



Urban Orchards for the Garden City

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1. Executive summary

- Fresh produce is becoming increasingly hard to access, due partly to the current cost of living crisis. Urban orchards increase accessibility and literature shows that they provide significant environmental and social benefits.
- Our research question was: What is the feasibility of planting fruit trees in public parks to be maintained by church communities?
- Surveys, geographic information system analysis, and social return on investment analysis were used to answer this question.
- These tools show that urban orchards in public parks are feasible and would provide significant benefits to the local communities.
- Findings were limited by the low numbers of survey respondents and limited criteria used to determine suitable sites.
- Future research could increase the number of criteria used to determine suitable parks.

2. Introduction

Accessing fresh produce is essential for a healthy life, however this is becoming increasingly difficult for many people in New Zealand, with the price of fruit and vegetables set to increase by 22% in the year ending April 2023 (Stats NZ, 2023). We are interested in the possibility of creating urban orchards around Ōtautahi Christchurch to improve access to fresh fruit. The orchards will be planted on Christchurch City Council (CCC) owned public land and maintained by churches. Each will have between ten and fifty fruit trees, depending on the size of the park. They will be spray-free, and preferentially planted with heirloom/heritage varieties.

Our community partners are Michael Reynolds of Roimata Food Commons (RFC), and James Beck of A Rocha Aotearoa. RFC is a mixed garden consisting of both vegetable beds and fruit trees, diversified by native vegetation. It is in Radley Park, Woolston, and maintained by a group of local volunteers. As a Commons, RFC is intended to belong to the community, with the understanding that anyone in need can help themselves to produce, with no obligation to give back, although this is encouraged. A Rocha is an international organisation which coordinates a global network of Eco Churches, including ten in Christchurch. Our community partner indicated that members of the local network are likely willing to help plant and maintain urban orchards. Therefore, we focused on these churches for this project.

Our research question was ‘what is the feasibility of planting fruit trees in Christchurch public parks to be maintained by church communities?’ The aims of our research were to identify the social, economic and environmental costs and benefits of the project, and to determine the most suitable orchard sites. To identify the costs and benefits, we conducted a literature review and online surveys. We then used GIS software to identify the most suitable sites. We also aimed to identify how urban orchards align with existing CCC policies such as the Christchurch Food Resilience Policy, Ōtautahi Urban Forest Plan (UFP), and the Edible Canterbury Charter.

3. Literature Review

Food Resilience

Public orchards can increase food resilience, which is defined by Tendall et al. (2015) as “the capacity over time of a food system and its units at multiple levels, to provide sufficient, appropriate, and accessible food to all, in the face of various and even unforeseen disturbances.” Public orchards increase local food security and sustainability by localising supply, resulting in fewer carbon miles required for transportation (Toth et al., 2015). This is in contrast to global supply chains, which are often long and have a higher environmental impact (Toth et al., 2015). Due to their increased length, they are also more vulnerable to external disturbances (Haylock & Connelly, 2018), which are likely to increase due to climate change (Toth et al., 2015).

Planting fruit trees in local parks increases food resilience, as they provide an alternative source of produce, and decrease the vulnerability of local communities to disruptions in the national food system (Toth et al., 2015). Soliman & Greenhalgh (2020) support this idea, as they found that food resilience can be increased through diversifying and localising food supply chains. CCC is generally supportive of local efforts to increase food resilience, as it aligns with their Christchurch Food Resilience Policy (Christchurch City Council, 2014).

Urban Trees

Planting fruit trees in public parks will increase urban tree canopy cover as the trees grow, which aligns with the UFP (Christchurch City Council, 2023). In addition, CCC expects a return of \$2.25 in ecosystem services for every \$1 spent on planting canopy-forming trees (Christchurch City Council, 2023). Fruit trees also increase the multi-functionality of parks (Padgham et al., 2015), increase biodiversity and habitat for fauna (Lin et al., 2015), and create a sense of ownership of a park within the local community. When considering the suitability of fruit tree varieties, environmental factors must be appraised, such as the climate, topography, and soil types.

However, urban fruit trees have limitations. For example, Christchurch urban soil is widely contaminated by heavy metals such as arsenic, zinc, and lead (Ashrafzadeh et al., 2018). These pose health risks to people, and there is potential for these contaminants to be taken up by trees into their fruit. Nie et al. (2016) found that for selected fruit varieties in China, this was insignificant, but there is a knowledge gap surrounding heavy metal uptake of fruit varieties in Aotearoa New Zealand. Generally, there is agreement that fruits contain lower concentrations of heavy metals than vegetables because they do not contact soil and heavy metals tend to be stored in other organs such as leaves (Nie et al., 2016). Another limitation is the potential for rotting fruit, which has a bad smell and appearance, may block footpaths and other infrastructure, and may attract wasps (Hodge et al., 2017). This limitation can be avoided through church communities harvesting fruit regularly but is still a possibility.

Community Development

Public orchards can strengthen local communities by providing a space for people to gather and build connections within their community (Firth et al., 2011). This can include connecting people with

different backgrounds (Shimpo et al., 2019). The provision of fresh fruit can increase the hauora (wellbeing) of people within a community, as it allows them to express manaakitanga (kindness and respect) by hosting social gatherings (Beavis et al., 2019). This is particularly important for Māori communities where expressing manaakitanga is culturally vital (Beavis et al., 2019; McKerchar et al., 2014). Urban orchards also allow for kaitiakitanga (environmental guardianship) to be expressed, and for the transmission of mātauranga Māori, particularly in regard to māra kai (gardening for food) and mahinga kai (customary gathering of food) (McKerchar et al., 2014; Viriaere & Miller, 2018). Mātauranga Māori can be transmitted vertically, from older generations to younger generations, but also horizontally within the same generation. These practices are increasingly difficult to do in the urban environment, but public orchards increase the accessibility of spaces where they can occur (Colinas et al., 2019).

Urban orchards can improve mental health in communities by increasing the amount of time people spend outdoors, which has concomitant decreases in symptoms of depression and anxiety (Nutsford et al., 2013). The provision of fruit from public orchards can also reduce stress from food insecurity (Beavis et al., 2019). Community resilience to natural disasters and events such as the COVID-19 pandemic can additionally be increased by urban orchards (Shimpo et al., 2019). They provide a space that has a sense of normality, where people can gather and connect with others through a shared experience (Shimpo et al., 2019). The importance of this is expected to increase with future climate change, as the frequency of some natural disasters is expected to rise (Joshi & Wende, 2022).

4. Methods

A variety of research methods were used to investigate our research questions and aims. These methods were two online surveys, a social return on investment (SROI), and a site suitability analysis using GIS.

One survey was designed for the RFC and Woolston communities, focused on the costs and benefits experienced by users of RFC, especially those who harvest food and/or volunteer. We were equally interested in why some respondents did not use RFC, and their understanding of the associated costs and benefits. As a mixed garden, RFC shares similarities with the urban orchards our project seeks to establish. Regardless, we anticipated that it would have many of the same costs and benefits. The goal of the survey was to gain a better understanding of these to guide the design of our project and factor into our SROI. It was distributed by Michael Reynolds on the RFC and Woolston community Facebook pages, and left open for four weeks.

The second survey was designed for the ten Christchurch Eco Churches, specifically anyone who attends an Eco Church, with the intention of garnering multiple responses from each church. We sought to understand the anticipated benefits and costs of, and barriers to, volunteering. By additionally considering the needs and limitations of communities, we aimed to determine whether taking on the planting and maintenance of an urban orchard was feasible for churches. The results of this survey were also used in the SROI. It was distributed via email to Eco Churches for distribution among parishioners by our community partner James, and was also open for four weeks.

