NIWA
Taihoro Nukurangi

Stewardship of community-based environmental monitoring data

A workshop exploring current initiatives and opportunities in Aotearoa New Zealand

Prepared for Our Land and Water National Science Challenge

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Climate, Freshwater & Ocean Science

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Cover photo: Volunteers assessing periphyton cover in the Hutt River. [Dave Allen, NIWA]

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Executive summary

The increasing amount of environmental data being collected by community, farmer and other non-governmental organisations across Aotearoa New Zealand could potentially inform a host of local, regional and national scale land and water management applications, environmental reporting, and biodiversity and biosecurity assessments. The National Institute of Water and Atmospheric Research (NIWA) and the regional sector are developing a national quality assurance (QA) framework for community-based monitoring (CBM) data. This framework, focussed on freshwater CBM data, will include a tiered system of standards and measures to ensure that data are of a known quality and 'fit for purpose'. Ultimately, CBM data needs to be hosted by an organisation(s) that will make the data accessible for the foreseeable future. A national on-line platform or portal with an associated QA framework would provide visibility and consolidated access to CBM data of 'known' quality.

In December 2020, with the support of the Our Land and Water National Science Challenge (Toitū te Whenua, Toiora te Wai), NIWA convened a workshop in Wellington to discuss the stewardship of an on-line portal for CBM data. The workshop provided an initial opportunity to discuss needs and opportunities for collaboration around data stewardship, including examples of current web-based initiatives that host or display freshwater monitoring data and might inform the development of a future national platform for hosting and/or displaying CBM data. The workshop was attended by representatives from central government, local government, primary industry and the private sector.

Discussions at the workshop addressed the need to:

- provide clarity on monitoring purpose and intended data use at the outset of CBM initiatives; this will determine appropriate methods and quality requirements,
- increase both the visibility of, and access to, existing CBM data,
- ensure that essential metadata, including data collection methods and associated data quality standards and quality codes, are documented and available (to support data use and promote potential data re-use for other purposes),
- use open and interoperable data management and delivery systems that provide for efficient and effective sharing of data and information from different sources,
- provide feedback and support for CBM groups ensure that they remain motivated to continue collecting fit for purpose data,
- consider Te Mana o te Wai and data sovereignty, and
- take a collaborative multi-organisational approach to stewardship of CBM data, with parties ideally committing to stewardship for the long-term.

There was strong support among the organisations present to continue further discussions on developing a collaborative and enduring approach to managing CBM data in New Zealand.

1 Introduction

Across Aotearoa New Zealand there is a rapidly growing amount of environmental data being collected by community, farmer and other non-governmental organisations. These data are potentially capable of informing a host of local, regional and national scale applications around land and water management, environmental reporting, and biodiversity and biosecurity assessments.

The National Institute of Water and Atmospheric Research (NIWA) and the regional sector are in the initial stages of developing a national quality assurance (QA) framework for community-based monitoring (CBM) data. The framework, to be developed between July 2021 and June 2023, is focused on freshwater, reflecting an immediate council and national need in this domain. However, it is envisaged that the framework will be applicable to other environmental domains – terrestrial, marine, etc.

The proposed national framework will provide critical information on data collection methods and data quality but to be available for consideration and use in various applications (e.g., modelling, reporting), the collected data must also be easily accessible. In recognition of this, the Our Land and Water (OLW) National Science Challenge (Toitū te Whenua, Toiora te Wai) contracted NIWA to convene a workshop in Wellington on 17 December 2020 to discuss the stewardship of an on-line portal for community-based environmental monitoring data. This workshop, attended by 26 representatives across central government, local government, primary industry and the private sector (Appendix A), provided an initial opportunity to discuss needs and opportunities for collaboration around data stewardship, including examples of current data platform-type initiatives that either host/display or might inform the development of a future platform for hosting and/or displaying New Zealand community-based environmental data.

