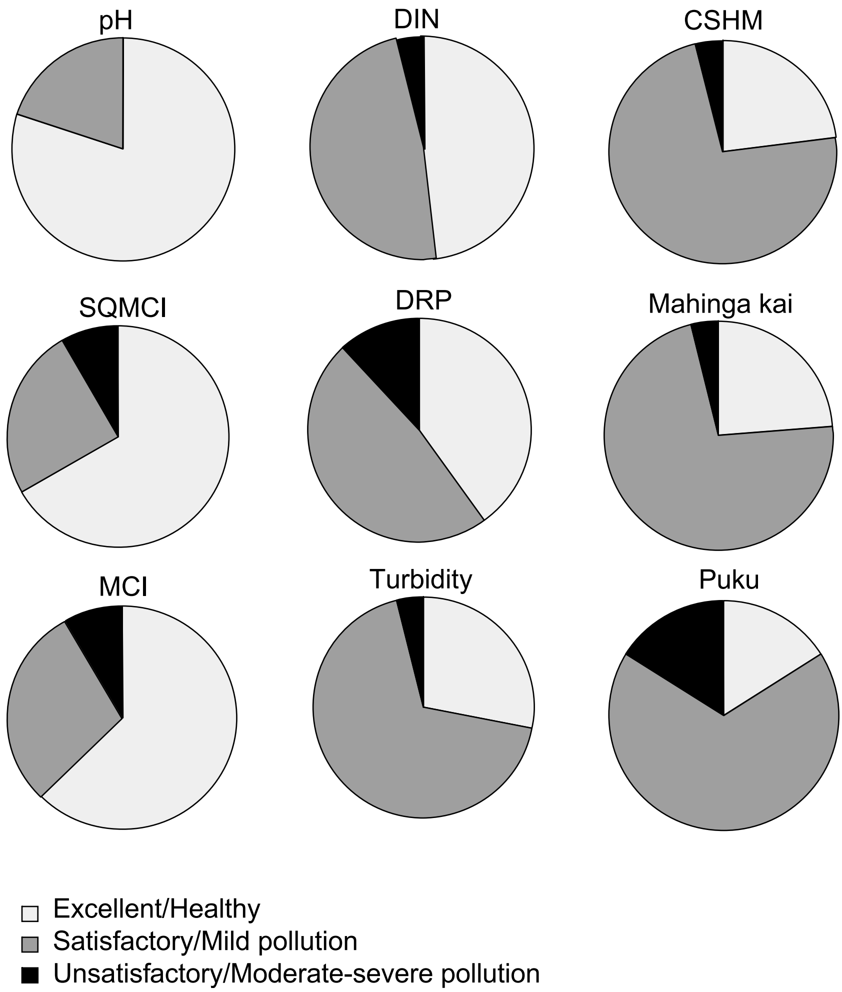

Figure 4 The proportion of sites ($n = 25$) in stream health categories as defined by scientific guidelines (Table 3) and for cultural indicators (unsatisfactory <2, satisfactory 2–4, healthy >4).

strong relationship between CSHM and MCI was observed (Townsend et al. 2004). 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, an 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 (Fig. 2). This relationship gives some guidance as to how the CSHM could be interpreted, with scores below 2 indicating poor stream health, scores between 2 and 3 indicating some concerns, scores between 3 and 4 indicating possible mild pollution, and scores above 4 representing good stream health. With training and shared knowledge these CSHM scores can become remarkably consistent within iwi/hapū; however, the interpretation of scores could vary from one iwi/hapū to another. When applying this healthy, satisfactory or unsatisfactory rating to cultural measures in the Motueka catchment, results show that the CSHM, puku and mahinga kai scores produced an overall poorer health assessment of the Motueka catchment than any scientific indicators. The full reasons for this disparity are unclear but probably relate to the more holistic nature of the CSHM (which is focussed on sub-catchment indicators rather than just in-stream features), use of mātauranga Māori knowledge through time (e.g. remembering how a place used to be) and differences in expectations associated with each monitoring approach, with the emphasis of the CSHM being to assess impacts on cultural values.

In this study, the CSHM translated into stricter stream health standards than those 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 CSHM of approximately 3 (Fig. 2), which is some way from what would be considered excellent conditions using the CSHM. A similar trend was observed between CSHM and MCI. It was apparent that the cultural stream health assessments imposed stricter environmental standards based on many criteria (Table 2), reflecting strong Māori values and preferences, which translated into high environmental limits and standards to achieve Māori aspirations and goals.

Comparison of scientific and cultural monitoring approaches

Scientifically based and culturally based indicators, along with community-based approaches have been prominent in various studies since the late 1990s (Harmsworth 2002; Harmsworth & Tipa 2006; Young et al. 2008). The approaches differ in the epistemologies they are founded on, their underlying methodology, their purpose, what they record and measure, and how that information is analysed and interpreted. However, they have enormous potential for articulating two world-views (perspectives) of river and stream health together, and on which to base future goals, objectives, defined standards and policy. Collaborative assessment approaches result in shared learning that has both environmental and social benefits (Roux et al. 2006).

Shared learning is an important outcome of applying both approaches in river monitoring in the Motueka case study. For iwi and hapū, cultural assessment has been fundamental for identifying changes in catchment condition and river health especially in areas regarded as culturally significant. Iwi and hapū have been able to prioritise and target areas for restoration and enhancement and monitor change in cultural resource condition throughout the catchment over time. Comparisons with scientific indicators have provided a context to communicate Māori values with the non-Māori community. For science researchers, the collaborative process has been essential for understanding Māori concepts and values, knowledge and frameworks, and to determine the relevance of biophysical and social research for Māori. The shared learning has enabled the researchers to recognise and respect the status and authority of indigenous Māori (tangata whenua) and their representatives and constituencies. Effective collaboration has improved access and uptake of science and technical information to Māori groups and improved the relevance of science to iwi and hapū.

Conclusions

This study showed that scientific and cultural approaches for monitoring stream and river health had merit in being used together. This research suggests that it is important that scientific monitoring approaches and indicators are not just compared with cultural approaches and indicators to show weaknesses and fallacies, but rather used side by side to illustrate different perspectives and articulate differing sets of values and human desires. For many Māori organisations such as iwi/hapū and kaitiaki groups, desired goals, standards and objectives may vary greatly, or coincide, with those of other stakeholders, such as industry groups, government and others. Different monitoring approaches provide necessary tools and indicators to benchmark perspectives, values and prescribe standards, limits and guidelines. They can also articulate better understanding of different views/perspectives, which may help resolve conflicts for resources. 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 in New Zealand.

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