More Than a Drain: Improving the health of St Albans Stream through riparian planting methods

A community research project partnering with the St Albans Residents Association and GEOG309 to enhance the quality of the much-loved Abberley Park

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Executive Summary

- St Albans Stream runs through Abberley Park, in St Albans, Christchurch. The park is an attractive, biodiverse greenspace. However, locals are concerned about erosion and water quality.
- We collaborated with the St Albans Residents Association (SARA) to investigate what native riparian planting methods should be applied in Abberley Park to improve St Albans Stream health.
- Enhancing green and blue space through riparian planting benefits wellbeing, stream health and community resilience. Using indigenous species, deep planting and mulching techniques improves the success of plantings.
- We engaged Rehua Marae and acknowledged a recent survey on the park's public perception.
- We measured conductivity, pH, dissolved oxygen, and macroinvertebrate community index (MCI). The MCI indicated poor stream health. pH and dissolved oxygen were within an acceptable range.
- We observed local bank conditions and vegetation cover. Upstream sections in Abberley Park with high canopy cover need to be planted in shade tolerant native species. Downstream sections with low canopy cover require dense planting of sun-tolerant species.
- There were limitations with data collection, available literature and community engagement.
- We suggest future research looks at continuing water monitoring, plant maintenance and community engagement. Future research should aim to expand water and bank assessment measures, continue Investigating public perception native plantings in heritage parks, analysing new stream enhancement techniques.

1. Introduction

Abberley Park is one of Christchurch's eight heritage parks and is highly valued for its social, cultural, and ecological values. It is located north of the Central Business District in Ōtautahi (Figure 1). Abberley Park has beautiful green space which attracts native birds such as the Pīwakawaka and Kererū. It also has an abundant resident species of monarch butterfly which is highly valued by the community. This emphasises the importance and value of the green- and bluespaces in Abberley Park. The stream, however, suffers from poor water quality. It was important for research to be conducted to find ways to improve the stream health, so the local community can continue to enjoy the scenery at Abberley Park.

The St Albans community are concerned about the streams water quality. Respondents from a survey conducted by Blundell-Dorey et al. (2022) highlight the publics negative perceptions on the maintenance and health of St Albans Stream. People interviewed mentioned that mud, rubbish and stormwater discharge is reducing stream health. Overall, *g*reen infrastructure is well supported in Abberley Park, but blue infrastructure is not.

Our GEOG309 group conducted research in partnership with Emma Twaddell and Shamani Gill from the St Albans Residents Association (SARA). SARA is a community run organization that aims to 'foster a spirit of community' in St Albans. One of their objectives is to encourage activity that will benefit the welfare of residents in St Albans (SARA, n.d.). A way to do this is to improve the water quality in Abberley Park, specifically St Albans stream which runs through the park.