The next stage of our research was to conduct an SROI. Our community partners indicated that some form of cost-benefit analysis (CBA) was necessary to apply for funding from CCC, and to gain approval from local community boards. An SROI is a research method that recognises the financial, social, and environmental impacts of a project (Corvo et al., 2022). An SROI was chosen for this research as many of the costs and benefits of our project are non-monetary, so an SROI would better capture the project's impact than a CBA. Financial costs were sourced from Michael Reynolds, based on the costs associated with establishing and running RFC. Most data on social costs and benefits were derived from our RFC survey, due to the similarities highlighted previously, and Eco Church survey. The survey findings were then backed up with a comprehensive review of relevant literature. Environmental data was sourced exclusively from this review.

The final stage of our research involved conducting a site suitability analysis using ArcGIS Pro. The goal was to identify and present the most suitable public parks for urban orchards, based on the primary criteria of being uncontaminated and optimally within a 1 km walking distance of the Eco Church of interest. This distance was identified by 50% of Eco Church survey respondents as a reasonable distance to walk to an urban orchard. Contamination status was ascertained using the ECAN Listed Land Use Register (Environment Canterbury, 2021). We first mapped Eco Church and park locations using layers sourced from various government authorities and departments, then refined the number of park locations according to the primary criteria. We then used the Network Analysis tool to determine which of these parks were the first and second closest to each Eco Church in terms of walking distance, factoring in the secondary criteria of area and existing land use (Appendix B).

5. Results

Roimata Food Commons Survey

We received 18 responses in total, 14 of which were from consenting respondents aged over 18 and living in a relevant suburb. These included Woolston, Bromley, Edgware, Waltham and Beckenham.

69% of respondents used RFC. Of these respondents, 89% harvested food and 44% volunteered. 88% of people who harvested food did so occasionally, and 71% estimated that they save \$0-10 on groceries per month. Exercise, recreation, and leisure were also popular reasons for using RFC, and respondents identified many uses for the multi-functional space (Figure 1).

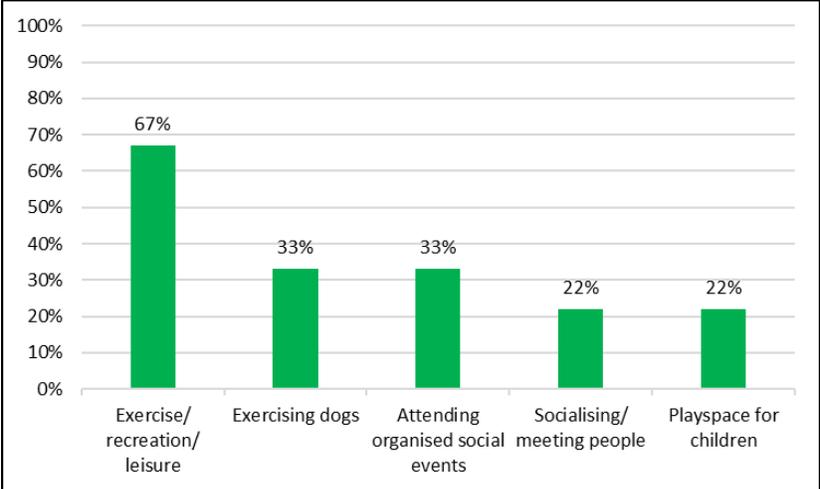


Figure 1: Other uses of RFC identified by users.

Volunteering refers to gardening, maintaining fruit trees, and undertaking any other task related to the upkeep of RFC. 75% of volunteers donate their time occasionally, although the lengths of volunteer sessions varied considerably between respondents. The benefit most frequently experienced by volunteers was an enhanced sense of place (Figure 2).

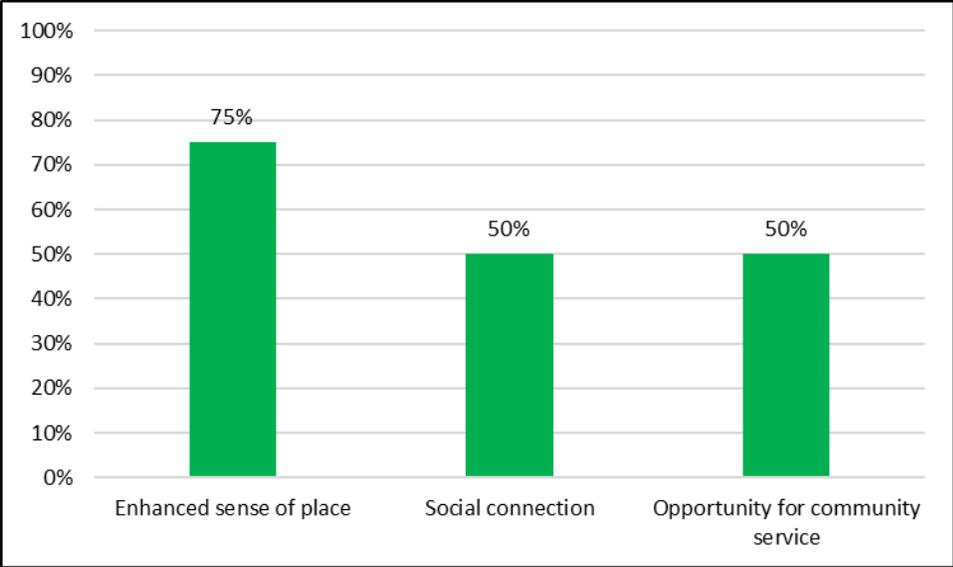


Figure 2: Benefits of volunteering at RFC identified by volunteers.

Most of the described costs and barriers to volunteering were not anticipated, including irregular/infrequent volunteer sessions, poorly advertised sessions, and the inability to attend weekday sessions (Figure 3).

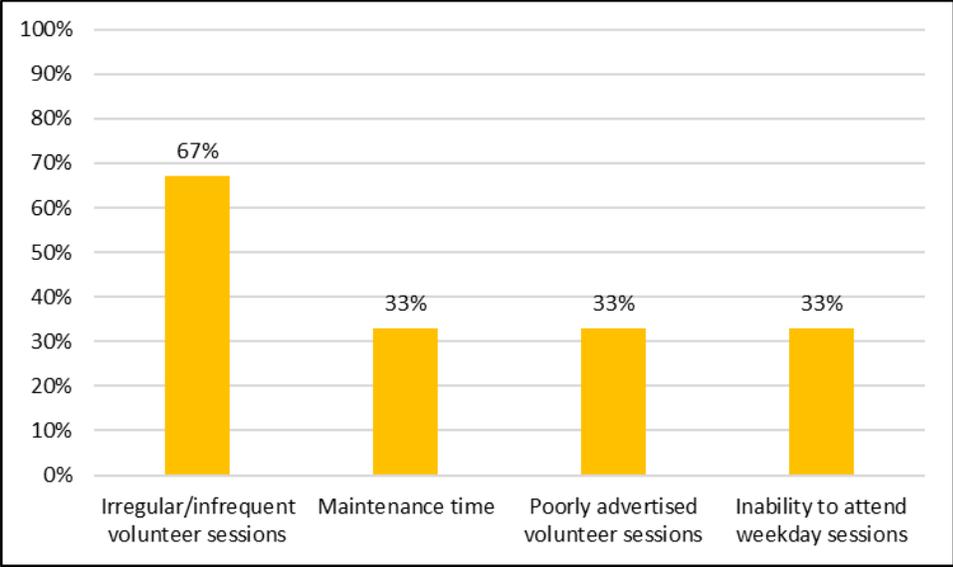


Figure 3: Costs and barriers to volunteering at RFC identified by volunteers.

