

Options for the Restoration and Enhancement of the Longfin Eel/Tuna Kuwharuwharu Population and Habitat in the Ōtākaro Avon River

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Executive Summary

- The longfin eel (*Anguilla dieffenbachii*) or tuna kuwharuwharu, is New Zealand's only endemic freshwater eel. It is valued for its cultural and ecological significance and is classed as 'at risk - declining'.
- This report aims to investigate some options and potential implications for the enhancement and restoration of longfin eels and their habitat in the Ōtākaro Avon River within the four central avenues of Christchurch City.
- Our research combined a literature review with a site visit, public survey, and semi-structured interviews.
- Survey results indicated a lack of knowledge but an appetite for education about the longfin eel.
- While our research does not make specific recommendations, it does provide an initial assessment of which options may (or may not) be worth pursuing further.
- Through reviewing relevant literature and taking into consideration varied viewpoints from key stakeholders and the public, we have gained an insight into concerns and opportunities for the longfin eel in central Christchurch.
- Due to the time frame and exploratory nature of the research, a full engagement process with local rūnanga was not possible.
- If any of these options were to be taken further, a partnership with local rūnanga is vital for a successful project.

1. Introduction

The longfin eel (*Anguilla dieffenbachii*) or tuna kuwharuwharu, is valued for its endemism to New Zealand and its cultural and ecological significance (Jellyman, 2012; Noble et al., 2016; McDowall, 2011). Longfin eels are classified as 'at risk – declining' (DoC, 2018) and have been impacted by commercial fishing, waterway passage barriers, habitat degradation and reduction, and poor water quality (PCE, 2013). A population of longfin eels are found in the Ōtākaro Avon River and likely subject to a number of these factors.

Di Lucas, from Lucas Associates, has been active in environmental issues in Christchurch and New Zealand for many years. She wanted to ensure this population can thrive and thought their central location provided an opportunity to build awareness of this species for both locals and visitors to the city.

This report aims to investigate some options and potential implications for the enhancement and restoration of longfin eels and their habitat in the Ōtākaro Avon River within the four central avenues of Christchurch City. We investigated four options; a water conservation order, reserve, habitat improvement, and education. In order to achieve our aim, we gathered data and sought input from stakeholders on each of our options regarding;

- appetite: whether there is support for work of this nature to be undertaken.
- need: whether work is necessary and would benefit the eels.
- feasibility: the logistics and achievability of implementation.

We also analysed existing literature to gain an understanding of longfin eels, and the effectiveness of each option.

The report will outline our literature review, methods, results/discussion, limitations and conclusion.

2. Literature Review

Our research process began with a review of relevant literature. The review assisted in narrowing down our aim, objectives and methodology, while providing background on the topic. The following is a summary of our key findings.

2.1. Biology and Threats

The longfin eel is an apex predator in our freshwater systems, thus controlling the numbers of species lower in the food chain (PCE, 2013). Further, "as opportunist scavengers, they dispose of and recycle many nutrients" (Jellyman, 2012), hence their ecological importance. They are a long-lived species that only breed once at the end of life, when they travel from their freshwater habitat to a still uncertain destination thousands of kilometres away in the Pacific Ocean. These attributes and uncertainty contribute to some of the challenges associated with their management (PCE, 2013).

McDowall (1984) suggests “the primary conservation need of all native fauna is sufficient and suitable habitat”. To address this, he suggests a combination of “experts” outlining and communicating what is needed, along with the establishment of “political and/or public will”. Other studies also suggest public support can be influential in the success of conservation goals, and a collaborative approach between environmental managers and communities is important (Tanner-McAllister et al., 2014). This influenced our decision to conduct a public survey and engage with key stakeholders to determine if support already exists and what is needed to support the longfin eels in our research area (if anything).

The literature outlined some of the habitat and environmental preferences of longfin eels, such as daytime cover/shade (Glova, 1999), and several predominantly anthropogenic threats to longfin eels nationwide. This initial review helped frame some of the questions we posed to stakeholders, regarding the threats to eels in the Avon and what could be done to mitigate these.

2.2. Cultural Significance

Tuna kuwharuwharu are a taonga (treasure) species and hold great significance to Māori for many reasons (Noble et al., 2016; McDowall, 2011). They are embedded into mythology and were historically a vital food source, with special traditions developed for their harvest (PCE, 2013). Today they are important for preserving the practice of cultural traditions and are still considered an important mahinga kai (Gordon, Harris, & Horton, 2018).