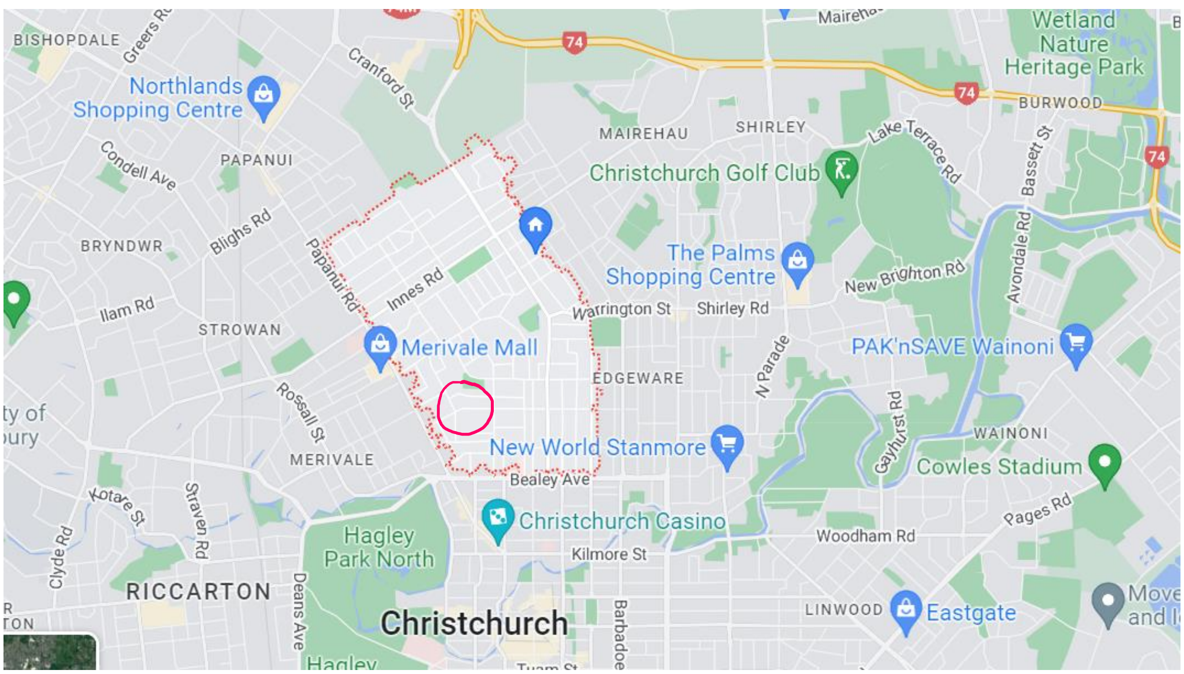

Figure 1. St Albans area with the project site, Abberley Park, circled in pink (Google, 2022).

The St Albans Residents Association have the 100-year anniversary of Abberley Park in 2040 and would ideally like the stream to have improved water quality by then. Therefore, there is 18 years to build and implement a plan for the stream. Urban stream health is not only important for its looks. Aquatic life (plants and macroinvertebrates) would also thrive with better water quality. The health of the water in a stream directly influences how well the aquatic life can grow and reproduce (US National Park Service, 2022). Therefore, this research is important to investigating solutions for the poor health of St Albans Stream.

2. Research Question

The research question decided on is: What native riparian planting methods should be applied in Abberley Park to improve St Albans stream health? The aim of this question is to provide guidance to SARA on riparian species selection, planting methods and maintenance. Identifying the benefits of riparian planting on stream health and community wellbeing will also be investigated.

Riparian planting was chosen due to the indication by Emma Twaddell and Shamani Gill that the lack of bank stabilization was a key factor in the degraded stream health. There is often partial collapse of the stream's sides especially after heavy rain. Riparian planting will decrease erosion and sedimentation, improve water quality, and improve ecological health (Soeter, 2020).

This research question builds on previous research conducted by Blundell-Dorey et al. (2022). This study addresses two recommendations from the report. The first being "additional research is required to identify areas of the stream where riparian planting is most needed" and the second, "to identify which species would be of best fit for planting." These two recommendations will be taken on board in this project to identify the riparian planting species, methods, and locations for the section of St Albans stream in Abberley Park.

3. Literature review

For our literature review we had five sub-themes: plant species selection, riparian planting methods and maintenance, greenspace and bluespace, community engagement and stream health. We chose these sub-themes because they relate to improving the St Albans stream health and align with SARA's interest to improving Abberley Park while having the community engaged in the process.

Plant species selection is vital to ensuring the riparian buffer improves stream and ecological health. Riparian planting methods and maintenance are needed to ensure the long-term effectiveness of the riparian buffer, reducing the risk of failure and need to replant. Knowing the benefits of greenspaces and bluespaces justifies why we are adopting riparian planting. Community engagement is important to ensure that stakeholders of our project get their ideas and opinions heard and to ensure they are onboard and included with what we are doing. Stream health measures gauge the physical, ecological and chemical conditions of St Albans stream and assess how riparian planting might improve these factors.

3.1 Plant species selection

This review considered the species selection along the banks of the stream with the focus on bank stabilization, succession, reducing pollutants from stormwater and including Māori indigenous plants. To select species for riparian planting in Abberley Park, the design and methods of previous research projects are required to form an educated decision for what plants suit the environment best to meet our community partners goals.

Two studies showed which plant species were better equipped to deal with different salinity levels of stormwater. One studied the natural succession of different plants in different salinities (Xiaoping, Fei, Hsiang-te, & Haiyang, 2017) while the other synthetically produced an environment to measure different plant species effectiveness at removing pollutants in different salinities (Tang, Chan, Farzana, Wai, & Leu, 2021). These studies both gave specific species that succeed in different salinities.

Key findings from Daigneault et al. (2017) and Renouf & Harding (2015) show enhancing greenspaces with additional plantings is more effective than natural plant succession. Hence, it is vital that we choose appropriate species to plant. According to the research this would result in benefits to the waterway in Abberley Park.

Riparian restoration programs using only indigenous New Zealand species has positive effects on low-order streams and waterways (Marden, Rowan, Phillips, & C, 2005). The results of the study by Marden et al. (2005) showed cabbage tree, lemonwood, ribbonwood, karamu, lacebark, and tutu resulted in the best outcomes. Deep rooted plants support bank stabilization, reduces pollutants entering the stream and provide social benefits to users of the park who can walk past indigenous nature, achieving the goals of the project.