67% of users thought that the main benefit of RFC was experiencing a greater sense of community (Figure 4). This is a very positive finding, as 100% of non-users expected that an urban orchard similar to RFC would facilitate a stronger sense of community among users (Figure 6). These statistics demonstrate that community is a really important value among respondents.

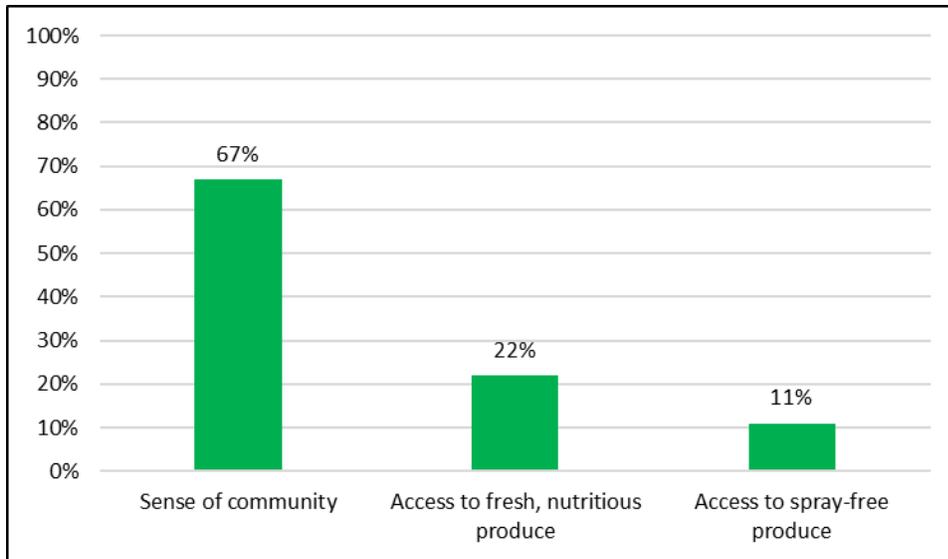


Figure 4: *Main benefit of RFC identified by users.*

Encouragingly, 43% of users thought there were no costs associated with RFC, although close to one-third were concerned about the potential for damage to infrastructure such as footpaths, cycleways, and underground pipes (Figure 5). One unanticipated cost was the sometimes untidy and neglected appearance of the Commons, according to some users.

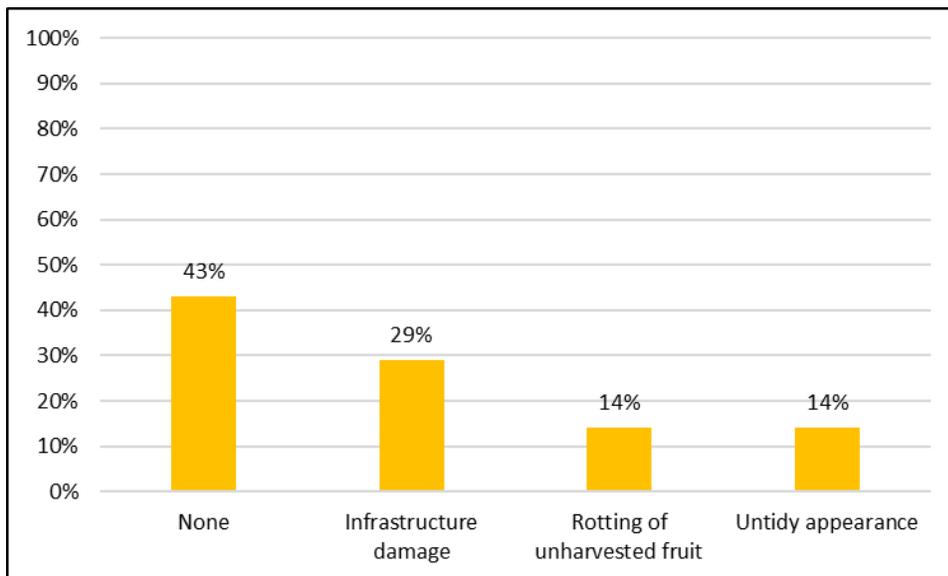


Figure 5: *Main cost of RFC identified by users.*

Of the survey respondents who didn't use RFC, 100% expected that a similar urban orchard would provide access to spray-free fruit, in addition to a greater sense of community as previously discussed (Figure 6). RFC has a spray-free philosophy, which would extend to the urban orchards in this project, in alignment with respondents' values. 11% of RFC users considered this to be the primary benefit. Access to fresh vegetables was an unanticipated benefit expected by some non-users and is unfortunately

beyond the scope of our project. However, there is future potential to develop established orchards into food forests or mixed gardens like RFC.

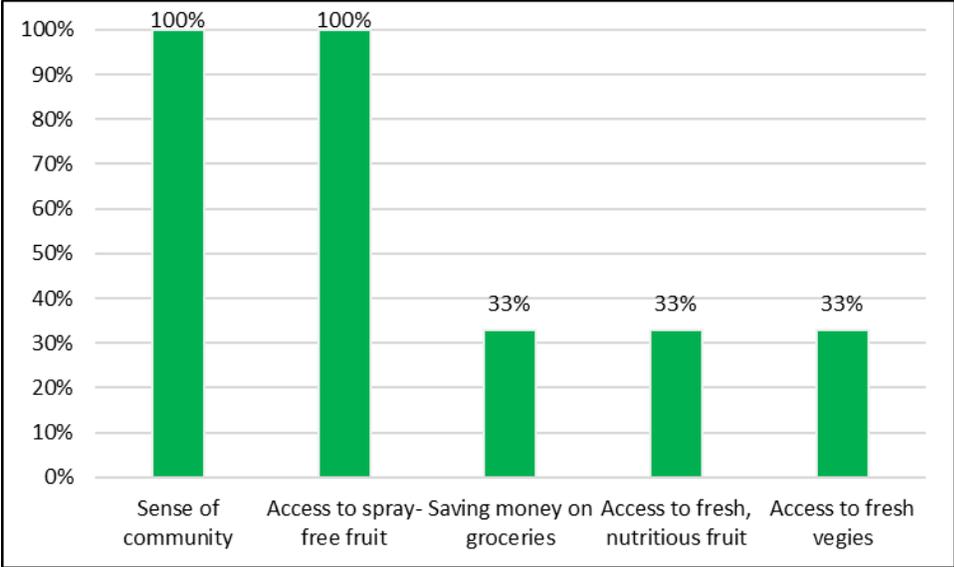


Figure 6: Benefits of using an urban orchard expected by non-users of RFC.

Few downsides of urban orchards were anticipated by non-users, with 33% believing there to be none (Figure 7). One we had not considered in depth was the potential for people to damage or steal trees and equipment, incurring both a financial cost, and a social cost in terms of decreased morale.