Understanding the cultural significance of freshwater to indigenous groups is important for environmental planning and decision making, particularly in New Zealand (Noble et al., 2016; Tipa & Nelson, 2008). Harmsworth, Young, Walker, Clapcott & James (2011) highlight the dominance of western scientific methods in the establishment of river standards and guidelines. Their results argue the potential for a greater role for Māori in environmental monitoring and management, and the importance of incorporating input from mana whenua in river assessment and management. This can be through Māori-led protection initiatives such as the establishment of Mātaitai reserves or through co-management approaches (Noble et al., 2016). Thus, engaging with mana whenua is a central component of our research.

Iwi management plans and resource management strategies provide information regarding the values and aims of Ngāi Tahu and Ngāi Tūāhuriri specifically. Te Whakatau Kaupapa discussed the importance of the Ōtākaro Avon River to Ngāi Tūāhuriri for mahinga kai, again noting tuna as an historically important species, but also the view that all natural resources are taonga to Ngāi Tahu (Goodall, Palmer, Tau, & Tau, 1990). The Mahaanui Iwi Management Plan 2013 expands on this, stating that iwi and hapū are obliged to act as kaitiaki (guardians) towards taonga in the environment (Jolly & Ngā Papatipu Rūnanga Working Group, 2013). These plans are important to consider in our research. They outline the value of the Ōtākaro Avon

River to Ngāi Tūāhuriri and Ngāi Tahu and further emphasize the importance of engaging with mana whenua in the management of mahinga kai resources.

2.3. Legislation

Hudspith (2012) outlines the uses of the Resource Management Act 1991 (RMA) in the protection of freshwater ecosystems in New Zealand. This study suggests that high levels of pollution in urban waterways (like that of the Avon) implies a management failure and therefore a lack of ecological sustainability, despite this being an important factor in the RMA. We decided to explore the Reserves Act 1977 as a potentially more suitable option than the RMA for the protection of an urban waterway.

The Reserves Act 1977 outlines the different types of reserves, which include; recreational, scientific, wildlife, nature, scenic, and local purpose reserves. These reserves offer varying levels of protection for fauna, in balance with other values such as recreation and tourism.

The National Policy Statement for Freshwater Management provides direction for regional councils in New Zealand. This centres on water allocation limits, pollutant discharge, and overall water quality degradation. It also requires the recognition of connections between the water and the broader environment, both ecologically and culturally (MfE, 2014). Although the Avon is not under the management of the regional council, important considerations can be taken from this document regarding the physical management of a freshwater ecosystem.

2.4. Current Work

There is a range of work underway in the Avon and elsewhere in New Zealand relating to the longfin eel. Reviewing current work allowed us to explore enhancement and restoration options which could be implemented in the Avon, as well as highlight future collaboration potential.

The 'Urban Eels: Our Sustainable City' project is a joint effort taking place in Manawatū between Gordon Consulting and Tanenuiarangi Manawatū Incorporated (Gordon, Horton, & Harris, 2018). Urban Eels aims to halt the decline in the local eel population, and create opportunities for improved education and connection between people and tuna. The work provided us with a template for not only specific actions that can be taken to enhance longfin eel populations and habitats in an urban environment, but also how co-design between mana whenua and local environmental consultants can lead to successful outcomes.

A guide for the restoration and enhancement of tuna populations in the Waikato and Waipaa river catchments has been developed in response to the declining population in the region (Watene-Rawiri et al., 2016). Examples of proposed remedial actions include; riparian planting, improved drain clearance and maintenance, and fish passage restoration. The guide also states that ongoing collaboration and dedication from individuals and organisations is essential. The

scale and location of the guide differs from our research, as do some of the listed threats. However, it is useful for understanding the importance of tuna ecologically and culturally, and the complexities involved in their various management solutions.

The Ōtākaro Avon River Catchment: Vision and Values document lists six core values (ecology, drainage, culture, heritage, landscape, and recreation) as drivers for improving surface water and waterways asset management in this area (CCC, 2016a). It also emphasises the importance of involving local rūnanga in planning and decision making, and provides an assessment of the current state of parameters assigned to each of these values. The document outlines some existing challenges within the river and the ways in which these hope to be addressed. This provided us with potential opportunities for work that could be done in conjunction or aligned with these values.

The Ōtākaro Avon River Corridor Regeneration Plan (2019) outlines the range of objectives and opportunities in and along the Avon, from Barbadoes Street to the coast. The plan was approved by council during our research period (August 2019) and has a heavy focus on mahinga kai, ecological enhancement, and upgraded stormwater infrastructure to improve water quality. This plan aided our understanding of current work and plans in the Avon and informed our assessment of enhancement and restoration options for the longfin eel within our proposed section of the river.