This report summarises the presentations delivered and key discussion themes. It provides a platform for further discussion and collaboration in the establishment of a national platform to host and access community-based environmental data.

The report comprises three main sections:

- Section 2 provides the initial background NIWA presented at the workshop.
- Section 3 summarises some example platforms of relevance to hosting CBM data.
- Section 4 documents the key themes captured during round-table discussions of organisational priorities around CBM and data stewardship and platform requirements.

2 Overview

Juliet Milne and Amanda Valois (NIWA) set the scene for the workshop with a short presentation outlining community-based monitoring and its potential applications in New Zealand, what we can learn from overseas examples, and the proposed Envirolink Tool to develop a national QA framework.

2.1 Workshop purpose

The primary aim of the workshop was to have an initial discussion around data stewardship of an on-line portal for community-based environmental monitoring data. An on-line portal with an associated quality assurance (QA) framework would provide visibility and consolidated access to 'trusted' community-based monitoring data.

2.2 What is community-based monitoring?

Community-based monitoring (CBM) is a form of citizen science and often also referred to as 'volunteer', 'local-based' or 'participatory' monitoring. Other related terms include 'participatory sensing', 'crowd sourcing' and 'citizen laboratories'. The term CBM has been adopted because it avoids some 'loaded' terms such as 'volunteer' or 'citizen scientist'. Although CBM doesn't represent all the diverse actors involved in citizen science (e.g., NGOs and academic institutions), some of these actors are paid participants so the term 'volunteer' doesn't apply. Variants of CBM include CBEM (community-based environmental monitoring) and CBWM (community-based water monitoring).

Whatever we call it, CBM is not a new concept. However, developments in information technology in the past decade and growing calls for public involvement in environmental management, policy development and decision making have created new opportunities in this area. In New Zealand, CBM has not only grown, but it has also become more organised. This has attracted increasing interest, including from local and central government bodies as well as industry, with an increasing number of organisations having requirements or strategic priorities that promote the collection and/or use of CBM data. For example:

- Several regional councils, including Greater Wellington Regional Council (GWRC) and Environment Southland, have draft citizen science strategies in development and some councils, including GWRC, Auckland Council and Nelson City Council having dedicated budgets for citizen science.
- The Conservation and Science Roadmap (MfE & DOC 2017)[1] identifies *"Citizen science, co-development and co-design of research, and effective communication of science"* as a research topic, with the outcome: *"Findings facilitate informed citizen participation in environmental decision-making, and uptake of robust scientific knowledge and data for informing policy."*
- Strategic Direction *1 of the Biosecurity 2025 Direction Statement for New Zealand's Biosecurity System* (MPI 2016)[2] is *"A biosecurity team of 4.7 million"*, noting that (for example) *"everyone can become citizen scientists by contributing their observations… to an online portal".*

[1] conservation-and-environment-science-roadmap.pdf (mfe.govt.nz)

[2] Biosecurity 2025 Direction Statement for New Zealand's biosecurity system

- Our Freshwater 2020 (MfE & Stats NZ 2020)[3] identified citizen science (and smart sensing) amongst future opportunities for improved environmental reporting.
- Fonterra and DOC's Living Water programme of partnerships with farmers, rural catchment groups and councils seeks to restore wetlands and *"measure their impact on water and wildlife quality".*

2.3 Applications of community-based monitoring

Actual or potential applications of CBM in New Zealand extend beyond (the once more common focus of) engagement and education to informing:

- environmental monitoring and reporting (e.g., Our Marine Environment 2019 (MfE & Stats NZ 2019)[4] includes community-based litter data),
- implementation of national legislation (e.g., provision of data for modelling exercises to inform limit-setting under the National Policy Statement for Freshwater Management 2020 (NPS-FM)),
- Farm Environment Plan development and implementation,
- modelling (e.g., data to inform models of national state),
- biodiversity surveys (e.g., NZ Garden Bird Survey, Project Hotspot – marine mammal sightings),
- biosecurity surveillance (e.g., aquatic or terrestrial weeds),
- restoration success & policy effectiveness (e.g., stream habitat restoration projects),
- early warning (e.g., algal blooms) and hotspot assessments (e.g., critical source areas), and
- resource consent monitoring.