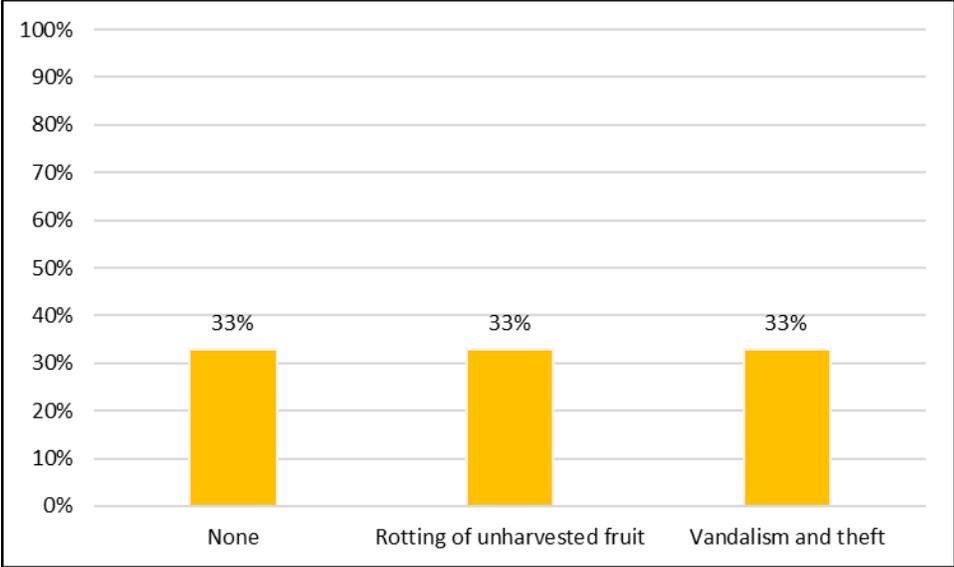


Figure 7: Downsides of having urban orchards in Christchurch public parks expected by non-users of RFC.

Most users of RFC were not reliant on harvesting food and did not use the space solely for this purpose, instead deriving many diverse benefits. The most notable was an increased sense of community. Overwhelmingly, respondents regarded the existence of RFC positively. Suggested improvements

included more social events, more volunteer sessions, and more communication about these, in order to maintain community connection and involvement.

Eco Church Survey

We received responses from seven out of ten Christchurch Eco Churches. The three churches that did not respond were The Chapel Street Centre (Christchurch North Methodist Parish), St Martins Presbyterian Church, and The Village Presbyterian Church. Of the 24 total responses, 18 were from consenting respondents aged over 18 and belonging to an Eco Church. 83% of respondents were interested in planting and maintaining fruit trees in a public park near their church.

Reasons for disinterest were a lack of time and perceived insufficient knowledge or skills to maintain fruit trees. These respondents conceived of multiple benefits they would expect to gain from an urban orchard, most notably a sense of community and access to fresh, nutritious fruit (Figure 8). The only anticipated downside was the potential for rotting of unharvested fruit, identified by 100% of disinterested respondents.

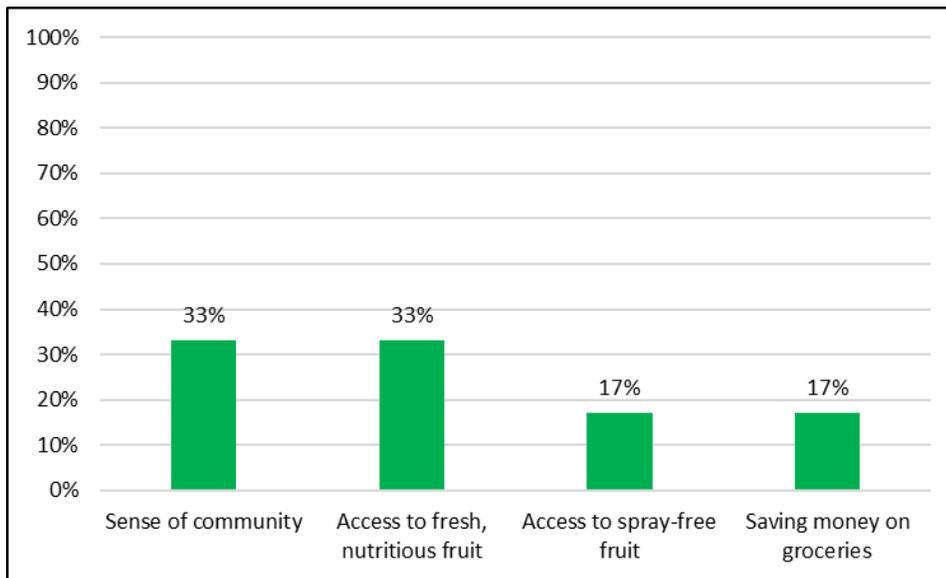


Figure 8: *Benefits of planting fruit trees in public parks expected by disinterested respondents.*

Respondents interested in volunteering identified an additional five benefits, three of which we did not anticipate (Figure 9). These were the opportunity to gain gardening experience and skills to apply at home, increased connection to the whenua, and aesthetic benefits of a flourishing greenspace, specifically spring blossoms, according to one respondent.

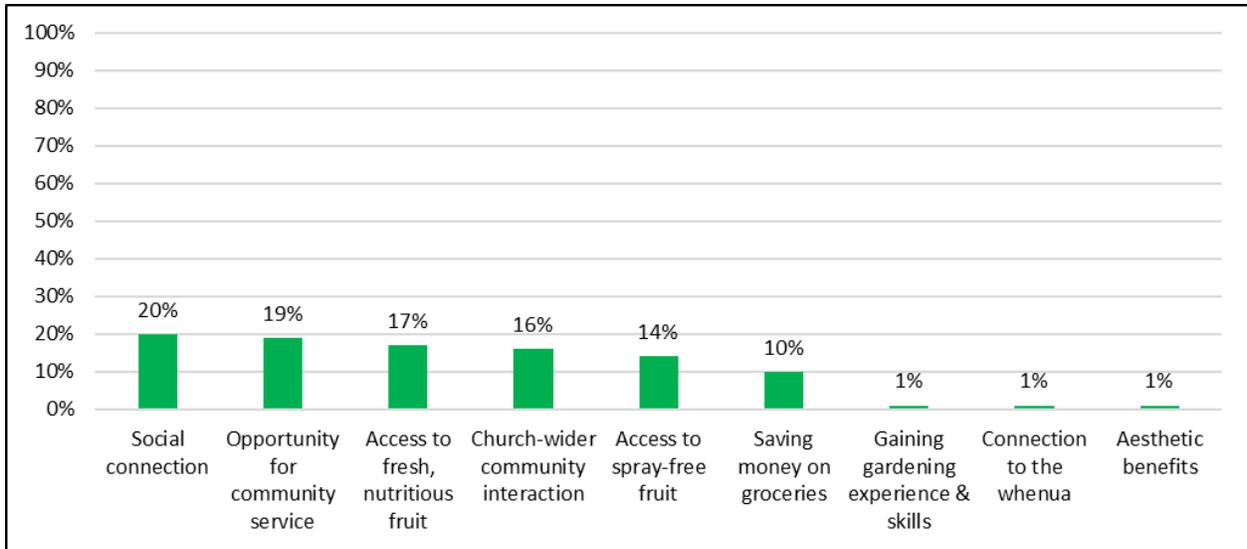


Figure 9: Benefits of using and volunteering at an urban orchard expected by interested respondents.

Relatively few costs were identified by interested respondents, the largest of which was maintenance time (Figure 10). Even as the largest cost, this was an encouraging finding because it indicated that <50% of respondents viewed donating their time as a cost. An interesting, although minor, cost identified was the opportunity cost of missing out on other activities, specified by one respondent as ‘whānau time, hobbies, rest and other ministries’. One respondent from All Saints Church Burwood indicated that the Church already maintains approximately twenty fruit trees on site, and that a key cost they encountered was the effort and expense required to excavate and replace sandy soil with more suitable soil prior to planting.