3. Methods

The general approach for this project was to compare potential options with existing legislative framework and engage with key stakeholders to gain input as to the possible value of each option investigated. In addition to the literature review, we collected data from a site visit, public survey, and semi-structured interviews with a range of stakeholders, including ecologists, policy makers, and cultural advisors.

The site visit aimed to observe the current environment and activities taking place within our proposed area. The visit was conducted at the beginning of the project (August 2019) and covered the river and riparian areas from the Botanic Gardens to the Margaret Mahy playground.

The public survey focused on current views and knowledge of longfin eels in order to assess the appetite for this project. The survey was distributed online and in person. A full copy of the survey is provided in Appendix 1. The online survey was shared on our personal Facebook pages and various community pages. We conducted surveys in person by convenience sampling at key locations along or near the Avon, including Margaret Mahy playground, the Terraces, Antigua Boat Sheds, and the Botanic Gardens. We also surveyed at a retirement village, where a group member has a family connection, to ensure we had responses from a broad age demographic. We received a total of 209 responses. The survey results were collated in excel with key findings presented in the figures found in this report. To create a word cloud of the key themes outlined in response to question five, answers were analysed and grouped as per the methodology outlined in Appendix 2.

The semi-structured interviews were predominantly held face-to-face with 15 key stakeholders, that potentially had an interest in our project or could offer information related to the need and feasibility. In some cases this was not possible, so email correspondence was used instead. Interviewees included ecologists, Christchurch City Council employees, individuals from Ngāi Tahu & Ngāi Tūāhuriri, the Department of Conservation, National Institute of Water and Atmospheric Research (NIWA), cultural advisors, and representatives from various relevant projects/organisations. These had similar objectives to our own work, such as the Avon-Ōtākaro Network and the Urban Eels project. A full list of those communicated with can be found in the acknowledgements.

4. Results and Discussion

The results (and implications of these) from our literature review, site visit, survey, and interviews are compiled into four main sections, reflecting the options investigated.

4.1. Water Conservation Order

In 1991, the Land and Water Act 1967 was repealed and the Resource Management Act 1991 (RMA) was imposed. Water Conservation Orders (WCO) were formed under the RMA as a legislative framework for the protection of ecological and cultural aspects in freshwater ecosystems (Resource Management Act 1991, s. 199). A WCO is only applicable to a body of water that displays outstanding natural, ecological, or cultural features. This can include features such as the last remaining population of an endemic species, important breeding grounds, or historic cultural significance. Applications for this level of protection are expensive and involve an extensive legal process, which was also confirmed in our interviews. Due to these factors, a WCO was deemed impractical for the Avon. Thus, a WCO was not explored further.

4.2. Reserves

Seven of the different types of reserves listed in the Reserves Act 1977 were considered throughout this project. The suitability of each type was judged based on its level of protection for eels, ability to retain the current recreational values of the Avon, and any adjustments in management required if the option was implemented. The importance of ensuring that a reserve does not encroach on customary fishing access or practices was highlighted in multiple interviews.

4.2.1. Scenic Reserve

A scenic reserve preserves an area for its beauty and public access (Reserves Act 1977, s. 19). However, it is focussed on natural vegetation and features, as opposed to fauna within the area. While this type of reserve offers unrestricted public access, it has limited benefits for fauna. This option has therefore been deemed unsuitable.

4.2.2. Nature Reserve

A nature reserve would provide the highest level of protection for the eels, but completely restrict public access (Reserves Act 1977, s. 20). If this reserve was implemented, ministerial consent would be required for any access, including maintenance contractors. This does not align with the recreational and tourism values of the Avon, as identified following both our literature review and interviews.

4.2.3. Scientific Reserve

Scientific reserves can manage and protect biological features within the reserve area. However, they also allow manipulation of biotic and abiotic factors for experimental purposes (Reserves Act 1977, s. 21). This is not the purpose of this project; therefore, this reserve type was also deemed unsuitable.

4.2.4. Recreational Reserve

A recreational reserve aims to conserve the cohesion between the natural environment and recreational value of the reserve (Reserves Act 1977, s. 17). While this is applicable to the recreational values of the Avon, it would not provide a high level of protection for the eel population. A recreational reserve is therefore feasible but would not be suitable in this case.