2.4 What does the international experience tell us?

There are some good examples of successful, well supported CBM programmes overseas. In the United States, some of the most well-established and long-running CBM programmes focus on the collection of water quality or benthic macroinvertebrate data from lakes and rivers. In many states, the number of lakes sampled and the frequency of sampling by community volunteers far exceeds that carried out by government staff. For example, volunteers have contributed more than half of all long-term (>15 years) records for water clarity, nutrients and algal biomass to LAGOS-NE (a multi-state, multi-party database, Figure 2-1). In some states, all long-term records are a result of volunteer contributions.

Confidence in CBM data has been aided by an emphasis on data quality and data use by supporting agencies, including NGOs, universities and dedicated government departments. This includes the development of standardised monitoring protocols, training, data management strategies and portals, and formalised QA plans (called a Quality Assurance Project Plan in the United States or a Data Confidence Framework in Australia).

[3] our-freshwater-report-2020.pdf (mfe.govt.nz)

[4] https://www.mfe.govt.nz/sites/default/files/media/Environmental%20reporting/our-marine-environment-2019.pdf

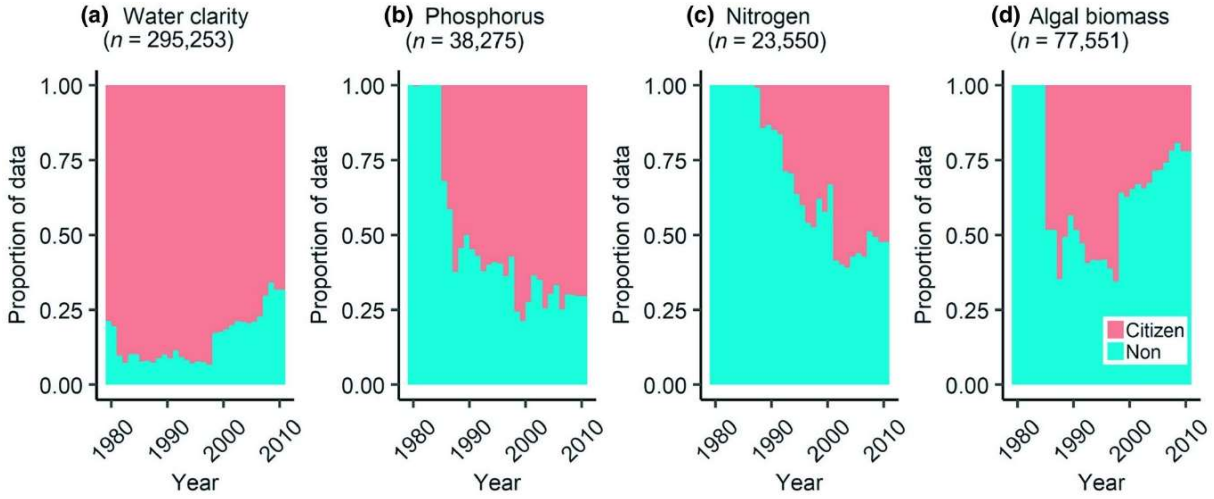

Figure 2-1: Proportion of lake water samples collected by volunteers (citizens - pink) and non-volunteers/government agencies (non - green) from 1980-2010 in 7 US states in the multi-state LAGOS-NE database. From Poisson et al. (2020)[5]

2.5 Developing the national QA framework

Central to unlocking greater use of CBM data is ensuring that data are of a known quality and 'fit for purpose'. This requires a robust and transparent framework to be established that can guide CBM groups on the methods and quality standards required to meet specific monitoring purposes. There also needs to be a repository for CBM data with an efficient and effective way of sharing and accessing it.