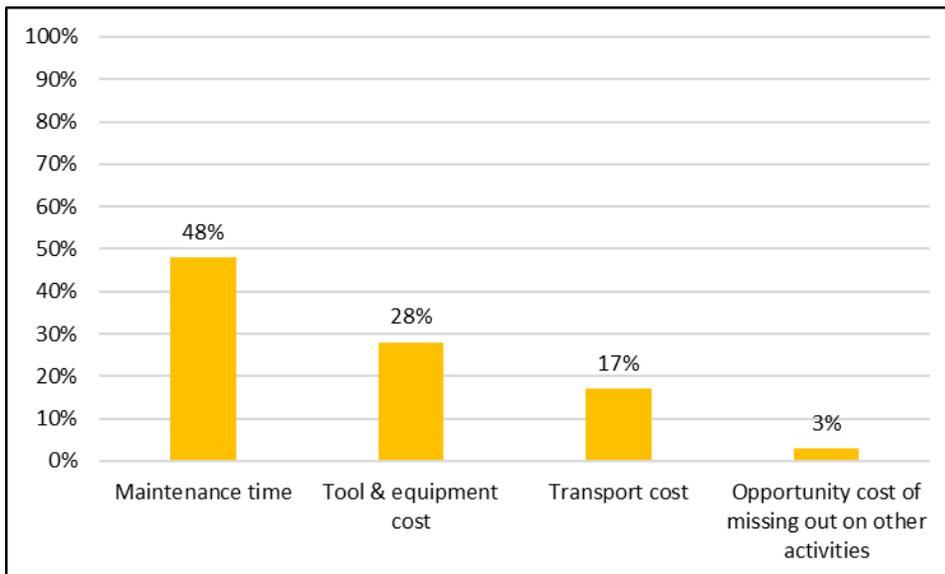


Figure 10: Costs of volunteering expected by interested respondents.

Like disinterested respondents, 65% of interested respondents identified rotting of unharvested fruit as the main potential downside of urban orchards (Figure 11). Other potential downsides we did not anticipate were the attraction of pests such as possums, an untidy appearance, and individuals taking more than needed, potentially with the aim of selling it for a profit. This contravenes the Commons Principle of RFC, but could be mitigated through signage explaining this concept: take only what you need and give back if you can.

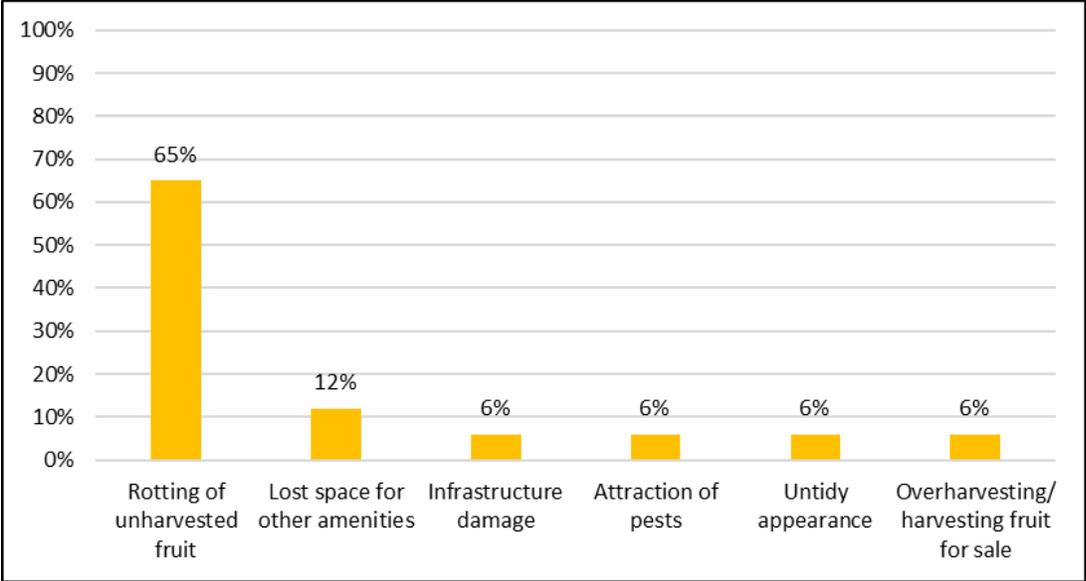


Figure 11: *Downsides of urban orchards expected by interested respondents.*

SROI Results

Table 1 shows a summary of the SROI results, broken down into three key aspects: financial, social, and environmental. These results were obtained from the survey findings and the comprehensive review of relevant literature.

Table 1: Costs and benefits associated with planting urban orchards.

| Aspect of SROI | Benefits | Costs |
|----------------|---|--|
| Financial | <ul style="list-style-type: none"> • Community savings on fresh fruit • \$2.25 of ecosystem services for every \$1 spent on canopy-forming trees | <ul style="list-style-type: none"> • Paid coordinator: \$27,000-40,000 (annually) • Trees: \$40-50 each (one-off) • Webbing and stakes: \$15 for each tree (one-off) • Hoses: \$100-200 each (one-off) • Connection to water mains: \$4000-6000 (one-off) |
| Social | <ul style="list-style-type: none"> • Health benefits from improving access to fresh fruit • Building a sense of community • Improving social connections • Education and sharing of mātauranga | <ul style="list-style-type: none"> • Reduced park area for sport and leisure • Potential increase in vandalism and theft in the park |
| Environmental | <ul style="list-style-type: none"> • Increased urban forest canopy cover • Reduction of the Christchurch urban heat island • Increased provision of ecosystem services • Increased biodiversity | <ul style="list-style-type: none"> • Pollen triggering allergies • Increase human health issues and disease transmission • Attracting wasps • Increased competition by exotic organisms |

There are significant financial costs at the outset of the project, however these are mostly 'one-offs', with the exception of the paid coordinator salary. The orchards are a long-term investment; their financial value will increase with time, as their capacity to render ecosystem services increases.

There are significant social benefits associated with urban orchards. The survey results and literature review highlight the key benefit of developing a greater sense of community (for example: Firth et al., 2011; Shimpo et al., 2019). Health benefits are also widely reported, and very important to survey respondents (Figures 4, 6, 8, and 9). These benefits cannot be quantified, but they are expected to increase over time as the orchards grow more established. Survey respondents also identified some social costs to urban orchards, with the most significant two being reducing the area within the park for other activities and the fruit trees potentially attracting thieves.

Environmental Aspects

Ecosystem services have a positive relationship with tree canopy cover (Guo et al., 2019). These include increasing air and water quality (Lin et al., 2015), carbon sequestration (Guo et al., 2019), and pest control (Lin et al., 2015). Crucially, urban orchards assist climate change adaptation and mitigation (Padgham et al., 2015; Rimlinger et al., 2021). They can also increase the biodiversity present in parks, by providing refuges and habitat for flora and fauna (Lin et al., 2015; Rimlinger et al., 2021; Zhao et al., 2021). This includes pollinators, as urban orchards are usually more florally rich than grass (Davis et al., 2017). Planting native vegetation as well as fruit trees, something that our partners are interested in, aids in increasing biodiversity (Lin et al., 2015), as well as providing for the ecological and functional diversity of birds (Télliez-Hernández). Increased biodiversity is positively related to ecosystem functioning, and therefore the provision of ecosystem services (Lin et al., 2015).

The urban heat island (UHI) effect refers to a phenomenon where urban areas have higher temperatures than their surrounding rural areas (Chun & Guldmann, 2018; Hung et al., 2006). This has implications for human and ecosystem health (Jalali et al., 2022). In Christchurch, the UHI effect is approximately 2.5°C (Tapper, 1990). Increasing the amount of urban vegetation helps to reduce this effect (Ackerman et al., 2014; Aflaki et al., 2017; Chun & Guldmann, 2018), as evapotranspiration from trees acts as a heat sink. Summer temperatures can be reduced by 2-8°C (Taha, 1997), which in turn reduces negative human health effects associated with high temperatures (Jalali et al., 2022). In winter, trees can conversely increase urban temperatures, also benefiting human health (Chun & Guldmann, 2018).

