Biodiversity monitoring options for the Mahinga Kai Exemplar area

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Katie Collier, Will Keay, George Moon,
Huiling Ni, Tim Stoddart
University of Canterbury

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Introduction

The Mahinga Kai Exemplar (MKE) area, located adjacent to Christchurch's Residential Red Zone (RRZ) (*Figure 1*), seeks to become an example of the concept of *mahinga kai* in action. A joint undertaking by the Avon-Ōtākaro Network (AvON), Te Rūnanga o Ngāi Tahu and Ngāi Tūāhuriri Rūnanga, the MKE project was established in late 2013 as part of a recommendation from Environment Canterbury's 2013 Natural Environment Recovery Programme report to "act on opportunities to restore and enhance mahinga kai" (Environment Canterbury, 2013, p. 15). Since the project was founded, a need has been identified for a biodiversity monitoring programme in order to provide information for ongoing project planning (Orchard, 2016).

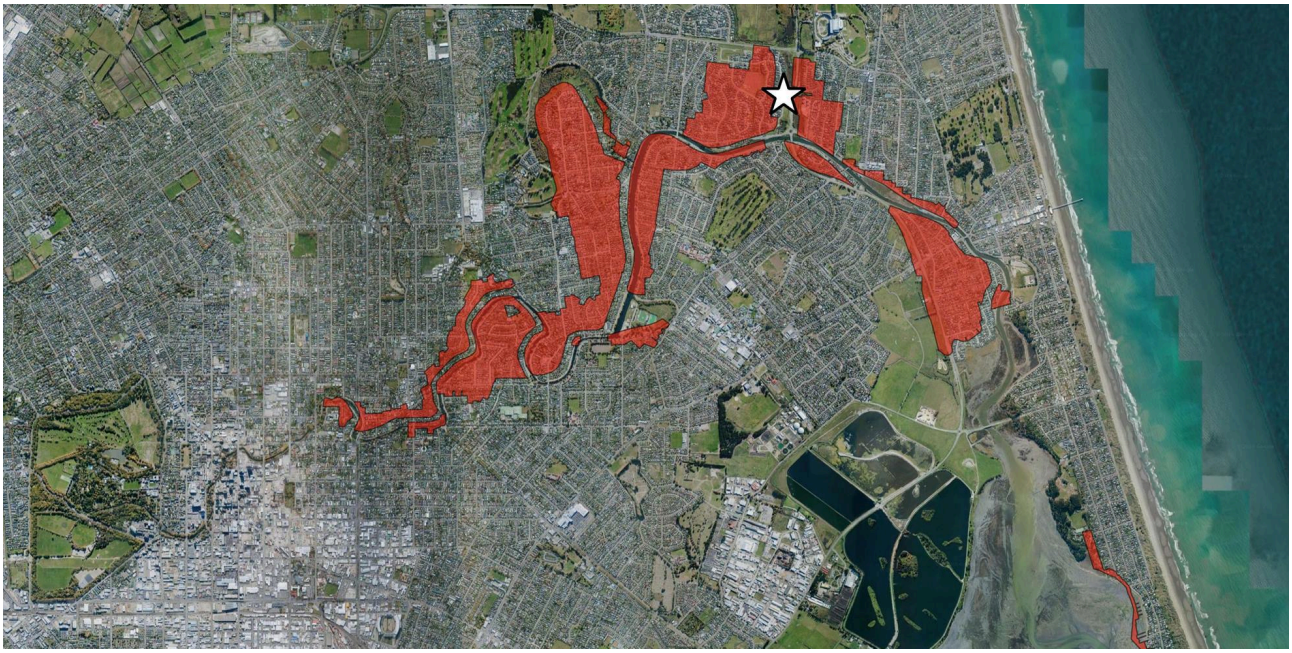

Figure 1: The location of the Mahinga Kai Exemplar area in Christchurch (white star), relative to the Residential Red Zone (red areas). Hagley Park is in lower-left corner. (Source: Google Satellite)

Defining *mahinga kai*

In order to understand the goals of the MKE project, it is necessary to define the concept of *mahinga kai*, a term derived from *mahi ngā kai*, meaning 'work the food' (Avon-Ōtākaro Network, 2013). The term has its origins in Ngāi Tahu's 1998 Waitangi Settlement Claim and generally refers to "the customary gathering of food and natural materials" (Ngāi Tahu Claims Settlement Act, 1998). To elaborate, mahinga kai differs from just gathering *kai* (food) in that it also encompasses the wider social, cultural, educational and sustainable aspects of the food. This includes the customs and ways that it is gathered, in line with *kaitiaki* (guardianship), *whakapapa* (geneology) and *rangatiratanga* (leadership) (Te Waihora, 2014a).