As the first phase of developing a national QA framework for community-based freshwater monitoring, NIWA is currently completing a review of international CBM QA frameworks in use or development, as well as case study applications of potential relevance to New Zealand. This review, funded through Envirolink Medium Advice Grant HBRC257 (MBIE Contract C01X21302), is being prepared for a consortium of eight regional and unitary councils led by Hawke's Bay Regional Council.

Development of the framework will formally commence from July 2021 with MBIE Envirolink Tool funding (championed by Greater Wellington Regional Council) and involves collaboration with a range of central government, industry and private organisations. In essence, this framework will include a tiered system of standards and measures to ensure that data are of a known quality and 'fit for purpose'. It will align with the mandatory NPS-FM 2020 national freshwater values of ecosystem health, human health for recreation and mahinga kai, and encompass a suite of water quality (e.g., visual clarity, dissolved oxygen, nutrients, *E. coli*), water quantity (e.g., velocity, flow/discharge), biological (e.g., periphyton cover, macroinvertebrates, fish) and physical habitat (e.g., deposited sediment cover) variables. Wherever possible, monitoring methods and QA criteria will draw from existing national protocols and National Environmental Monitoring Standards, thereby building on existing initiatives to improve national consistency in freshwater monitoring and reporting.

The framework will be trialled with a selection of CBM groups from across the country. These groups will ideally span a range of experience, monitoring focus (e.g., water quality, ecosystem health, swimming), purpose (e.g., engagement, information for farm environment or catchment plan development or to gauge the success of a restoration project), methods (e.g., water or biological

[5] Quantifying the contribution of citizen science to broad-scale ecological databases (wiley.com)

sample collection, sensor-based technology, photo points) and location (e.g., rural and urban). Feedback during and following the testing phase will contribute to revision and refinement of the QA framework.

Ultimately, community-based freshwater monitoring data needs to be hosted by an organisation(s) that will make the data (and associated metadata) accessible for the foreseeable future. A single on-line platform or portal (e.g., LAWA and NZ Water Citizens) with an associated QA framework would provide consolidated access to CBM data of known quality.

3 Current community-based monitoring initiatives

A series of short presentations were delivered on example existing platforms relating to CBM data or offering insights into how a portal for CBM data might operate. Due to time constraints, the New Zealand Freshwater Citizens and NatureSpace platforms were not discussed; a summary of the information that would have been presented on these two platforms is provided here for completeness.

It should be noted that the initiatives and platforms summarised here do not represent the full suite of platforms. Other examples include: Marine Metre Squared database (NZ Marine Studies Centre, University of Otago), Nature Agents ArcGIS Online platform (EOS Ecology), NZ Freshwater Fish Database (NIWA), iNaturalist NZ - Mātaki Taiao (New Zealand Bio-Recording Network Trust).

3.1 Litter Intelligence

This presentation was delivered by Brent Ellison and Tameem Shaltoni (Enlighten Designs). Litter Intelligence (https://litterintelligence.org/) is a long-term programme led by Sustainable Coastlines, a registered New Zealand charity, in close collaboration with MfE, DOC and Stats NZ. The programme supports collection of litter data by citizen scientist 'Monitoring Groups' and displays this on a web portal, with the ultimate aim of demonstrating the extent of New Zealand's litter problem so as to create behavioural change. The initial focus was litter in the marine environment and adoption of standardised survey protocols meant that the litter data were accepted for use as a Tier 1 statistic in the 2019 marine domain state of the environment report. More recently, standardised protocols for monitoring litter in freshwater and stormwater have been developed in partnership with NIWA, Auckland Council and Nelson City Council. There are currently 186 community groups carrying out 3-4 litter surveys per year. Four critical factors for success to date have been leadership, community mobilisation and engagement, user testing and building in quality aspects from the outset to provide confidence in the data. Quality checks include the use of defined survey areas, use of site photos on each survey date to verify the correct site is being surveyed, use of defined types of litter to ensure consistency in data, restrictions on data entry to designated users, and a review and verification step of submitted data by a trained Sustainable Coastlines member. As a future development, artificial intelligence is being considered as an option to automate counting of litter from photographs. The platform is a 'hub and spoke' model; a publicly open API can be used to link data to another website.