4.2.5. Customary Fisheries Management Areas

Mātaitai reserves and rāhui are two forms of customary fisheries management areas in New Zealand, although they are not within the framework of the Reserves Act 1977. These were suggested as options to investigate by various stakeholders. A rāhui is a temporary closure which can have varying levels of limitations on fishing and public access (McCormack, 2011). Mātaitai reserves focus on the protection of aquatic species from commercial fishing (Fisheries [South Island Customary Fishing] Regulations 1999, s. 24) and provide a high level of protection for freshwater or marine ecosystems. Customary management areas give local iwi more authority, allowing them to focus on the protection of their values. However, these reserves are proposed by Māori and generally run by local rūnanga. In light of this, it is inappropriate to suggest these options. However, it was suggested that we could offer to support Ngāi Tūāhuriri if they felt one of these options should be implemented.

4.2.6. Government Purpose Reserve

Government purpose reserves (also known as wildlife management reserves) can be used for the purposes of wildlife management (Reserves Act 1977, s. 22), thus would offer eels a high level of protection. It would give the government overarching authority on the waterway. Government purpose reserves are often used on larger rivers for protection from commercial fisheries. A reserve of this extent would be unnecessary, given that commercial fishing does not take place in the central city Avon.

4.2.7. Local Purpose Reserve

The final option we explored under the Reserves Act 1977 is a local purpose reserve. While not originally considered, this option was suggested by an individual from the Christchurch City Council. This option can protect certain species and give the district council authority (Reserves Act 1977, s. 23), while still allowing partnership options with mana whenua. As the riparian margins and river are council managed, turning this area into a local purpose reserve is unlikely to have large impacts on current processes. Christchurch City Council Parks and Reserves bylaws could also be imposed if this was implemented. This means, for example, that no harm or interference could be done to animals in this area and no pollutants could be purposefully discharged without prior council approval (CCC, 2016b). Signs around the area could remind people of these rules. This type of reserve could be specifically named a longfin eel reserve. This provides opportunities to increase awareness, education, and tourism. Interviews suggested that increased awareness and education could indirectly benefit the population of longfin eels nationwide, through the improvement of public perceptions about the species. An increase in tourism could also positively impact the city's economy.

4.3. Habitat Enhancement and Restoration

Water quality in the Avon is degraded by heavy metals, sediment, and other pollutants, originating from stormwater runoff (CCC, 2016a; Boffa Miskell, 2017). This was also highlighted in our interviews, particularly with ecologists. Apart from a limited number of small rain gardens and filters, stormwater enters Christchurch's waterways directly. It was also brought to our attention that stormwater filters, while good in theory, are expensive and can cause harm to eels (and other fish) if they enter the filter system. The poor stormwater infrastructure in the older part of the city will be difficult and expensive to update. It was also indicated that water quality in the Avon is worsened by highly polluted tributaries, such as the Addington Brook and Riccarton Stream. The pollution in these tributaries could be limiting recruitment, as less pollutant tolerant juvenile eels tend to search for small tributaries. There is limited research into recruitment levels of longfin eels in urban environments and the impact predation from introduced species (like trout) may also have on recruitment. Improving water quality is already a major focus of the council and work is underway, particularly in relation to stormwater management (CCC, 2016a). An individual from the council highlighted the benefit in increasing public knowledge around stormwater and highlighting ways in which everyone can reduce contaminants.

Ecologists we interviewed indicated that habitat degradation and reduction could be a limiting factor for the eel population, particularly a lack of daytime cover. Pipes of varying sizes, often referred to as 'tuna townhouses', have been installed in the riverbank perpendicular to the stream, under the earthquake memorial in the central city Avon (Boffa Miskell, 2017). This mirrors similar projects in the Heathcote River and Dudley Creek. The adult eel population could benefit from more of these, alongside overhanging vegetation and undercut banks. We were also made aware that some of the pipes have been installed too high. It is important that the pipes are installed so that they are fully submerged, even at low flow levels.

Aquatic plants are a complex issue. City Council employees have indicated aquatic plants in the Avon are trimmed up to three times a year to prevent excessive growth. While these plants provide daytime cover and habitat for eels, they degrade water quality by trapping sediment, and they reduce the flood flow rate. Therefore, a balance needs to be struck between these conflicting factors. A potential solution is to enhance shade cover from riparian plants and preferably native trees (CCC, 2016a). Increased shade will prevent excessive growth of aquatic plants, while ensuring that eels still have natural daytime cover. Riparian plantings also add to the aesthetic value of the river and aid in filtration of stormwater runoff.

Survey responses, as well as the site visit, indicated that people are feeding the eels but not necessarily the ideal food. A longfin eel expert suggested that feeding stations could provide a quality food source for the eels, enhancing their growth rate and potentially shortening the length of time it takes before they mature and are ready to go to sea. Examples of existing and proposed feeding stations can be seen around the country, including at Willowbank here in Christchurch and in the Urban Eels project in Manawatū.