3.2 Riparian planting methods and maintenance

Riparian planting is defined as planting along the edges of waterways. Planting stabilises banks, reduces soil erosion and shades the stream, reducing temperatures. Roots filter out contaminants such as nitrates, phosphorus, and pathogens. Reducing contaminants improves waterway health while shade from the plants improves ecological health (Dairy NZ, 2022).

Whip cuttings have low maintenance and irrigation requirements while having high survival rates making them the best option to implement tress and large shrubs. Seedlings have higher rates of survival standard seeds and so should be used to implement understory plants. Whip cuttings also work to stabilise banks and reduce soil erosion (Dreesen et al., 2008). If the right shade-tolerant species are used, seedling survival can improve by 70-85% (Sweeney, 1993).

Increasing density, diversity and stratification increases riparian planting success and water quality (Jo et al., 2014). Wider riparian buffers are more effective at improving water quality. In Abberley Park, the width of the riparian buffers should be at least five meters. (Parkyn et al., 2000).

Riparian buffers in urban zones are more prone to invasive species which reduce the riparian buffers effectiveness at improving stream health (Loewenstein & Loewenstein, 2005). We have planned to use biodegradable herbicides to spot-spray weeds with minimal impact to the riparian planting (Department of Conservation, n.d.). Mulching the soil is recommended before planting to remove weeds and grasses (Jo et al., 2014). Diseased plants need to be constantly replaced to maintain vegetation density (Department of Conservation, n.d). Canopy cover reduces the growth of grasses which reduce plant competition (Moore et al., 2011). Therefore, shady sites require lower weed management.

3.3 Greenspace and bluespace

Blue and Greenspace are used in an urban context. Bluespace includes outdoor water features like streams and greenspace includes vegetated areas like parks. While there are negative impacts resulting from greenspace, the average New Zealander would pay $184, or volunteer 4 hours, to save 20% of trees in their local neighbourhood (Vesely, 2007). Hence, interest in our project is strong.

Greenspace directly and indirectly improves people's wellbeing. Greenspace improves people's physical health through increasing exercise (Chomley, 2021). Greenspace improves people’s mental health by relaxing the brain and reducing stress, anxiety, and anger (Nutsford et al., 2016). Greenspace improves neighbourhoods by increasing social interactions and cohesion. This increases property values and reduces crime (Durning, 2010; Vesely, 2007; Nutsford et al., 2016). These benefits however differ between people.

Greenspace offers ecosystem services including carbon storage, wind and noise reduction, air quality (Vesely, 2007), seed dispersal, biodiversity and habitats (Nguyen et al., 2021). Greenspace also improves bluespace by reducing contaminants, runoff, erosion (Durning, 2010) and temperatures (Chomley, 2021). Therefore, riparian planting will enhance the green space in Abberley Park and the bluespace of St Albans Stream, thus achieving our research question.

3.4 Community engagement

Within communities like St Albans smaller groups form around shared values and interests. These groups have the power to shape local neighbourhoods (Gibson-Graham et al., 2013). SARA is one of these groups and has ongoing initiatives to promote community engagement.

Aspects from the government’s inclusive community engagement guidelines (Department of the Prime Minister and Cabinet, 2021) guided our project. This included identifying different stakeholders, such as the Rehua Marae, Mana Whenua, SARA and the St Albans community. It is important to include ideas, opinions and concerns through conversation with stakeholders. Failure to do so could result in dissatisfaction, loss of trust and project failure, which could cost the community more to resolve in the future (Ferguson, 1990). Ensuring community engagement in the planting and maintenance process is critical to ensuring the planting is valued and supported. It also lets community members take pride and ownership in the project. This will benefit the project's long-term success.

3.5 Stream health

The macroinvertebrate community index (MCI) measures the abundance of pollution sensitive taxa in a waterway, and it is a widely agreed method of assessing stream health (Suren et al., 2005; Thompson & Parkinson, 2011; Gadd, 2020). Using a combination of water quality parameters in conjunction with the MCI is recommended (Che, 2012). Our research methodology was informed by this. It should be noted that macroinvertebrates may be constrained by the urban environment, limiting the rate of colonisation possible by the invertebrates.