Despite the significant environmental benefits associated with urban orchards, disservices must also be considered. These can include an increase in the amount of pollen present in an area, which can trigger allergies, and there is some evidence that urban agriculture may increase human health issues and disease transmission. However, this is in the context of urban animal husbandry and is unlikely to be an issue in urban orchards (Lin et al., 2015). Fruit produced by trees may not be harvested and may rot on the ground, which could attract wasps to the area (Hodge et al., 2017). Additionally, urban orchards provide habitat for introduced organisms as well as natives, so there is potential for exotic species to increase in abundance in the areas surrounding urban orchards, and possibly compete with native organisms for resources (Lin et al., 2015).

Site Suitability Analysis

The most relevant results of the Network Analysis undertaken in ArcGIS are summarised in Table 2. For each Eco Church, we have recommended two (or three) possible sites, based on the primary criteria of

being uncontaminated and within a 1 km walking distance, or approximately 10 minutes walking time, of the Eco Church. Secondary criteria included park area and existing land uses (Appendix B).

Table 2: Recommended urban orchard sites for each Eco Church.

| Eco Church | Most suitable site | Walking distance | Walking time | Second most suitable site | Walking distance | Walking time |
|--|-------------------------|------------------|------------------------|---------------------------|------------------|------------------------|
| Papanui Baptist Church | Morrison Avenue Reserve | 354 m | 3 minutes, 30 seconds | Papanui Domain | 470 m | 4 minutes, 40 seconds |
| Northcity Church* | Papanui Domain | 161 m | 1 minute, 40 seconds | Morrison Avenue Reserve | 603 m | 6 minutes |
| The Chapel Street Centre | Marble Wood Reserve | 282 m | 2 minutes, 50 seconds | Morrison Avenue Reserve | 1067 m | 10 minutes, 40 seconds |
| The Village Presbyterian Church Bryndwr | Morley Reserve | 460 m | 4 minutes, 40 seconds | Ryeland Reserve | 822 m | 8 minutes, 10 seconds |
| St Barnabas Church | Daresbury Park | 761 m | 7 minutes, 40 seconds | Waiwetū Reserve | 946 m | 9 minutes, 30 seconds |
| Hope Presbyterian Church Hornby | Helmore Park | 259 m | 2 minutes, 40 seconds | Trevor Reserve | 450 m | 4 minutes, 30 seconds |
| South West Baptist Church | Glynne Reserve | 424 m | 4 minutes, 10 seconds | Cardigan Bay Reserve | 905 m | 9 minutes |
| The River Ōpāwaho | Ernie Clark Reserve | 190 m | 1 minute, 50 seconds | Beckenham Park** | 838 m | 8 minutes, 20 seconds |
| St Martins Presbyterian Church | Acorn Reserve | 1068 m | 10 minutes, 40 seconds | Beckenham Park** | 648 m | 6 minutes, 30 seconds |
| All Saints Church Burwood | Amelia Rogers Reserve | 560 m | 5 minutes, 40 seconds | Avondale Park | 762 m | 7 minutes, 40 seconds |

*We have recommended a third urban orchard site for Northcity Church, on account of the close proximity of the first and second site recommendations. These are also the top two recommendations for Papanui Baptist Church, and one is a top two recommendation for The Chapel Street Centre.

**Part of Beckenham Park is contaminated (Figure 12). It is a recommended site for two churches due to a severe lack of sufficiently large, uncontaminated parks close to these particular churches. The second

recommended sites of each would otherwise greatly exceed the optimal 1 km maximum walking distance criterion.



Figure 12: Contaminated (grey) and uncontaminated (blue) areas of Beckenham Park. The nature of the contamination is 'persistent pesticide bulk storage or use' (Environment Canterbury, 2021).

Due to the negative human health impacts associated with persistent pesticide exposure (Rokni et al., 2023), and our partners' express desire to avoid contaminated sites, we recommend that an uncontaminated area of Beckenham Park be used, if required.

Maps of each Eco Church and the routes to their most suitable sites are contained in Appendix A. Additionally, site address data is contained in Appendix B, while Eco Church address data is readily searchable in Google Maps.

6. Discussion

Surveys

The results of the RFC survey provided useful qualitative data about the social, and to a lesser extent, financial costs and benefits of urban orchards (summarised in Table 1). We gained insight into the real-world costs and benefits experienced by users, and benefits, costs, and barriers experienced by volunteers. We also received highly valuable feedback on what could be improved about RFC's model, such as better organisation and communication of volunteer sessions.

The perspectives of prospective volunteers represent the majority of Christchurch Eco Churches and enabled us to determine their anticipated benefits, costs, and barriers to volunteering, their needs, and most importantly, the feasibility of these communities successfully maintaining an urban orchard.

Benefits that came across strongly from both surveys were enhanced sense of community and place, and access to fresh, spray-free, locally grown fruit (Figures 1, 2, 4, and 9). Responses from both communities were overwhelmingly positive, with many more benefits than costs raised.

Social Return on Investment

The SROI indicates that planting fruit trees in public parks has numerous benefits. Many of the social benefits are highlighted by the surveys, as discussed, and align strongly with existing research. For example, the finding that a sense of community is one of the main benefits of urban orchards (Ilivea et al., 2022). Another social benefit of urban food systems is education, especially through the sharing of knowledge among volunteers (Kirby et al., 2021).

Environmental benefits associated with urban orchards include decreasing GHG emissions (Martinez et al., 2018), increasing ecosystem services and biodiversity (for example Guo et al., 2019; Lin et al., 2015; Rimlinger et al., 2021), and decreasing the UHI effect (Chun & Guldmann, 2018). The proposed urban orchards will have these effects in Christchurch, with significant benefits for the city.

The cost breakdown on the financial front shows that the project is achievable. The upfront costs cover the cost of the trees, webbing, stakes, and water infrastructure. Because the trees are being planted in public parks, CCC would likely fund the connection to water mains and the installation of a backflow preventer. Therefore, based on the information in Table 1, the upfront costs for an urban orchard of between 10 and 50 trees would be between \$850 and \$3450, depending on orchard size. The most significant cost is the paid coordinator salary, however having a paid coordinator is important to ensure the success and longevity of the project (Kelly, 2023).

In summary, the SROI offers a solid framework for assessing the feasibility of growing fruit trees in public parks. Our study found that the financial, social, and environmental benefits far outweigh the costs of the project, indicating that it is definitely feasible.

Alignment with Council Policies

The UFP encourages community participation in urban greening projects (Christchurch City Council, 2023), which these urban orchards will facilitate, as well as increasing green areas and canopy cover. This improves the sustainability of urban ecosystems and climate resilience. Urban orchards encourage local food production and increase the food resilience of local communities, which aligns with the goals of the Christchurch Food Resilience Policy (Christchurch City Council, 2014). They also increase the accessibility of fresh fruit because it is locally grown, which supports sustainable food practices. Their presence in the community links members to the production of their food, which aligns with the Edible Canterbury Charter (Food Resilience Network, 2015).

Limitations

Our research contains several limitations including:

- Using a limited number of criteria for the site suitability analysis (contamination, distance). A more in-depth study could factor in community garden locations, food deserts based on supermarket and grocery store locations, and the deprivation status of neighbourhoods.
- Not considering partially contaminated parks (other than Beckenham Park). Contamination status was coded as 'yes' or 'no', however not all contaminants are mobile in food chains, therefore there are likely more suitable parks than our analysis indicates.
- Number of survey respondents (18 for the RFC survey and 24 for the Eco Church survey).
- A lack of response from three Eco Churches meant that we were not able to determine their willingness to participate in this project.