3.2 Land Air Water Aotearoa (LAWA)

This presentation was delivered by Abi Loughnan (National Project Manager for the Environmental Monitoring and Reporting (EMaR) Project). The LAWA website was launched in 2014 and sits under the wider regional sector led EMaR project that also includes National Environmental Monitoring Standards (NEMS) and the Environmental Data Management System The website (www.lawa.org.nz) is intended to be a user-friendly, one-stop-shop for environmental information and has a focus on sharing credible information, storytelling and raising awareness of freshwater (and other environmental) issues. Although some data can be downloaded from LAWA, it is not a database, but a federated model that largely 'pulls' data from councils and CRIs; some of this occurs automatically in near real-time (e.g., air quality and recreational water quality data) and some via periodic manual data feeds of pre-checked and 'approved' data. There is currently no CBM data displayed on LAWA but there are features of community stories and events, some of which involve environmental restoration and/or monitoring.

3.3 Environment Canterbury Water Data Programme

This presentation was delivered by Helen Shaw (ECan). The Water Data Programme started in August 2019 with the ultimate goal being a real time, quality assured water data infrastructure that will support integrated water quality and quantity modelling and forecasting for the Canterbury region. This first requires processes to be established to sort, manage and integrate existing data sources. The focus to date has been on the work and data flow needed to answer some key questions around water allocation, consenting and use, resource state, plan effectiveness, and resource consent compliance (e.g., "How much water is used from xxx river?"). The platform uses cloud-based technology called Snowflake. Data are drawn from many different sources and ingested via links and script-based calculations (e.g., for calculating lake trophic index or TLI) scores on the fly). Data are shared by APIs and web applications. A public web portal is being developed and there is interest in trialling ingesting of CBM data as part of the Envirolink Tool CBM QA project.

3.4 Know Your Catchment

This presentation was delivered by Vanessa Winning (IrrigationNZ). Know Your Catchment (https://waitakiirrigators.co.nz/) is a web platform for the community to engage and learn about freshwater in the Waitaki catchment, spanning the Canterbury and Otago regions. Supported by $150K from the Sustainable Food and Fibre Future fund, development of the platform was driven by irrigators wanting to build trust through telling a story of their data. The data and information include water quality, irrigation, wetlands, recreation, and different ways freshwater supports wellbeing. Data are taken every hour from ECan, Otago Regional Council and NIWA and irrigator consent data also supplied. There is fact-checking of information and stories about sites of interest; different consent requirements/standards between the two regional councils has been a complication.

3.5 Takiwā Data Analytics Platform

This presentation was delivered by Mike Taitoko and Mike Lee (Takiwā). The Takiwā Data Analytics Platform (https://takiwa.co/) is a cloud-based web application for providing Software as a Service (SaaS) products. The products are delivered as packages of particular features, enabling users with tools for manipulation and analysis of heterogeneous data, usually including spatial and temporal components. Takiwā products combine geographic information system (GIS), a business intelligence platform, and enterprise management system functionality. An example was given of a river catchment in Waikato where iwi wanted to be able to consider the different information available for themselves to enable more meaningful participation in decision-making processes. The Takiwā platform is supporting this by allowing iwi to access various catchment and subcatchment GIS layers (e.g., nutrient inputs from on-farm to catchment scale). Real-time water quality information (e.g., dissolved oxygen, nitrate) is also able to be displayed visually (captured via high frequency water quality sensors provided by EcoDetection), along with cultural data. Separate water sample analysis by Hill Laboratories has been carried out as a quality checks of sensor performance. Narrative is provided with the data to avoid misinterpretation of the data. Takiwā provides access to thousands of publicly available datasets in a consolidated and easy to use platform. Where specific narratives are being articulated, subsets of these datasets can be grouped to enhance communication. Where clients have private datasets, Takiwā provides user and role-based access to ensure security, where needed, is enforced to protect these data assets.