Riparian planting is a tool in a set of enhancement techniques, it is not at all a cure. Riparian planting has the biggest impact on diversification of streamside habitats, biodiversity, bank stability and water quality traits like temperature (Suren et al., 2005; Thompson & Parkinson, 2011). The benefits identified add credibility to our research and our plan to implement riparian planting to improve the St Albans Stream health to meet the goals of our community partners.

The naturally flat topography of Christchurch, low flows, sediment from urban development, storm water inputs bypassing the riparian buffer and the imperviousness of the urbanised catchment limit the benefits of riparian planting (Gadd, et al., 2020; Suren et al., 2005; 2005). Riparian planting still benefits local conditions without changing the catchment (Thompson & Parkinson, 2011) which fits right alongside our community partners goals.

4. Mana Whenua significance

This research is relevant to Mana Whenua, particularly, Te Ngāi Tūāhiriri Rūnanga, who are kaitiaki of the land at St Albans (TeRunanga o Ngai Tahu, 2022) and Rehua Marae, who were our primary contact for consultation. The goal of this project aligns with the values of Mana Whenua. This includes wish water quality, fish passage, riparian margins, Mahinga kai, native species biodiversity, runoff and bank erosion. This addresses Te Taiao, Mātauranga Māori from Ministry of Research Science and Technology

(2007), and the Mahaanui Iwi Management Plan (2013). Furthermore, the incorporation of traditional ecological knowledge into this research through plant species selection and stream health enhancement methods enhances the cultural wellbeing of the park.

5. Methods

Quantitative and qualitative research methods were used to answer our research question. Secondary data analysis of peer reviewed journals and government resources informed on the planting techniques, maintenance, and species selection for this project. Primary data was collected at four sites in Abberley Park (Figure 2). Sampling was conducted in overcast conditions on the 19th of September between 10.30am to 1pm. The weather leading up to our sampling date was generally fine with a few showers on Tuesday the 13th and Friday the 16th.