This commitment to customary use implies sustainable management, or *kaitiakatanga*, where by "cultural harvest of … these resources will occur only when the resource is sustainable." (Avon-Ōtākaro Network, 2013, p. 1). Ngāi Tahu view this management concept through the philosophy of '*ki uta ki tai*' recognising that the environment is an interconnected system (Te Waihora, 2014b).

Mahinga Kai Exemplar project

Mahinga kai not only refers to the food and practices around its gathering, but also the physical places where it occurs. Born out of the opportunities provided by the Canterbury earthquakes "to create an improved and healthier environment" (Environment Canterbury, 2013, p. 1), the MKE project was first discussed in November 2013 in which AvON and local rūnanga identified the Anzac Drive Reserve as the desired site for various reasons, including its location linking the Travis Wetland to the river and the potential for expansion in the adjacent RRZ (Avon-Ōtākaro Network, 2013). It encompasses a variety of pre-existing natural features including native vegetation (*Figure 2)*, Lake Kate Sheppard (*Figure 3*), wetlands and reed beds (*Appendix A*). Other non-native vegetation, such as fruit trees, is also situated at the site, with plans to plant more. This is consistent with Ngāi Tahu's support for "the metaphor of a plaited rope with the weaving of exotic and indigenous species and of Pākehā and Ngāi Tahu traditions" (Avon-Ōtākaro Network, 2013, p. 1).

One of the first projects contributing to the 'greening of the red zone', the MKE project aims to achieve three main goals. The first is to restore the natural environment, consistent with the principles of *kaitiakitanga*. The second goal is to become a learning resource, likened to an 'open air classroom', teaching understanding of mahinga kai and environmental values. The third goal is to eventually be able to expand further to other reserves and communities (Avon-Ōtākaro Network, 2016). Across all of these themes, involving young people is highlighted as a critical component to the success of the project, whether through environmental, ambassadorial or educational roles.

Much progress has already been made, including ongoing tree plantings involving local primary schools (Te Rūnanga o Ngāi Tahu, 2014), the council, high schools and businesses (Avon-Ōtākaro Network, 2015). Reports have also been completed looking into biodiversity (Orchard, 2016) and outdoor classrooms (Grove, Woodall, Smith, Johnson, & MacMillan, 2015). Much of this work has been facilitated by Kathryn Bates, the MKE project manager, working with AvON and local rūnanga.

Figure 2: Clockwise from top left – an existing native tree, the site of new plantings beside the wetland, part of the cycle trail through the reserve

Figure 3: Clockwise from left – Lake Kate Sheppard, the site of the Matariki Gardens and a former road in the RRZ

Biodiversity monitoring in the MKE area

In order to achieve these goals, especially in regard to environmental restoration, one of the key recommendations raised in biologist Shane Orchard's baseline survey of the area (2016) was the need to address information gaps, such as through biodiversity monitoring programmes.

A monitoring programme is an ongoing defined programme of regular observation that provides meaningful data. The data collected should be able to inform approaches to improving biodiversity by showing the effectiveness of different approaches and potentially highlight results that were not expected (Hill, Fasham, Tucker, Shewry, & Shaw, 2005).

In the context of the MKE project, monitoring not only provides the opportunity to provide valuable information on the efficacy of the environmental restoration but it also has the potential to engage the local community, especially young people, through a citizen science programme (Conrad & Hilchey, 2011) thus contributing to the stated focus of engaging young people in the MKE project.

Research aim

Bearing in mind the goals of the MKE project and the need for a monitoring programme, a research question was formulated to direct this enquiry:

> What is the most viable option for monitoring biodiversity, considering perspectives/values, in the Mahinga Kai Exemplar area, with regards to the future?

Method

The group met frequently over a two-month period in consultation with Kathryn Bates (MKE manager) and Shane Orchard (AvON strategic group member) in order to determine an approach for answering the research question. After initially considering developing a specific monitoring plan, then looking to survey local school pupils on various citizen science tools, a methodology of researching other similar conservation groups' approaches to monitoring was decided on following further meetings.

The data collection process is akin to a review and is based on the methodology of Peter, Eames and Hamilton (2015). The goals of the paper were similar to the research aims for this project, as the authors intended to evaluate use of citizen science collection for biodiversity research throughout New Zealand.

Ten case studies of New Zealand-based ecological restoration reserves and initiatives were selected. This approach is consistent with interview research methods as noted by Anna Secor, in which depending on the nature of the research, interviews should use 10 to 30 participants (2010). Due to the depth of the interview content and the time constraints imposed on our research, it was decided that it was sufficient to fall on the lower end of this spectrum.