7. Conclusion

Our survey results, SROI and site suitability analysis show that establishing urban orchards in Christchurch parks is feasible. Every Eco Church has suitable parks nearby where an orchard could be planted and maintained by their members. CCC should encourage the partial conversion of local parks into urban orchards because of their significant financial, social, and environmental benefits, and strong alignment with existing policies. Future work could consider the socioeconomic status of communities and their access to supermarkets and grocery stores, to determine which communities would benefit most from urban orchards.

8. Acknowledgements

We would like to thank our community partners Michael Reynolds from Roimata Food Commons, and James Beck from A Rocha Aotearoa. We would also like to thank our supervisor Tyler McNabb, and Professor Simon Kingham for his assistance.

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10. Appendix A

Red: route to the most suitable site.

Blue: route to the second most suitable site.

Pink: route to the third most suitable site.

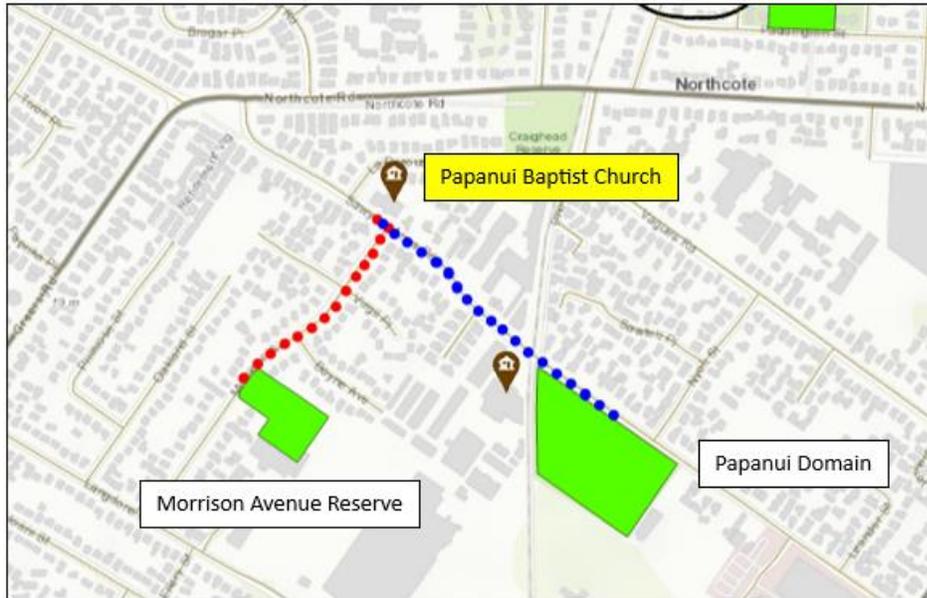


Figure A.1: Locations of most suitable urban orchard sites for Papanui Baptist Church.

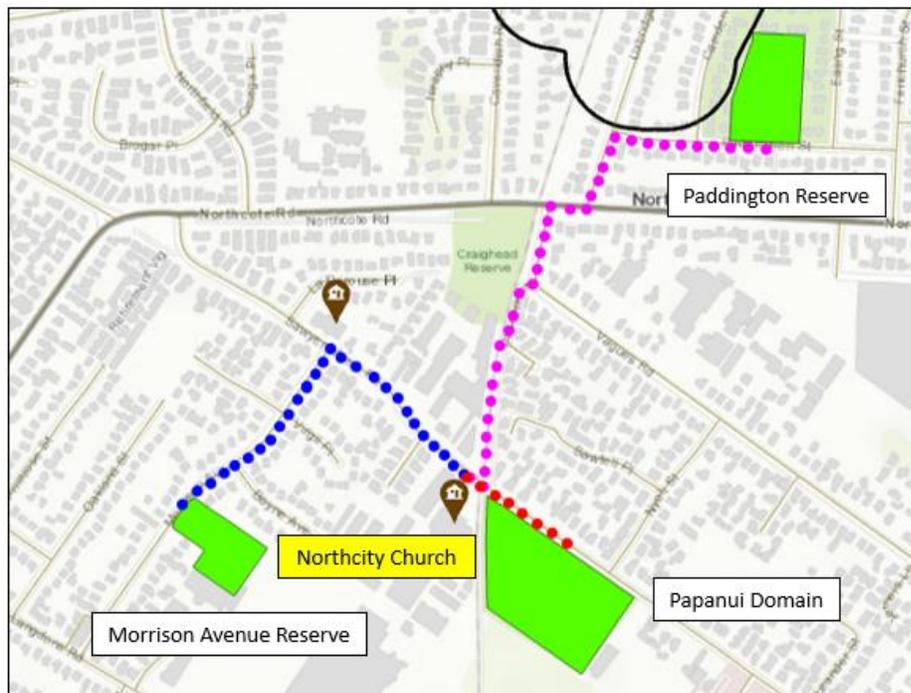


Figure A.2: Locations of most suitable urban orchard sites for Northcity Church.



Figure A.3: Locations of most suitable urban orchard sites for The Chapel Street Centre.

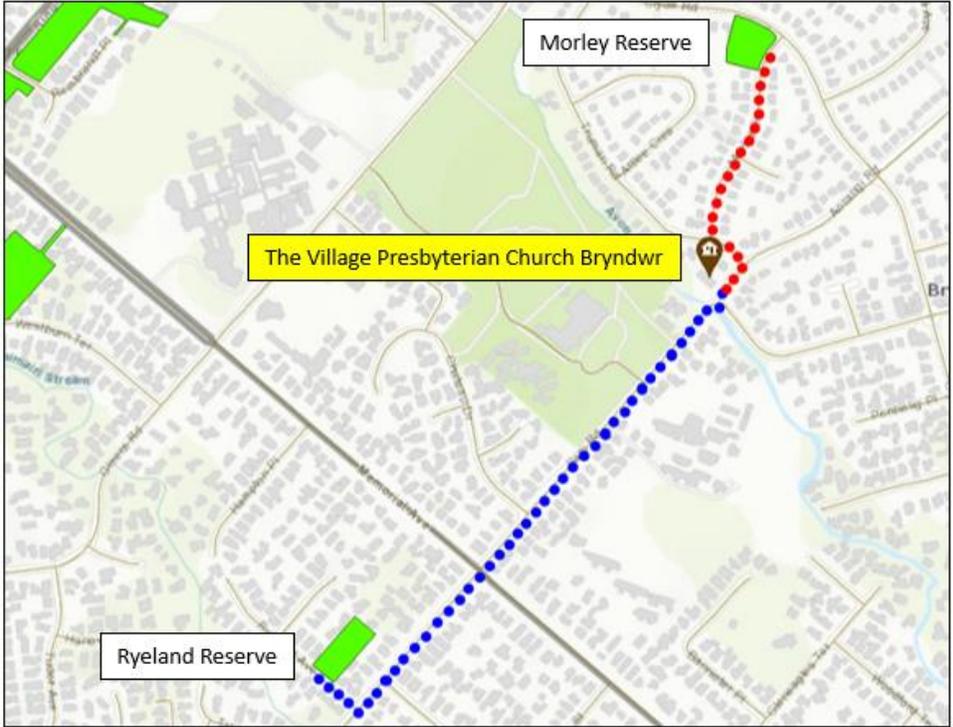


Figure A.4: Locations of most suitable urban orchard sites for The Village Presbyterian Church Bryndwr.