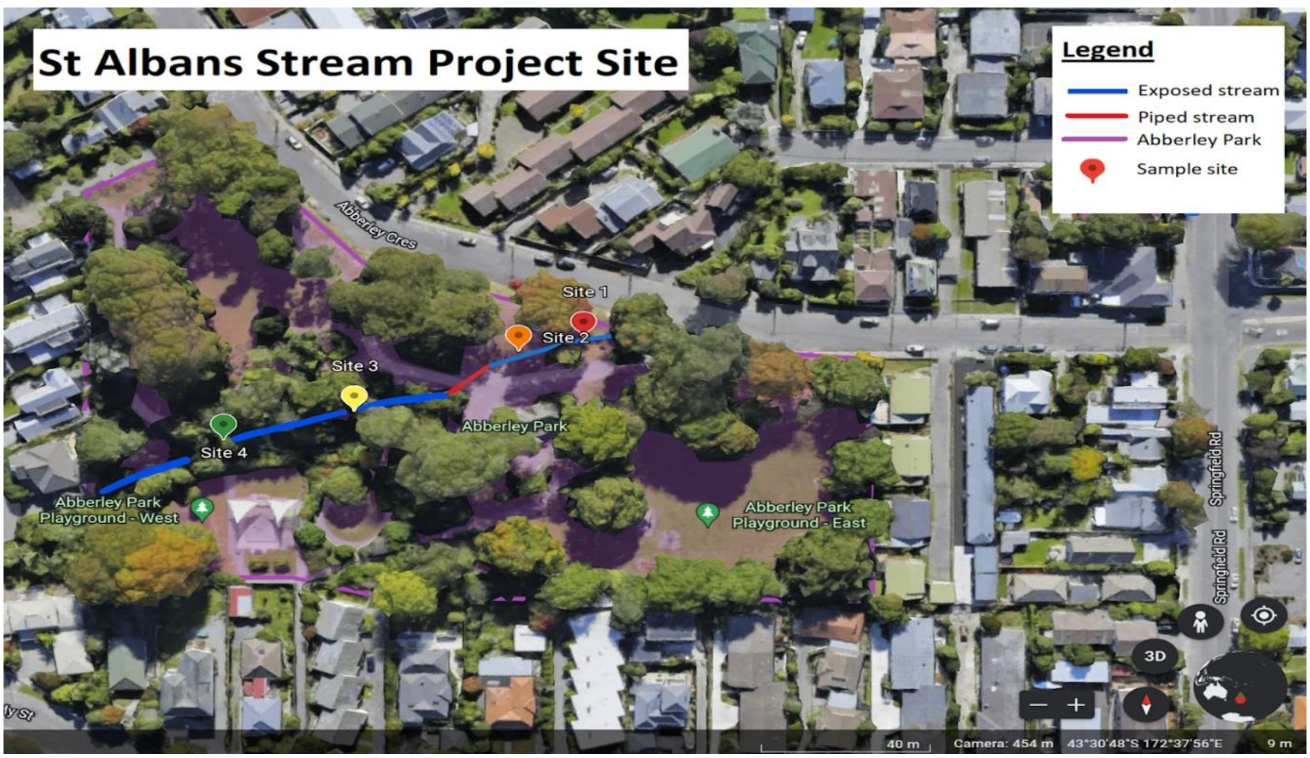

Figure 2. Map of Abberley Park and the four study sites along St Albans Stream assessed for water quality and habitat characteristics. The stream flows left to right.

5.1 Aquatic invertebrate sampling

We collected information on the MCI to assess the long-term ecological health of the St Albans stream. Using a D-net we collected a sample from each site (Figure 2) working from the downstream end upwards. At each site, the D-net was placed just above the stream bed while a colleague disturbed the sediments ~1m up stream. To accurately represent the habitat conditions we sampled 2 sites under canopy cover and 2 from the exposed reach. All material was preserved in a 2:1 ethanol and stream water solution and processed 2 days after collection.

Processing each sample individually, a 500µ sieve was used to separate out excess material such as leaves. The contents of the sieve were put in a tray with water and specimens were identified by eye then examined under a microscope to determine species when possible. From this an MCI and species richness were calculated for each site.

5.2 Water quality sampling

To supplement MCI data and provide more insight on the drivers of stream health we measured physical water quality parameters. A Hach water quality instrument measuring pH, conductivity, and dissolved oxygen (DO) was used to measure water quality parameters. Three readings of each parameter were taken at each sample site, this was averaged for each site to remove sampling error.

5.3 Site description

We conducted a habitat assessment to describe each of the four sites.

We recorded Latitude and Longitude using an eTrex® 10 GPS receiver. Co-ordinates are displayed in WGS 84 format and mapped in Google Earth (Figure 2).

Instream habitats are classified as a riffle, run or pool. Pools are slow, following eddies. Runs and riffles indicate flowing water, runs have smooth water flow and riffles have turbulent surface flows. Stream substrates were classified as either mud, silt, gravel, or pebbles.

Bank slope was categorized as flat, moderate, or steep. The bank width is the maximum realistic width of the riparian margin. Measurements were made for the right tributary (right side when facing downstream) and left tributary.

Plant species were identified and categorized as groundcover or canopy species. Canopy and groundcover were also observed. Canopy cover measures the percentage of canopy overhanging the stream. Groundcover indicates the percentage of the streambanks that are vegetated. In addition, plant species identified by INaturalist users near our study sites were listed (Table 2).

5.4 Plant species selection

Extending from the literature review, we identified suitable plant species that would enhance Abberley Park from Christchurch City Council (n.d.) and Lucas associates (n.d.) planting guides. Plant species that had low tolerance to wind, wet conditions or frosts were excluded. Species were differentiated based on tolerance for sun and shade and distance from the waterway (Figure 3). Species with Mahinga kai significance as indicated by ECan, (2022) are noted.