Each group member was responsible for contacting a number of groups to establish whether or not they were currently carrying out, or had knowledge on, biodiversity monitoring. If they responded positively to this, further questions were then asked via email, phone call, or face-to-face interviews.

The interviews centred around six questions:

1. What are the details of your biodiversity monitoring plan?
2. What have the successes of your plan been?
3. Have there been any challenges in implementing your plan?
4. What are the goals of your biodiversity monitoring plan?
5. Have you learnt any lessons throughout the duration of your monitoring?
6. Who do you engage in the monitoring process?

Once these questions had been answered, the interviewer would assess the similarities and differences to the Mahinga Kai Exemplar. This often involved asking further questions, but in some cases also relied on reading about the case study.

The case study data was then collated into a spreadsheet where it was synthesised into broad themes which could be compared. Literature was then used, not only to assess

the validity of the themes from the case studies, but also to make recommendations, based on the experience of other monitoring projects. From the literature and case studies, a series of recommendations for the Mahinga Kai Exemplar were then developed.

Results

A total of seven community environment groups, two government authorities and one Māori iwi responded either via email or in face-to-face interviews. This information was able to be categorised into broad themes: programme goals, conventional monitoring methods, citizen science methods, data management, community engagement, challenges and lessons learnt.

Goals of monitoring programmes

Most groups interviewed had more than one goal for their biodiversity monitoring programmes. These included assessing the success of the vegetation restoration, improving wildlife conservation, establishing abundant kai resources and increasing public awareness of conservation.

Conventional monitoring methods

In an open-ended question asking interviewees to detail their biodiversity monitoring projects, six community groups reported that they contributed to bird monitoring. Common monitoring methods identified included recording data through walk transects and observation spots.

Additionally, three community groups engaged in vegetation monitoring. This was typically completed through using photo-points and 'permanent plots'. One of these groups recommended that the frequency of monitoring is highly dependent on the species and the time of year (*Appendix B-03*). Two groups reported that they were adopting an indicator species for their monitoring. In terms of fish species monitoring for the importance of mahinga kai, one interviewee, Ngāi Tahu, reported that they were using 'State of the Takiwā' as a modular methodology to assess the fish habitats, cultural keystone species and other environmental parameters.

Citizen science monitoring methods

Six community groups stated that they were using citizen science data as part of their monitoring programmes. That is, using citizen volunteers to collect and report

scientific data (Conrad & Hilchey, 2011). Of the six, four groups reported that citizen science was undertaken through volunteers manually recording observations. The remaining groups used the free online database NatureWatch NZ for identifying and reporting observed species. One interviewee described NatureWatch as being "… easily used without any training and so far there has been no issue to use this tool in our group" (*B-09*). Alternatively, a different community group is developing a mobile application for visitors to identify bird species and to report their sightings with information including locations, date, time of day, behaviour and health conditions. In addition, the BioBlitz method, a short-term event in which the public collects species data (Landcare Research, 2012), is a highly-regarded method used by two community groups.

Data management

There were different approaches to data management across interviewees. Five groups stored monitoring data on online web databases such as eBird and NatureWatch. The data collected was used in different ways, like using GIS tools to create maps. Some groups noted that the data collected was only used for project-specific purposes and not submitted elsewhere where it could be analysed externally. Only one community group submitted their vegetation datasets to the national vegetation survey databank, managed by Landcare Research.

Community engagement and involvement

In terms of the level of community engagement in monitoring process, generally the wider community members of these groups contributed only to the collection of data. This was highlighted by three groups who reported that currently only experts and/or part-time workers engaged in the more technical and scientific aspects of their monitoring.

Five groups were engaging school students, however only two of them provided opportunities of actual biodiversity monitoring for schools. For example, one of the groups, Otago Peninsula Biodiversity Group, is undertaking a backyard biodiversity science education programme for eleven Dunedin schools equipped with rodent mammal detection devices. The students have opportunities to identify species and to enter data by themselves.

Challenges and lessons learnt

When interviewees were queried as to what challenges they face in implementing their monitoring plans, five broad challenges became apparent (*Figure 4*).

A challenge highlighted by six of the ten groups was the lack of trained volunteers. A staff member from the Department of Conservation (DOC) described the necessity of trained volunteers for citizen science monitoring: "…, particular species targeted within citizen science approaches to biodiversity monitoring have to be realistic for volunteer's expertise levels… citizen science is useful but make sure it is reliable – this goes for 'trained' people" (*B-06*). A different interviewee suggested that undertaking continual training of volunteers for citizen science monitoring is a way of solving the problem (*B-10*).