Several of the habitat restoration and enhancement options identified could be implemented alongside other projects, and align with other priorities and values for the area. For example, 'tuna townhouses' and overhanging riparian vegetation can be installed during bank stabilization projects. Monitoring has suggested that some endemic bully species have also been utilizing the 'tuna townhouses'. This demonstrates that some eel-focussed options can have benefits for other species. The ideal habitat for juvenile eels is gravel in fast flowing areas, which allows them to avoid predation while still benefiting from food sources flowing by. Similarly, the bluegill bully (currently classed as 'at risk - declining') also prefers fast-flowing riffle habitats.

4.4. Education

The survey provided us with useful data on the public appetite for this project and the need for education. Figure 1 shows a combined majority of respondents had positive feelings towards eels. Many people, particularly those with children, commented on their enjoyment in seeing and interacting with eels. However, the results show a lack of knowledge in some attributes of the longfin eel; only 24% of people knew why eels are considered important to New Zealand ecologically or culturally. Interestingly, even though so few respondents knew reasons for their importance, 60% thought they were either 'at risk - declining' or 'threatened - nationally endangered' (Figure 2). PCE (2013) opines that the perceived absence of cuteness or charisma in eels is potentially one of the reasons New Zealanders are "more blasé about their endangerment" than with other similarly threatened, more iconic species. Figure 3 outlines the key themes from those who stated they knew why longfin eels are considered important. While these key themes do cover a number of the ecological and cultural aspects we found to be important, such a small number of respondents knowing this highlights the potential for education. Encouragingly, we found there

was a strong appetite for education with 61% of respondents indicating an interest in learning more, particularly around habitat and cultural significance.

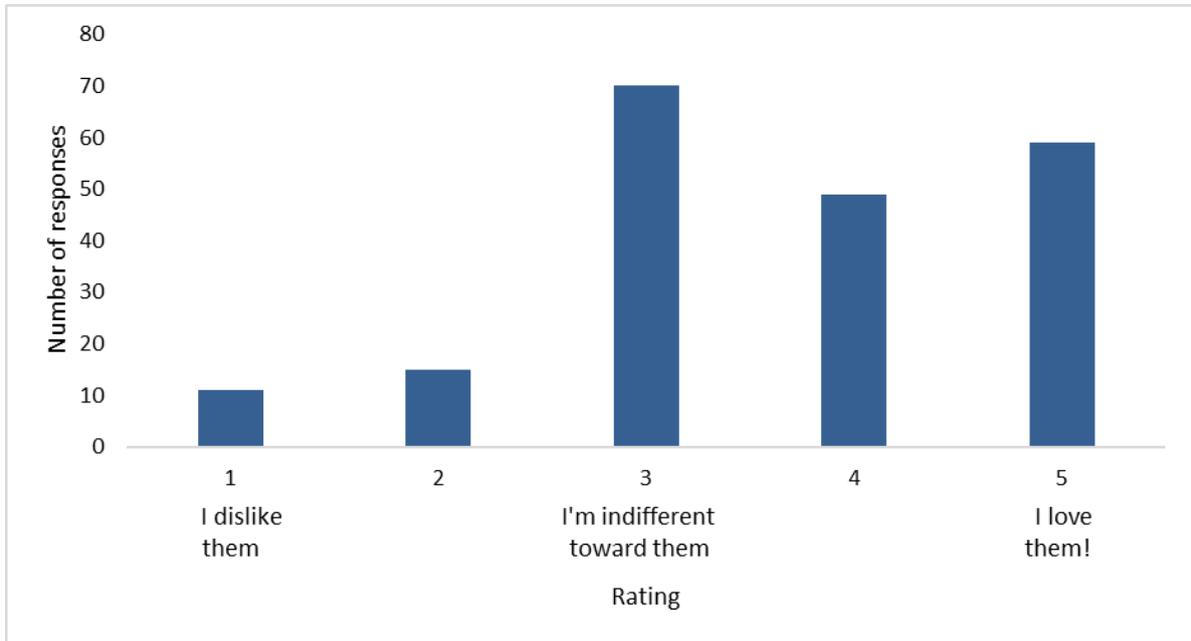


Figure 1: Answers given by the public in response to question two of our longfin eel survey, conducted both online and in person along the Avon River in central Christchurch. Respondents were asked “On a scale of 1 – 5, how do you feel about eels/tuna?” with the rating levels further clarified as per the graph.