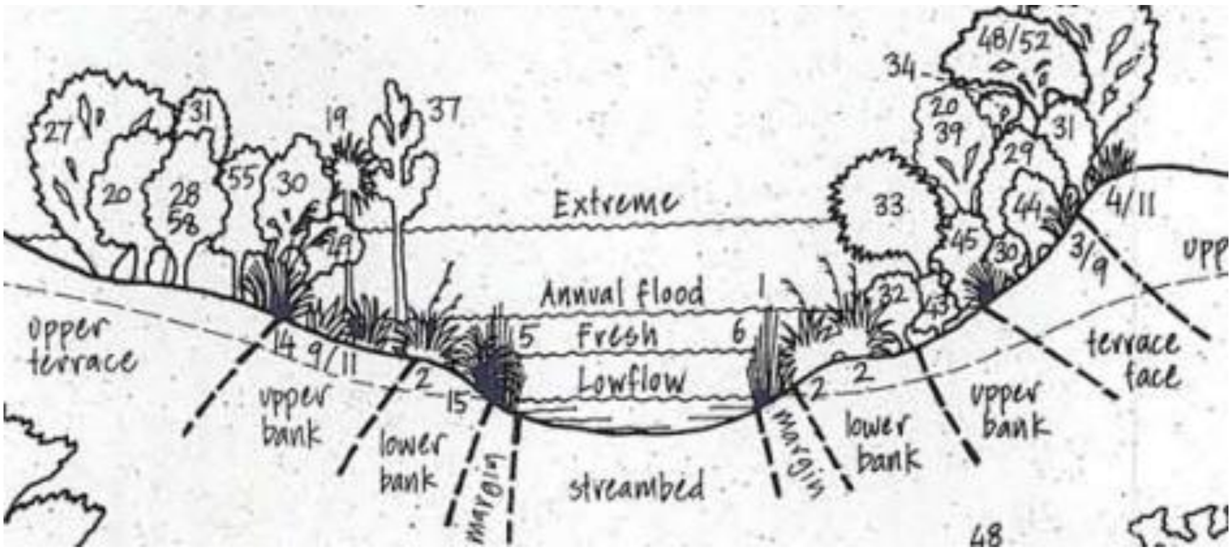

Figure 3. Zonation of plants based on distance from waterway. Lower bank species are right next to the river, upper bank species can tolerate flooding. Crest or upper terrace, where plants are above usual flood levels (Lucas associates, n.d.)

6. Results

6.1 Water quality

Table 1 shows water quality has low variability across sites. This was expected as the stretch of stream is no more than ~150m and dependent on surrounding anthropogenic activities. The pH of the water is slightly basic but is within the 6.5-8.5 allowable range set out in the Canterbury Land and Water Regional Plan (Environment Canterbury, 2018). DO levels were great for supporting pollution sensitive aquatic life. This indicates factors that affect DO: temperature, organic matter, and flow, were at sensible levels when sampled. Conductivity measures the presence of dissolved ions in the water, hinting at the water’s origin. Our conductivity measurement suggests that the water is rainfall and surface runoff dominated, with some input from Waimakariri River seepage (Hayward, 2002). There is a moderate level of ions leached from the land surface and aquifer material (Cawthron, 2022).

6.2 MCI and species richness

Table 1 also shows the MCI score at all sites. MCI values are well below the national bottom-line of 90 (Ministry for the Environment, 2020) Despite sites one and two having no riparian buffer, MCI scores were similar to sites three and four, which are well vegetated. Sites one and four had gravel substrates, which could reflect higher scores. Sites two and three's low scores could be explained by their proximity to the piped portion of the stream and very muddy substrate.

Table 1. Averaged values for water quality parameters sampled at St Albans Stream. MCI and species richness values calculated for each sample site, providing a long-term view of stream ecological health.

Site	pH	Dissolved oxygen (mg/L)	Conductivity (μS/cm)	MCI score	Species richness
1	7.55	9.18	161.1	76.0	2
2	7.53	9.17	159.03	73.6	3
3	7.52	9.12	156.33	73.7	4
4	7.51	9.06	155.97	77.6	3

6.3 Species breakdown

All sites were dominated by worms and leeches, which are pollution tolerant species (Figure 4). Site three was the only site where a caddisfly was collected. However, an individual specimen is not an indication of an established presence in the stream, but does indicate that somewhere along St Albans Stream, conditions are favourable for these species. This is important for the future colonisation of St Albans Stream by pollution sensitive species.