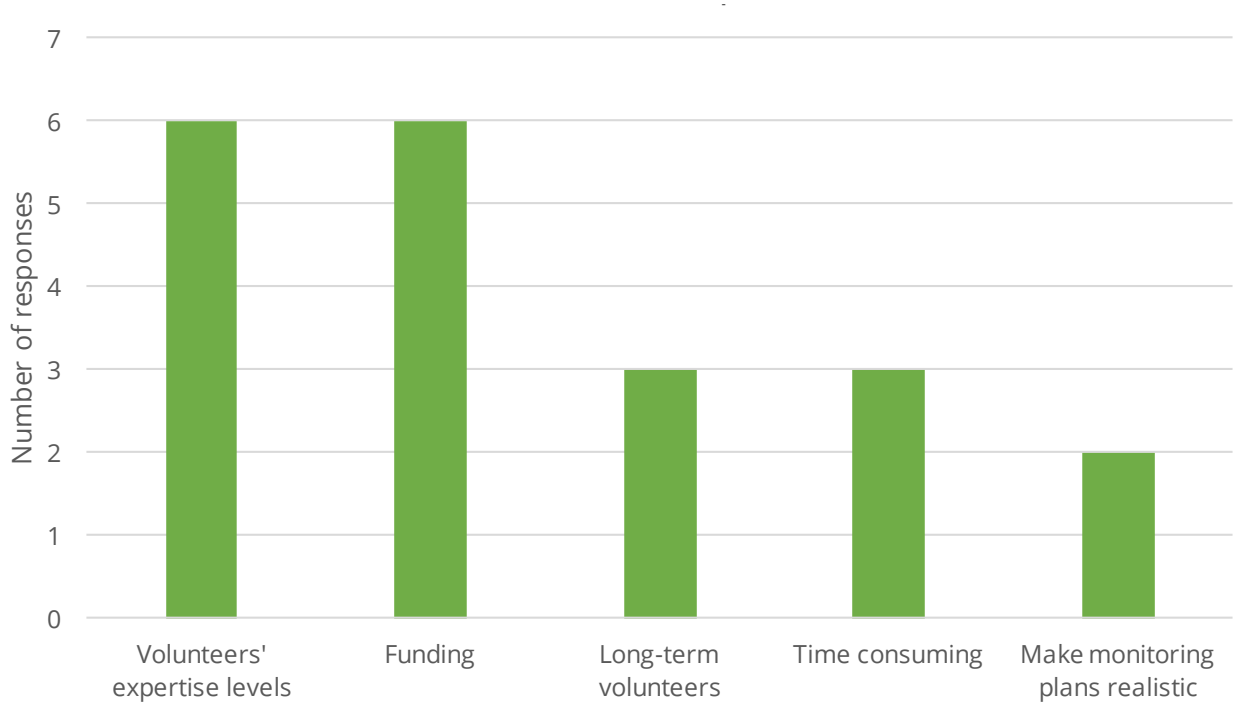

Figure 4: Challenges across responses from interviewees

Additionally, raising sufficient funding for ongoing monitoring was also regarded as a major challenge by six groups. One person commented that "the costs involved are too great…the costs of employing science professionals to do researches may be beyond the resources of a small voluntary group" (*B-09*). Another person made a recommendation to develop partnerships as a way of getting ongoing funding (*B-08*).

Other challenges noted across three groups included the difficulties of keeping long-term volunteers and the time-consuming nature of monitoring. For example, one interviewee reported that "we do not always have the same volunteers monitoring the same plots every year … it affected our data quality" (*B-10*). Another community group noted that there was too much difficulty training unqualified volunteers as they do not necessarily have a longstanding commitment to the group (*B-09*).

Two community groups reported that some aspects of their monitoring projects had not been done since their plan was established. This can be explained by a community member: "we found some monitoring projects in the plan actually do not interest us or are not necessary to implement… some tasks are unrealistic… our monitoring plan is too ambitious" (*B-09*). One respondent noted that in order to address this, it is important to "… make sure your plan is realistic and can be achieved with the available labour, resources and funding" (*B-06*).

Discussion

Limitations of method

The results should be qualified by recognising several limitations with the methodology. The first is the constraints imposed by a short time frame, resulting in having to use a small number of case studies; fewer than researchers would usually recommend (Secor, 2010). This time frame also impacted the interview process in that there was not sufficient time to revisit and delve into the answers given. Because the data had to be collected over a very brief period, it resulted in responses that are not as in-depth as they could have otherwise been. A less tangible effect of the short time frame was that despite spending a long time developing our research process, once it was decided on there was insufficient time to make alterations if our data came back without meaningful results. To address this last issue, a pilot interview could have been run, as recommended by David Hill (2005), but again, time constraints prevented this.