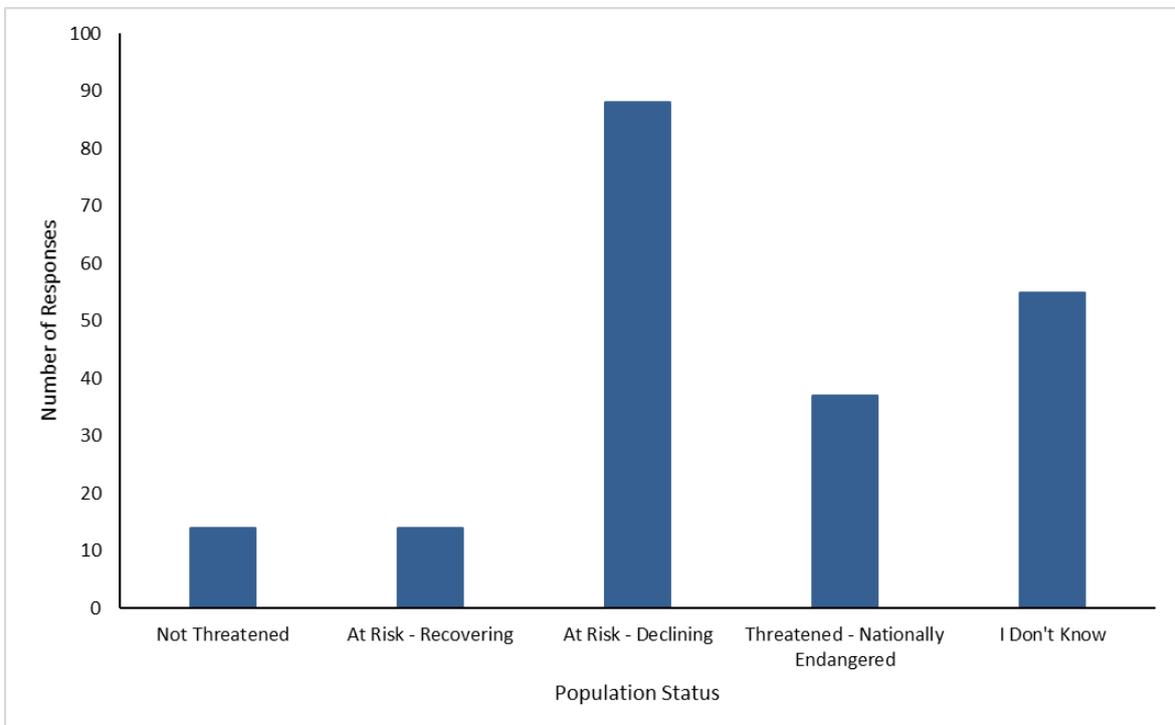


Figure 2: Answers given by the public in response to question six of our longfin eel survey, conducted both online and in person along the Avon River in central Christchurch. Respondents were asked “What do you think the population status of the longfin eel/tuna kuwharuwharu in New Zealand is currently categorized as?” and provided with the five options, as outlined in the graph.

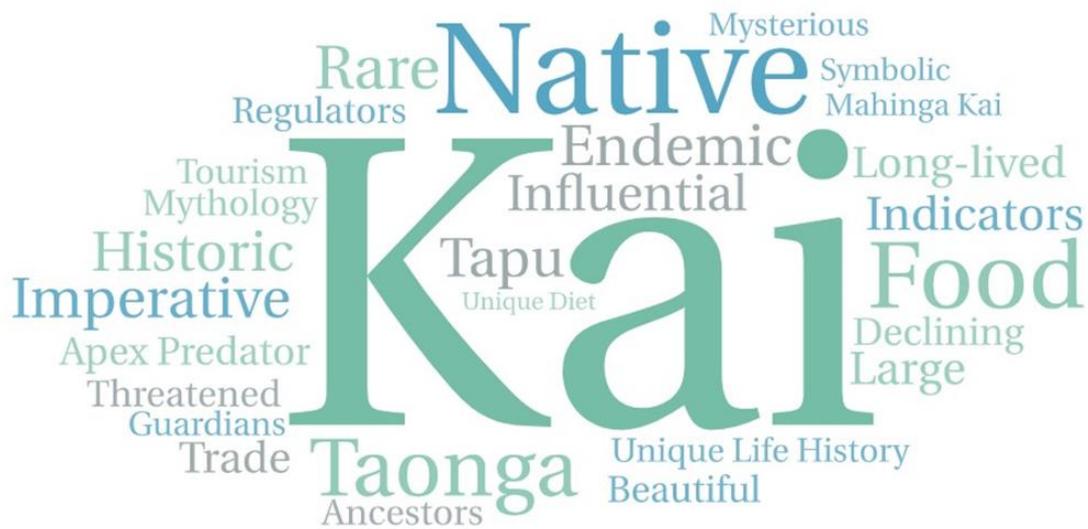


Figure 3: Answers given by the public in response to question five of our longfin eel survey, conducted both online and in person along the Avon River in central Christchurch. Respondents were asked “Do you know why the longfin eel/tuna kuwharuwharu is considered important to New Zealand/Aotearoa both ecologically and culturally?”, and if they answered yes to elaborate on this. This word cloud highlights some of the key themes given in response.