3.6 Nature Space

Nature Space (www.naturespace.org.nz) is a website designed to support community restoration efforts in New Zealand and provide a one-stop-shop to access information and resources for undertaking a successful restoration project. Launched in 2012, the website currently has over 42,000 active group members and provides an inventory of what different groups are doing and where. The interactive map feature allows interested members of the public to discover and connect with community in their area. Nature Space is maintained by DOC and has a Governance Board comprising representatives from DOC, the regional sector's Biodiversity Managers Forum and Conservation NGOs. No monitoring data are stored on the website.

3.7 NZ Water Citizens

NZ Water Citizens (www.nzwatercitizens.co.nz) is a web platform (made in Drupal, an open-source web content management system) for community-based stream monitoring. Developed by NIWA in partnership with a consortium of regional and local councils, the platform provides a database for storing, understanding, presenting and viewing data from various sites, resources to help community groups learn methods for stream monitoring, a link for ordering NIWA's Stream Health Monitoring and Assessment Kit (SHMAK) and a forum for giving feedback, asking questions and sharing stories. As at December 2020, 153 groups use NZ Water Citizens. The data entry pages are designed to work with SHMAK, but data can be collected using another toolkit or other standard methods. An option to certify the quality of the data (through a simple yes or no check box) submitted to the database is available in the database but has not been made functional as yet. NZ Water Citizens is supported by the National Advisory Group (NAG) on Freshwater Citizen Science, a collaboration between central government, regional and city councils, farming industry bodies, NGOs, and NIWA. The core purpose of the NAG is to foster well-resourced and coordinated freshwater citizen science monitoring programmes in New Zealand.

4 Data stewardship

Data stewardship is the careful and responsible creation, collection, management, and use of data. In its simplest sense, stewardship is the act of taking care of something. This section summarises the wide-ranging roundtable discussions from the workshop, grouped into key themes.

4.1 Monitoring purpose

Establishing the purpose of any monitoring is critical to ensure that the 'right data' are collected using the 'right methods'. For CBM, co-designing the programme with the intended end user(s) of the data will help ensure that fit for purpose data are collected from the outset. Sometimes data might be collected for a particular purpose but could be of interest to other users for a different purpose. Essential metadata, including methods of collection and any associated data quality standards, must be documented and available to support potential data re-use.

4.2 Visibility and accessibility

Some attendees noted that their organisations had not done a good job at acknowledging the different knowledge sources potentially available to them, including community data. However, it is difficult to know that some CBM data sources even exist (data visibility) and, even if a source is known about, access to the data can be difficult. This was described by NIWA in the workshop introduction as 'the data vacuum'; a lack of data for environmental decision making, not because of a lack of data being generated but due to much of the data being inaccessible and undocumented. For CBM data to be used, the data and associated metadata (e.g., methods, data quality codes) must be visible and accessible, with data able to be both easily ingested and extracted. Increasing technological advancements (as showcased in the various web-based platform presentations) and a growing trend towards open data are creating new opportunities for addressing these challenges.

4.3 Standards and quality

The recent resource management reforms for freshwater mean that the quality of data is more critical than ever for robust environmental reporting and determining whether or not policies, targets and limits to improve the state of our freshwater resources are working. Data collected by CBM can support national state of the environment reporting and assessments of effectiveness of mitigation actions, but the reliability of the data will be scrutinised. Data quality standards are one tool to ensure CBM data are fit for purpose. Data quality standards are only useful if they are evaluated to ensure they have been met and this supporting information (e.g., quality control samples, calibration logs) is stored with the raw data (as metadata).