There were also some limitations summarising the information. Because of the limited sample size, there were only a few responses to deal with. The goal was to draw themes out and make recommendations based on those. However, because of the nature of the broad and open questions asked, the answers received varied significantly, often to the extent that drawing comparisons between respondents was sometimes unachievable. Because the respondents came from different backgrounds (including commercial enterprises, volunteers, on-site personnel and advisors) their answers could be quite disparate. Furthermore, the open questions were not necessarily leading enough to draw responses that covered all aspects of a complete biodiversity monitoring plan. This means that that it was difficult to comment on some issues that AvON had particular interest in, and sometimes resulted in being forced to make comments based on little evidence from the data returned.

Supplementary literature

Literature was not only used to validate the findings from the interviews, but to also to develop additional recommendations. There are a multitude of papers that provide valuable insights into community based methods for biodiversity monitoring. Outlined below are two papers which, following review, are considered to be of most value due to the quality and relatability of the findings.

A review paper of community based monitoring (CBM) methods from Canada presented a series of benefits. Firstly, larger organisations or government agencies may benefit from CBM as an extension to their monitoring networks. Secondly, communities and non-government organisations benefit from CBM through the development of social capital and increased ability to influence local decision-making. Finally, increased community influence over land use and environmental planning processes can shift the "locus of power" (Whitelaw, Vaughan, Craig, & Atkinson, 2003).

However, there were a series of issues outlined including a loss of interest by volunteers, inconsistent funding resulting in data fragmentation and the accuracy of data collection. Despite this, a series of options were presented to mitigate such issues including: securing adequate funding before launching monitoring activities, providing feedback to volunteers and developing a recognition program, using simple and scientifically tested methodologies and incorporating training on monitoring protocols, supervising volunteers in the field and incorporating verification into the design (Whitelaw, Vaughan, Craig, & Atkinson, 2003).

Open Air Laboratories (OPAL) is a United Kingdom community-driven programme which incorporates both scientists and communities to address three key environmental issues: environmental degradation, loss of biodiversity and climate change through promoting active participation and involvement with nature. The programme is executed through nine regional programmes, each led by a university, and primarily targets areas of deprivation and people from disadvantaged backgrounds (Davies, et al., 2011).

OPAL conduct national surveys through the use of pre-created "packs" for water, soil and air surveying, with each pack including an explanation of the topic and how to complete the survey. In one year over 200,000 people have participated in surveying of over 7000 sites. Results have been submitted to an online database with over half of the results from school children. One primary concern was the uncertainty of the data, however, when some results were re-examined to assess accuracy, adults had identified

two-thirds of specimens correctly, whereas children had identified over half of their specimens correctly. Despite uncertainty, correlations and trends are being recognised and new research is being developed accordingly based on these results. Moreover, it was reported that people had a positive experience when undertaking monitoring and also that participants wanted to know how their data was going to be used and who is going to use it (Davies, et al., 2011).

Recommendations

The interview results allowed the group to analyse the goals, successes, lessons learnt and techniques used within other local initiatives. After identifying key themes across responses, the information was then used to contribute to the creation of a set of criteria to evaluate the effectiveness of biodiversity monitoring programmes, including the simplicity of the monitoring techniques, the level of community engagement, resources required, quality of the data collected and applicability to the MKE area.

Throughout the interview process, it became apparent that each individual had their own positionality, experiences, values and resources, resulting in the various methodologies and approaches recorded between the different case studies. *Figure 5* demonstrates this relationship, showing the trade-offs between economic, ecological, cultural and social factors in the development of a monitoring programme. Dearborn and Kark (2010) state how conflicting resources, values and cultures can lead to differing perspectives for conserving urban biodiversity. Therefore, it is important to recognise that different monitoring programmes and organisations are likely to be more influenced and/or driven by certain factors within the diagram than others. In order to provide appropriate recommendations, it was essential to assess how each one of these components intersected most effectively and realistically for the vision of the MKE project.

Figure 5: The factors influencing the development of a monitoring or restoration programme. Adapted from Norton and Miller (2000)

By exploring the themes from the case studies and analysing the applicability of the research findings, six recommendations were established for consideration when developing a biodiversity monitoring programme within the MKE area.

1. Identify target or indicator species

Other biodiversity monitoring projects have been less successful in the past because of monitoring programmes that were too broad or unrealistic. As several initiatives recognised, monitoring changes in pest, bird, vegetation or fish taxa can all be effective approaches, but only if reliable and achievable sample sizes are used. Within the results, the identification of key species was identified as the most efficient method of managing the scope of a monitoring programme by organisations such as Department of Conservation (DOC), Forest & Bird, Battle for the Banded Rail and the Quail Island Ecological Restoration Trust. However, main target species do not necessarily have to be native or threatened, as stated in interviews with DOC and Travis Wetland who suggested that pest and invasive species data is of high value for assessing changes over time.