From our interviews, there was a general consensus regarding the benefits of educating the public, especially children, on the ecology and cultural significance of the species. In fact, some education initiatives are already underway. EOS Ecology runs eel encounter sessions with schools, teaching students about the eels, their habitat, and stream restoration. An education program is also being developed by the Avon/Ōtākaro Network which currently focuses on inanga, but could be used as a template for other species. Highlighting the existing options available for schools is important. Children, who are generally enthused and excited about eels, could pass on their excitement and new knowledge to their parents. For more education initiatives to go ahead, there needs to be funding or voluntary efforts. Currently schools are required to pay for some of these initiatives, but funding or subsidies would help to ensure that schools unable to cover the cost could still benefit.

Further education initiatives could include informative signage along the river and educational sessions, held in conjunction with scheduled feeding times. Feeding stations provide the public with an opportunity for direct interaction with longfin eels. This direct interaction could help to (re)build a connection with the species and a sense of responsibility in preserving them for future generations. It was suggested that educational sessions would be most effective when conducted by people who have a deep connection to the river and species, and can speak from the heart/experiences, such as mana whenua. Ngāi Tūāhuriri elders often have the spare time, and love to share knowledge with younger generations. Education initiatives could lead to more awareness of the species, why it is important, and the threats it faces. This could have indirect benefits for the population in the Avon, as well as the species as a whole. If more people care about their preservation, there is more pressure on councils and legislators to act.

5. Limitations

It is important to acknowledge there are some limitations to our research.

Given the survey was distributed online from our personal Facebook pages, there is potential for selection bias toward younger respondents with similar demographics and values to ourselves (Tolich & Davidson, 2011). We attempted to minimize this with in-person surveying in the central city and a retirement home. Furthermore, the sample size of the survey, lack of additional demographic questions aside from age, and a set minimum age of 18 for respondents means we cannot be certain the responses are representative of the general Christchurch population.

The short time frame for this research, along with its exploratory nature, made partaking in a full engagement with local rūnanga infeasible. Having not been through this process, we feel it is inappropriate to recommend any particular option (or combination of options) at this stage. However, some of the options outlined above could be feasible moving forward. Further, interviewees highlighted that despite being rich in knowledge, rūnanga are often resource limited, which would need to be considered and addressed if this project were to progress.

6. Conclusion

This report has investigated some options and potential implications for the enhancement and restoration of longfin eels and their habitat in the Ōtākaro Avon River. While our research does not make specific recommendations, it does provide an initial assessment of which options may (or may not) be worth pursuing further. Through reviewing relevant literature and taking into consideration varied viewpoints from key stakeholders and the public, we have gained an insight into concerns and opportunities for the longfin eel in central Christchurch.

As noted in both the literature and our interviews, engagement and partnership (as opposed to consultation) is crucial for a successful project and would be our recommended next step. We have been advised there is no formal process for engagement, but a good place to start is initiating contact with the chair and/or operations manager of Ngāi Tūāhuriri who can then direct to the appropriate people. This is a better option for true engagement, as opposed to consulting through mana whenua advisory companies, whose views may not be representative of wider Ngāi Tūāhuriri whanau.

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Appendices

Appendix A: A copy of our public survey, conducted both online and in person along the Avon River in central Christchurch.



Eel/tuna Research Survey

This survey is being conducted by third year science students at the University of Canterbury in conjunction with a community partner. The survey is part of a research project centred on longfin eels/tuna kuwharuwharu. The project meets the requirements of the University of Canterbury's Human Ethics Committee. If you have any questions about this contact Simon Kingham at simon.kingham@canterbury.ac.nz. Any responses will be kept anonymous. Responses may be included in a public conference presentation and/or final report. Every question is optional and you can withdraw at any time. The survey will take approximately 3-5 minutes to complete. By completing this survey, you are consenting to the above terms.

Note: Tuna is the word for eel in te reo Māori and tuna kuwharuwharu is one of the names used for the longfin eel.