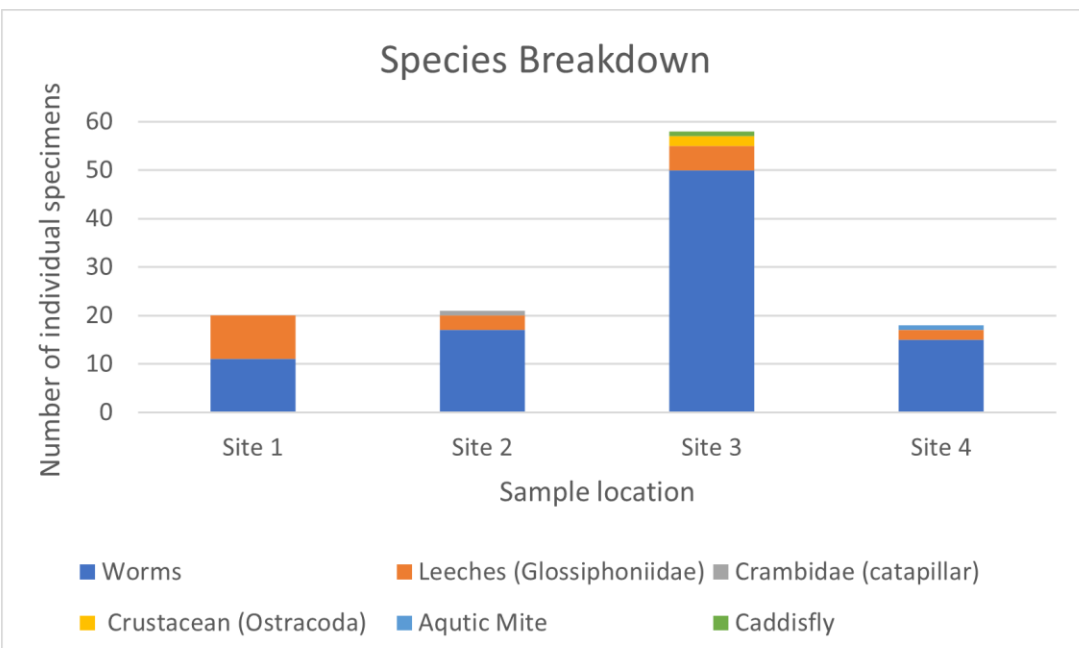

Figure 4. Number of species is found at each sample location shows a clear proliferation of worms and leeches which resided in the muddy substrate common throughout the stream.

6.4 Comparison to previous water quality assessments

Blundell-Dorey et al. (2022) conducted water quality baselines at each of these sites. Conductivity has increased and pH decreased from previous baseline data. MCI scores at site three improved, while the other two are slightly worse. Worms, ostracods and mites were common across both baseline tests – with worms being most frequent. Leeches, caddisfly and caterpillars were found in our samples, but amphipods and snails were only found in previous samples.

6.5 Habitat Assessment

Site location, instream habitat, canopy and ground cover and species identification were observed in the habitat assessment. Results of the assessment are in Table 2 with supporting site images seen in figure 5.

Table 2. Bank and in-stream habitat assessment for the four monitoring sites. Results recorded on Monday 19 September 2022

Site	One	Two	Three	Four
Description	Exit at Abberley Crescent	Downstream of culvert	By drainpipe and big totara	Downstream of footbridge
Latitude	43 30 48 S	172 37 49 S	172 37 47 S	172 37 46 S
Longitude	172 37 50 E	43 30 48 E	43 30 49 E	43 30 49 E
Instream Habitat	Riffle	Run	Run	Run
Substrate	Gravel/pebbles	Silt/mud	Silt/mud	Gravel/pebbles
Right Tributary	Moderate slope (5m wide)	Steep slope (3 m wide)	Steep slope (5 m wide)	Steep slope (5 m wide)
Left Tributary	Flat slope (wide bank)	Moderate slope Undulate (wide)	Flat (5+ m wide)	Flat (5 m wide)
Canopy cover%	5	1	60	20
Ground cover%	90	95	40	20
Groundcover species photographed	Grass (to bank) Sedges - Carex Rushes Silver tussock	Grass (to bank) Agapanthus Silver Tussock	Ivy, mosses, ferns on edge Gully fern	Mosses, Ferns
Canopy cover species photographed	Oak Hydrangea	Weeping Willow	Totara Mistletoe Lemonwood Camelia	Kohuhu Karumu Kowhai
Plant species recorded on INaturalist			Kowhai	Maple Karamu Bay Laurel

Sites two and three had the muddiest substrate. Sites one and four had gravel substrates. Paths near these sites likely contributed to this. Site one was the only riffle habitat, all other sites were classified as runs.

Sites one and two have high groundcover but low canopy cover. This is because the wide riparian buffers are mostly grassed down to the water's edge, but few mature trees are present. Sites three and four have low groundcover, but high canopy cover. Understorey vegetation is low, particularly on the left tributary, but canopy cover is high, particularly at site three. Deciduous plants dominate the canopy at sites one and four, so canopy cover should increase in summer. Slopes are steep on the right side and gravel driveways limit riparian width.