For example, our observations at the MKE demonstrated Canada geese (*Branta canadensis*) were prominent in several locations. This nuisance species could be one that is targeted by monitoring, with controls put in place to regulate the population (Littlewood, 2011).

2. Ensure community involvement through appropriate data collection methods

The challenge of engaging the community with biodiversity monitoring was noted in most case studies, as certain aspects of data collection and analysis required extensive training and technical expertise. Training volunteers in more specialised areas of monitoring, such as invertebrate identification, was cited within several interviews as being too expensive and time consuming for existing staff, with many instead choosing to adopt multiple roles and work longer hours to ensure consistent data quality. This can alienate the public and volunteers as their contributions are often promoted as being less credible than those of senior staff (Gollan, de Bruyn, Reid, & Wilkie, 2012).

As AvON promotes a community driven approach, using accessible methods such as bird counts, acoustic recordings, app interaction and pest trapping would ensure public interest and participation. These approaches would cater for volunteers with varying experience without compromising the overall credibility of the data collected. Other more technical and scientific aspects of the monitoring could be guided by experts or larger organisations such as Environment Canterbury where appropriate, but the best use of funding and resources would have to be considered during the decision making process.

3. Generate a resilient framework for data management

One problem often encountered within the initiatives was that personnel involved in monitoring change over time. This can lead to varying and subjective data over the study period as replacement staff may use altered methods or approaches. Therefore, ensuring that there is clear guidance on how to accurately gather and store data over time is critical for the longevity and integrity of the project. Establishing an online database with universal objectives, guidelines and feedback would be a useful method to ensure data consistency and storage. Sullivan and Molles (2016) discussed the value of developing user-friendly online data entry systems, allowing individuals to maintain consistent data as well as other experts and organisations to provide ongoing feedback. This method also addresses the implications of individual volunteers having unique approaches to monitoring.

Therefore, developing a database or simply using NatureWatch would provide a resilient data storage system that could be used for the MKE area and wider scope of the AvOn's projects.

4. Development of a monitoring/education pack

The creation of biodiversity monitoring packs would also be an effective way to remedy issues surrounding data consistency, ensuring volunteers have the appropriate resources and guidelines to collect and interpret quality data. Included within the packs could be information sheets, identification charts, learning tools and equipment specifically aimed at monitoring the MKE area. These could be designed for different age groups and distributed to local schools or other participating organisations. This would then allow volunteers to have the knowledge and resources required to monitor either during an education programme or in their own time. Providing links to an online database or app, would enable the storage of the collected data which could then be reviewed by experts for further validation and feedback. The use of biodiversity monitoring packs linked with an online database was noted as being of high value by the Otago Peninsula Biodiversity Group.

5. Create a volunteer rewards programme

Some initiatives recognised that although there is currently a wide range of information available on how to monitor biodiversity, there are ongoing concerns with the limited numbers of volunteers involved with citizen science. This could be due to a lack of enthusiasm about volunteer programmes or issues with availability as a result of busy schedules. One solution could be to develop a rewards initiative to engage people and incentivise public involvement. As volunteers give their time and contribute to the database, they could be rewarded with points that may be used for discounts at local businesses willing to participate. Using a system similar to a time bank may also enhance this by exchanging volunteering hours for time credits that could be traded for different services. These options would provide further incentives for volunteers to spend time monitoring biodiversity, whilst attracting greater public interest and involvement. As a result, more comprehensive spatial and temporal data would also be collected within the area.

6. Establish a wider context

Finally, by providing volunteers and contributors with knowledge of the wider environmental, social and cultural ideas they are working towards, greater purpose would be instilled within the monitoring. This could encourage more people to become involved by recognising the greater context of their restoration and monitoring efforts. The use of signage and displays throughout sites were promoted by several initiatives as vital methods to convey information to and engage with the public. In the context of the MKE area, providing physical information on the links between different sites,

mahinga kai, *mātauranga* (indigenous knowledge) and of the Resident Red Zone (RRZ) would be highly beneficial. Nassauer (2004) suggested that by reframing ecological sites as an experience of aesthetic, educational and cultural significance for visitors, people are more likely to value them and exhibit stewardship. Harnessing eco-tourism alongside other ideas was also discussed by Peters (2016) as a way to encourage visitors to share photos and observations of biodiversity, leading to greater data collection.