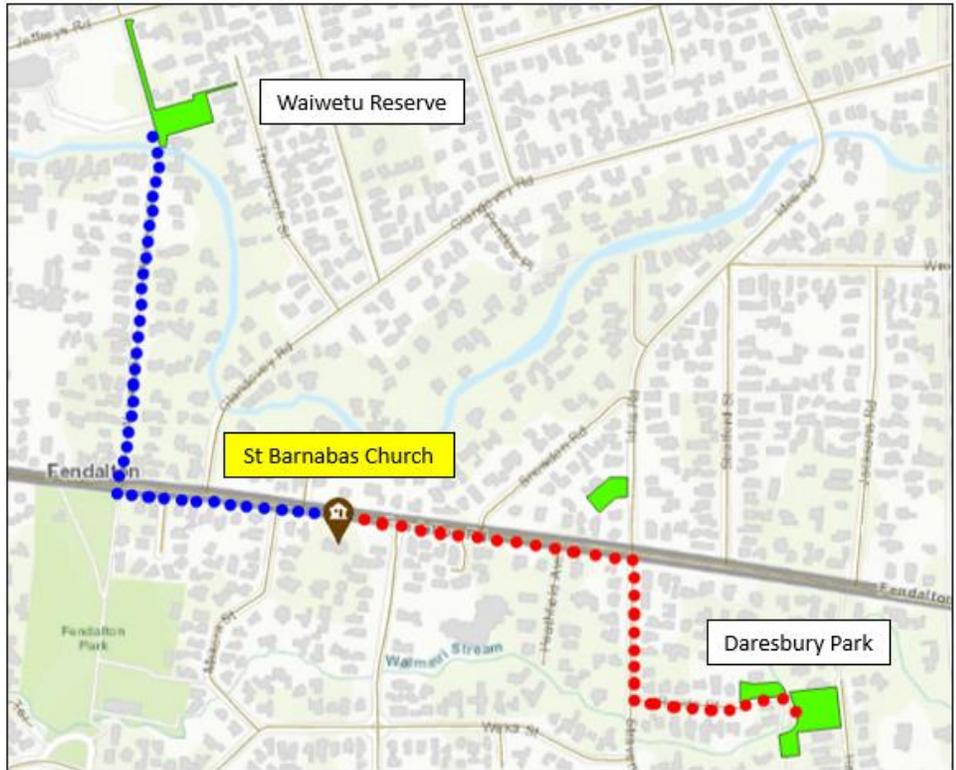


Figure A.5: Locations of most suitable urban orchard sites for St Barnabas Church.

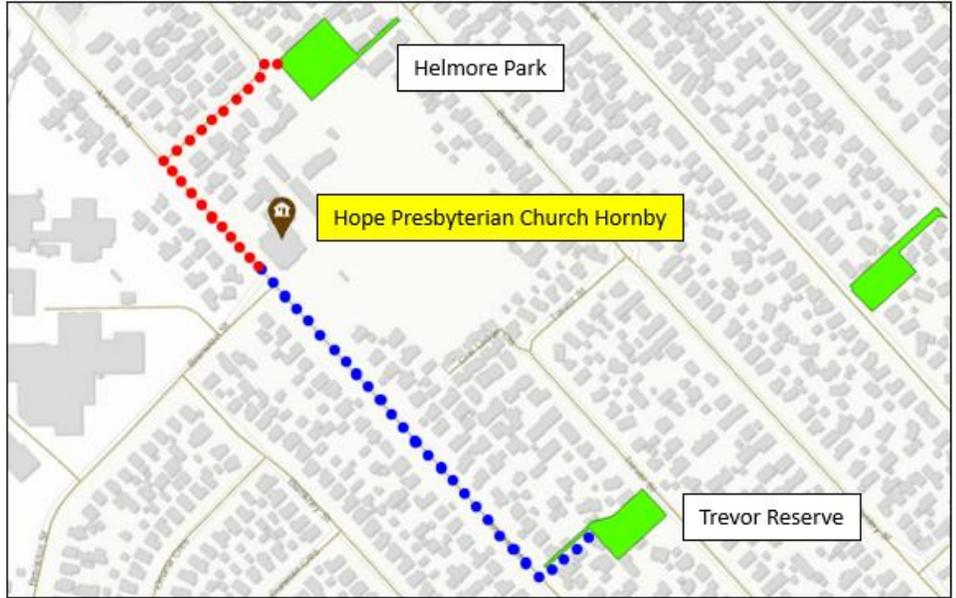


Figure A.6: Locations of most suitable urban orchard sites for Hope Presbyterian Church Hornby.



Figure A.7: Locations of most suitable urban orchard sites for South West Baptist Church.



Figure A.8: Locations of most suitable urban orchard sites for The River Ōpāwaho.



Figure A.9: Locations of most suitable urban orchard sites for St Martins Presbyterian Church.



Figure A.10: Locations of most suitable urban orchard sites for All Saints Church Burwood.

11. Appendix B

| Site | Address | Area (m ²) | Existing land use |
|-------------------------|------------------------------------|------------------------|---|
| Morrison Avenue Reserve | 26 Morrison Ave, Northcote | 8935 | Small basketball court, park benches, native plantings, exotic trees around periphery, Morrison Ave Bowling Club |
| Papanui Domain | 61 Sawyers Arms Road, Northcote | 27,359 | Rugby pitches, playground, Papanui Tigers League Club, park benches, scaffolding, exotic trees around periphery, cricket batting cage |
| Paddington Reserve | 21 Paddington Street, Northcote | 13,755 | Playground, park benches, volleyball court, small basketball court, trees around periphery, a lot of unused open space |
| Marble Wood Reserve | 6 Marble Wood Drive, Papanui | 4307 | Small pavilion, sparse exotic trees, mainly around periphery |
| Morley Reserve | 33 Morley Street, Bryndwr | 4066 | Aikido Shinryukan Burnside Dojo, Bryndwr Community Garden (small), playground, park benches, community hall, exotic trees mainly around periphery |
| Ryeland Reserve | 6 Ryeland Ave, Ilam | 4006 | Small playground, park benches, kindergarten adjacent, sparse exotic trees |
| Daresbury Park | 105 Harakeke Street, Fendalton | 5033 | Playground, park benches, large number of trees, possibly quite limited space |
| Waiwetū Reserve | Waiwetū Street, Fendalton | 3875 | Some plantings and trees, small playground, park benches |

| | | | |
|-----------------------|-------------------------------------|--------|--|
| Helmore Park | 27 Tower Street, Hornby | 3091 | Hornby Plunket Clinic, sparse trees, limited visibility on Google Maps as park is accessed by walkways |
| Trevor Reserve | 29 Trevor Street, Hornby | 2332 | Small playground, trees mainly around periphery, somewhat limited space |
| Glynne Reserve | 17 Glynne Crescent, Spreydon | 4004 | Playground, trees mainly around periphery |
| Cardigan Bay Reserve | 2 Wrights Road, Addington | 6639 | Playground, park benches, large number of trees but there appears to be open space in the interior (from Google Maps imagery) |
| Ernle Clark Reserve | 143 Studholme Street, Somerfield | 15,409 | Playground, mostly vegetated, there appear to be unvegetated pockets on the interior (from Google Maps imagery) |
| Beckenham Park | Norwood Street, Beckenham | 46,617 | Partially contaminated (cricket ground), park benches, ponds, public toilets, mostly vegetated, playground, Southern Districts Cricket Club, Beckenham Tennis Club |
| Acorn Reserve | 97 Fifield Terrace, Waltham | 2631 | Some large trees, park bench, enough room for a small orchard |
| Amelia Rogers Reserve | New Brighton Road, Burwood | 20,989 | Sparse trees, borders the Red Zone, a lot of unused open space |
| Avondale Park | 18 Mervyn Drive, Avondale | 39,860 | Neighbours Avondale Community Garden (tiny), borders the Red Zone, small basketball court, another sports court, playground, sparse trees mainly |

| | | | |
|--|--|--|---|
| | | | around periphery, football fields, public toilets/storage shed, park benches |
|--|--|--|---|