4.4 Efficiency and effectiveness

A lot of time continues to be spent 're-packaging' environmental data. This weighs, for example, on many farmers who are increasingly gathering and supplying more data and have to re-enter data for multiple agencies or purposes. The aim should be to "do it once, do it right". Consistent standards, a single platform (or at a minimum not many platforms that only accept a few data types) and connectivity with other frameworks/systems (interoperability) are important.

4.5 Sustainability

Sustainability and a long-term (say 2, 10 and 20-year) view are critical to realising the value of CBM data. It can be relatively easy to get an exciting new project, programme or initiative like a web

platform started but it is more difficult to maintain interest and attract ongoing funding over time to maintain it[6].

4.6 Feedback and support

It is common for community groups to lose motivation over time; data collection may cease or quality standards may slip. Regular feedback and ongoing support have been shown to be critical to maintaining volunteer interest. Feedback should include information on how a group's data are being used and what the data indicate. Scale is an important consideration; data collected at catchment scales may be used at regional or national scales. Feedback and support therefore need to be tailored to the catchment scale where most groups operate. In this way groups can better link actions – such as stream plantings – to outcomes such as improved fish diversity.

Ideally a platform hosting CBM data would provide mechanisms for ongoing support of, and feedback to, CBM groups. Self-populating graphs with trigger levels or report cards that explain the "so what?" aspects of monitoring results at an appropriate scale and responses or comments from end-user organisations associated with the monitoring are useful components of CBD data platforms. However, it was noted in the workshop that CBM data platforms cannot replace people. Feedback from councils and other stakeholders will be important for monitoring groups regardless of the sophistication of their data platforms.

4.7 Regulatory considerations

One strength of CBM is that it can capture 'on the spot' event-based data, such as during storms and short-duration spills or discharges to waterways. These data, if deemed reliable by the relevant council (or other regulatory organisation), could be considered by the council to support a potential case for enforcement action. A question was raised about what might happen if the data actually pertained to the collector's activities (e.g., a farmer collected stream water samples that demonstrated practices on farm were significantly impacting water quality). Council representatives at the workshop noted the importance of trust in fostering CBM and that the use of CBM data for regulatory enforcement against the collectors of that data did not 'align' with the intent of fostering CBM and would not be encouraged. Other participants also acknowledged the importance of trust to realising the benefits and value of CBM.

4.8 Te Mana o te Wai

The role of Māori and giving effect to Te Mano o te Wai in the NPS-FM was raised, as well as the need to consider co-governance requirements and data sovereignty issues. The Kahu Wai Māori group is probably a forum for these discussions. It was noted by NIWA that the proposed national QA framework for CBM is not intended to establish standards for traditional monitoring by iwi or hapū; Matauranga Māori is another recognised source of knowledge. However, where an iwi, hapū or other Māori entity might want to use a 'western science' based monitoring method in the framework to measure a particular variable (e.g., *E. coli* concentrations to inform mahinga kai practices), they could utilise the associated data standards. In addition, CBM has the opportunity to be informed by traditional knowledge to develop more robust and holistic programmes. As expert knowledge holders, tangata whenua could form an essential part of validating, explaining or contextualising CBM data.

[6] The authors note that the Atlas of Living Australia (national CBM database in Australia) is funded by the National Collaborative Research Infrastructure Strategy (NCRIS) which offers long-term support to priority research areas.

4.9 Collaborative approach

New Zealand is a small country, with limited resources so ‘a coalition of the willing’ approach is warranted. Ideally willing parties would also commit to collaborating on data stewardship for the long-term. Although initial thoughts were to consider a single national portal for CBM data, the platform examples demonstrate that this isn’t essential; what appears more important is consistent data standards so that data are compatible between different platforms/hosts. This would facilitate data sharing and provide hosting ‘cover’ if one platform was to shut down. It was also suggested that data stewardship could be short-term to begin with (e.g., 2 years).