Another key aspect of the research aim was to consider the implications of the recommendations for the future of the RRZ. To address this, research focused on biological derived concepts and community based outcomes, both of which improve social and natural resilience. These concepts can be linked through the common theme of connectedness in both an ecological sense and a community sense. In order to conserve and restore habitats the wider ecosystem and its functions need to be considered, resulting in enhanced ecosystem services, which are defined as ‘‘the benefits human populations derive, directly or indirectly, from ecosystem functions’’ (Costanza, et al., 1997, p. 253).

One suggestion to improve ecosystem health in a wider context is the creation of stepping stones. Stepping stones are small habitat blocks or green spaces linking urban areas allowing the fluid migration of fauna between locations (Dearborn & Kark, 2010). Hostetler, Allen, and Meurk (2011) also state the idea that creating natural corridors will restore and conserve urban biodiversity. They also recommend removing regulatory barriers. A contextual example of this from the MKE is the legal verge restrictions which require 9 meters of free space on the roadside (New Zealand Transport Agency, 2014).

Another way to improve urban biodiversity was to engage residents and communities (Hostetler, Allen, & Meurk, 2011). Colin Meurk (2016) proposed a similar idea including stepping stones and connecting various natural aspects of in his eco-city vision for Christchurch. Overall, these findings are relevant to the MKE because essentially the RRZ is a ‘surrounding landscape’ and could be incorporated in this vision.

From the literature, it is clear that there are a range of benefits from engaging communities including; the consideration of *mātauranga* (Peters, Eames, & Hamilton, 2015), enhanced social capital (Whitelaw, Vaughan, Craig, & Atkinson, 2003) and that monitoring could be educational and thus provide secondary beneficial outcomes (Braschler, Mahood, Kerenyi, Gaston, & Chown, 2010; Davies, et al., 2011; Hostetler, Allen, & Meurk, 2011; Watson & Novelly, 2004).

There is a wide range of literature that outlines the benefits of biophilia and the incorporation of green spaces in urban landscapes for communities (Beatley, 2011), including increased urban resilience (Beatley & Newman, 2013) and improved ecosystem services (Dearborn & Kark, 2010). These ideas are further reinforced by Tidball and Krasny (2014) in their book "Greening in the Red Zone".

Conclusion

Based on our findings we are confident that our recommendations could be integrated not only within the context of the MKE but also into future uses of the RRZ and beyond. Monitoring using citizen science would provide meaningful data and in-turn, aid policy and decision-making from the bottom up. This would enhance community engagement and improve social-ecological resilience across a range of scales. Future research could include implementing a pilot study to engage local schools and community members. The data and results of this study could be used to develop the resilient data management framework, aiding the establishment of the final programme.

It should be noted that our research approach and methodology is likely to be the some of the first of its kind within a New Zealand context. Therefore, results of this research should be examined closely with relation to the potential wider implications. Not only could the MKE be a leading example of community-driven biodiversity monitoring for the area and the surrounding RRZ, but the establishment of a community driven monitoring programme could be integrated into the goals of larger organisations. Therefore, the MKE project findings could be used to connect numerous established monitoring initiatives together generating a larger collaborative data pool.

In summary, this research and the suggested recommendations align with a wide range of literature and currently active initiatives. These recommendations are able to supplement decision making by the Avon-Ōtākaro Network and local rūnanga with the continued development of their managed areas or projects in the future.

Acknowledgements

This research has been completed on behalf of our community partner, the Avon-Ōtākaro Network (AvON) and we thank Kathryn Bates for her work as our main point of contact. Thanks also to Shane Orchard for his contribution to understanding the present biodiversity of the area.

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Further reading

In addition to the recommendations presented above, if AvON and other project partners wish to learn in more depth about the specifics of potential monitoring approaches, we recommend that they refer to the following literature:

- Open Air Laboratories (OPAL): A community-driven research programme.
  (Davies, et al., 2011)
- Establishing the Canadian Community Monitoring Network.
  (Whitelaw, Vaughan, Craig, & Atkinson, 2003)
- An Inventory of Citizen Science
  (Peters M. , 2016)
  (A New Zealand-based report providing a range of broader monitoring ideas and useful contacts)

Full citations are noted in the references.