1. What age bracket do you fall under? *(Please tick one)*

- | | |
|--------------------------------|-----------------------------|
| <input type="radio"/> Under 18 | <input type="radio"/> 45-54 |
| <input type="radio"/> 18-24 | <input type="radio"/> 55-64 |
| <input type="radio"/> 25-34 | <input type="radio"/> 65 + |
| <input type="radio"/> 35-44 | |

2. On a scale of 1 – 5, how do you feel about eels/tuna? *(Please circle one)*

- | | | | | |
|------------------|---|-----------------------------------|---|----------------|
| 1 | 2 | 3 | 4 | 5 |
| (I dislike them) | | (I'm indifferent
towards them) | | (I love them!) |

3. What have been your interactions with eels/tuna in the past?

4. Have you ever seen an eel/tuna in the Avon River/Ōtakaro? *(Please tick one)*

- Yes No

PLEASE TURN OVER PAGE FOR FINAL QUESTIONS

5. Do you know why the longfin eel/tuna kuwharuwharu is considered important to New Zealand/Aotearoa both ecologically and culturally? (Please tick one)

- I'm not sure
- Yes (Please explain why)

6. What do you think the population status of the longfin eel/tuna kuwharuwharu in New Zealand is currently categorized as? (Please tick one)

- Not threatened
- At Risk – Recovering
- At Risk – Declining
- Threatened – Nationally Endangered
- I don't know

7. If you were offered an opportunity to learn more about longfin eels/tuna kuwharuwharu, would you take it? (Please tick one)

- Yes
- No

8. If you answered yes to question 7, are there any specific areas you would be more interested in? (Please tick as many as you wish)

- Habitat
- Diet
- Cultural Significance
- Other (please specify): _____

9. What do you think happens to storm-water once it has entered the drains in Christchurch/Ōtautahi? (Please tick one)

- It goes to a treatment facility
- It enters the Avon River/Ōtakaro directly
- I don't know
- Other (please specify): _____

Thank you for completing this survey!

If you wish to receive a copy of the results or have any questions please contact Kate Belcher at katebelcher802@gmail.com

Appendix B: Word cloud response analysis

Table B.1: Responses to question five of our longfin eel survey were analysed and grouped by overarching theme/sentiment. A representative word(s) was then chosen to more clearly represent the key themes given by respondents in a word cloud. The table outlines each of the word(s) used in the word cloud with examples of the types of responses this word represented.

Representative word	Examples of survey responses
Ancestors	“Tuna can be considered ancestors...”
Apex predator	“They are the apex predator in our freshwater systems” / “Pretty close to the top of the food chain...” / “Apex predator”
Beautiful	“...a beautiful species”
Declining	“Declining population” / “In decline”
Endemic	“All spawn in New Zealand” / “Endemic” / “Indigenous species”
Food	“Food source for Europeans” / “Vital part of diet in NZ” / “Food source”
Guardians	“Tuna can be considered... guardians...”
Historic	“Part of our heritage” / “Historic” / “They've been here longer than us” / “Old”
Imperative	“Key part of ecosystem” / “Eels important to health of rivers and lakes” / “Deserve to be protected for their own sake” / “Deserve to be here as much as anyone”
Indicators	“Good way to assess water and habitat quality” / “Good barometers for ecological changes” / “Indicator species”
Influential	“Good for local ecosystem” / “Helps with ecology and sustaining waterways” / “Part of the water ecology”
Kai	“Food source for Māori” / “Important culturally as a food source” / “Kai”

Large	“It’s New Zealand’s largest eel”
Long-lived	“Very long-lived” / “Live very long lives”
Mahinga kai	“(they) are a mahinga kai species” / “important Mahi Kai for Māori”
Mysterious	“(There is) limited knowledge of their life history” / “Unknown life cycle”
Mythology	“Mythical aspects (stories)” / “Mythology”
Native	“Native fauna” / “New Zealand native”
Rare	“Rare” / “Hard to come by”
Regulators	“Regulate the ecosystem” / “Keep waterways clean” / “I think they clean water”
Symbolic	“Become an important symbol and artistic motif”
Taonga	“Significant to Māori” / “Taonga”
Tapu	“Considered tapu in some iwi” / “Tapu”
Threatened	“Threatened by...” / “Threatened due to...” / “Under threat”
Tourism	“Important for sight-seeing”
Trade	“Trading resource”
Unique diet	“Eat stuff that others don’t”
Unique life history	“Unique in their living in both fresh and saltwater. Overland migration from Te Waihora is amazing” / “(They) have an incredible lifecycle” / “They migrate to the pacific islands to breed every year”