5 Conclusions and next steps

Over the next 2.5 years, NIWA (through MBIE Envirolink Tool funding with the regional sector and other partners) will develop a national QA framework to support the collection of credible CBM freshwater data of 'known' quality. This framework will require CBM data to be hosted in an-online portal(s) so that the data are visible and accessible for extraction and use. Although portal development and operation fall outside the scope of the Tool project, it is important to start discussing now how CBM data in New Zealand will be managed into the future. This is needed not only to support implementation of the framework but also to ensure that the many benefits CBM offers to freshwater management can be realised.

There was strong support among the organisations present to continue discussions on developing a coordinated, collaborative and enduring approach to managing CBM data. Opportunities for these discussions will occur with the different organisations in the first half of 2021 as NIWA's establishes the programme of work to develop the national QA framework for CBM data. Further meetings or workshops with a specific focus on data stewardship would be particularly beneficial around late 2021/early 2022 to examine how CBM data collected under the framework might be managed and made publicly available via an on-line portal(s).

6 Acknowledgements

We would like to acknowledge Richard McDowell for his support and ideas, and the Our Land and Water National Science Challenge for funding the workshop and preparation of this report. We would also like to thank all presenters and participants that attended the workshop.

Appendix A Workshop attendees

The following people attended the 17 December 2020 workshop. Andrew Hoggard (Federated Farmers) was also invited but unable to attend.

Organisation/Group	Name	Position/Role(s)
NIWA	Juliet Milne	Resource Management Scientist & Envirolink Tool co-lead
	Amanda Valois	Freshwater Scientist & Envirolink Tool co-lead
	Chris Daughney	Chief Science Advisor & part-time secondee at MfE
Our Land Water NSC	Richard McDowell	Chief Scientist OLW and Professor at Lincoln University
	Jenny Webster-Brown	Director OLW (joined remotely)
BioHeritage NSC	Kevin Collins	Collins Consulting Ltd – consultant to NSC and provider of strategic analysis
MfE	Natasha Lewis**	Deputy Secretary, Strategy and Stewardship
	Dan Elder	Senior Analyst, Strategy and Stewardship
	Alice Bradley	Senior Analyst
Stats NZ	Michele Lloyd	Senior Manager, Environmental Reporting
DOC	Sharon Alderson**	Director Planning & Support
	Neil Deans*	Senior Advisor
MPI	Matthew Newman	Team Leader Monitoring & Benchmarking
	Matt Nabney	Policy Analyst, Land and Water Policy (attending for Sophie Murphy, Manager Water Policy)
Regional Sector Science Advisory Group (SAG)	Iain Maxwell	SAG convener & Group Manager Integrated Catchment Management at HBRC
	Tim Davie	SAG rep & Director Science at ECan
Regional Sector Environmental Data Special Interest Group (ED SIG)	Mike Ede	ED SIG convener, NEMS Steering Group convener and Manager Environmental Information at MDC
ECan Water Data Programme	Helen Shaw	Product Owner – Water Data (on secondment from Surface Water Science Manager)
LAWA/EMaR	Abi Loughnan	National Project Manager – Environmental Monitoring and Reporting (EMaR) Project
Federated Farmers	Andrew Hoggard	National President and Manawatu dairy farmer
DairyNZ	Aslan Wright-Stow	Manager Environment and Catchments
IrrigationNZ	Elizabeth Soal*	Regional Policy and Planning Manager
	Vanessa Winning	Chief Executive
Hill Laboratories	Jane Sherrard	Market Sector Manager (Environmental) and contact re Hilltop Software suite for environmental data
Enlighten Designs	Brent Ellison	Account Manager
	Tameem Shaltoni	Senior Project Manager
Takiwā	Mike Taitoko	Chief Executive, Takiwā Data Analytics Platform
	Mike Lee	Chief Operating Officer, Takiwā Data Analytics Platform

* Unavailable on the day

** Present for the initial part of the workshop only