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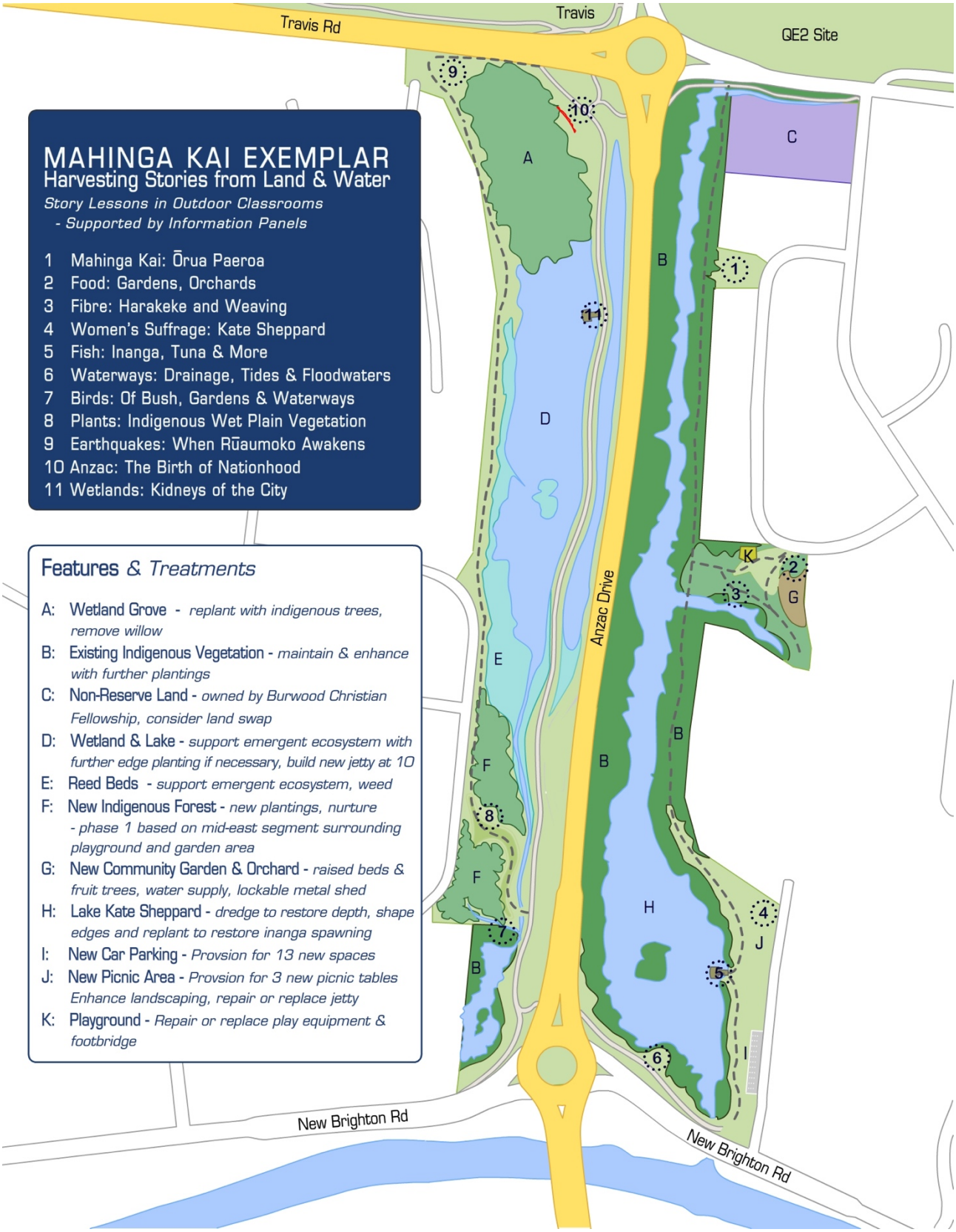
Appendices

Appendix A: Plan of the Mahinga Kai Exemplar project area

Source: Avon-Ōtākaro Network



Appendix B: Groups and individuals interviewed

01. Forest & Bird North Canterbury
    (Colleen Philip, Chair of Forest & Bird North Canterbury branch)
02. Kea Conservation Trust
    (George Moon, Arthur's Pass Citizen Science Project Team)
03. Zealandia
    (Neil Anderson, Ranger)
04. Battle for the Banded Rail
    (Elspeth Collier, Tasman Environmental Trust)
05. Travis Wetland Trust
    (Denise Ford, Secretary)
06. Department of Conservation – Waimakariri area
    (Dean Turner, Senior Ranger – Biodiversity)
07. Christchurch City Council – Natural Environment Strategy and Transformation Group
    (Brenda Greene, Senior Adviser)
08. Ngāi Tahu
    (Nigel Scott, Principal Adviser – Mahinga Kai)
09. Quail Island Ecological Restoration Trust
    (Ian McLennan, Chairperson of Quail Island Ecological Restoration Trust)
10. Otago Peninsula Biodiversity Group
    (Sarah Irvine, Project Manager – Otago Peninsula Biodiversity Group)