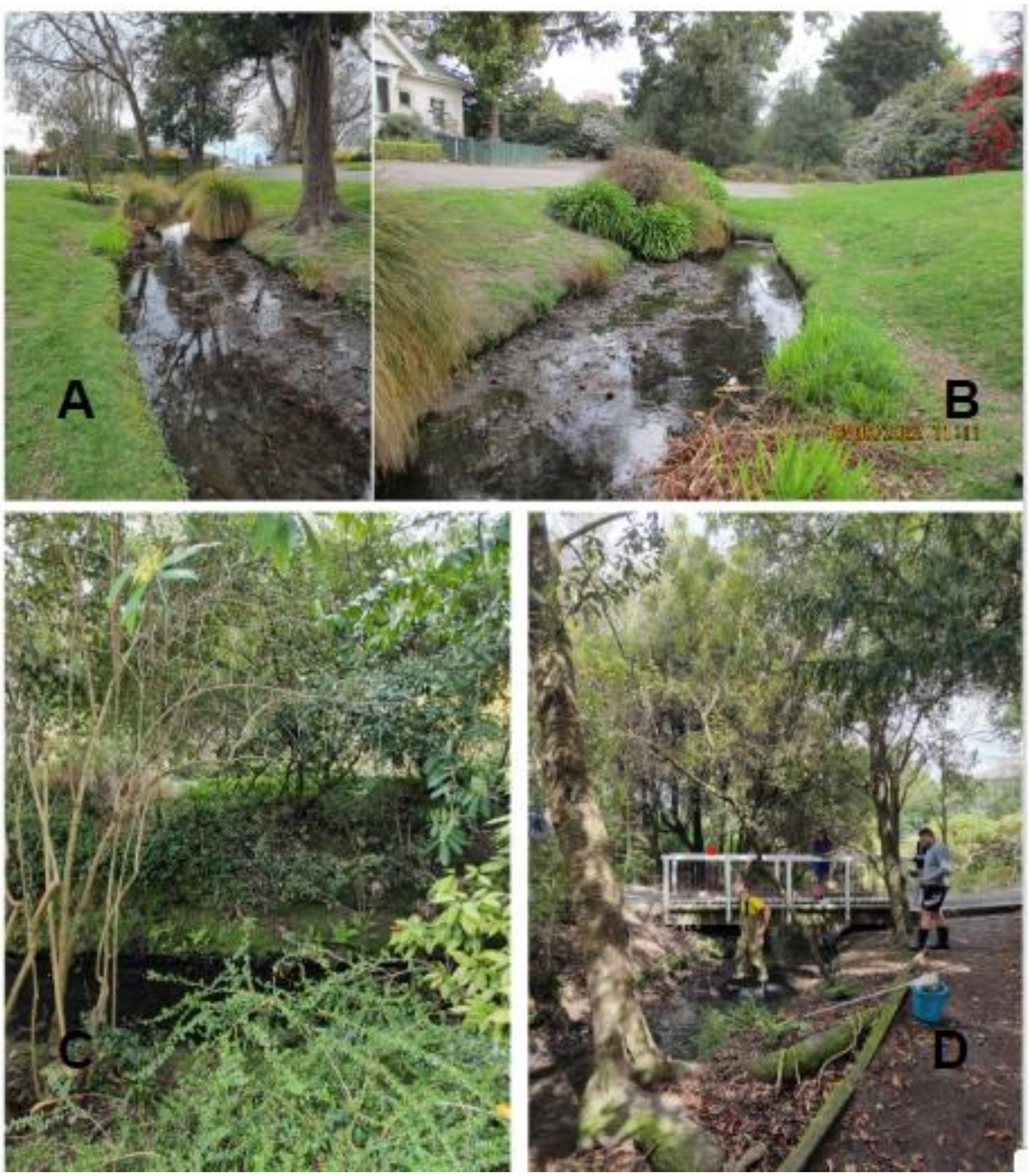

Figure 5. Photos of stream sample sites in Abberley Park; a) Site one b) Site two c) Site three d) Site four

6.6 Plant Species Selection

Suitable species for planting are listed in Table 3. Sun tolerant species suit sites one and two, while shade tolerant species suit sites three and four. Species are further divided into three zones: margins, banks, and terraces, which map the distance from the waterway those species best suit. Plants already found along St Albans Stream (Table 2) match the plants recommended (Table 3). Therefore, these plants can grow successfully.

Table 3. Species appropriate for each site and zone (Christchurch City Council, n.d.; Lucas Associates, n.d.). Species that have cultural and Mahinga kai significance are marked by an asterisk (ECan, 2022)

Sites	**One and Two (sun tolerant)**	**Three and Four (shade tolerant)**
Margin **<.5 m from stream**	Bogrush (*Schoenus pauciflorus*) Harakeke/NZ flax (*Phormium tenax*)* Kapungawha/lake club rush (Schoenplectus) Makura (*Carex maorica*) Pukio/tussock sedge(*Carex virgata/secta*) Spike sedge (*Elaocharis acuta*) Tussock rushes (Juncus) Upoko-tangata/umbrella sedge (Cyperus ustulatus)	Kiokio (*Blechnum minus*) Puniu (Polysiichum Vestitum)
Bank **.5 to 2-3 m from stream**	Harakeke/NZ flax (Phormium tenax)* Kaihikatea (Dacrycarpus dacrydoides)* Kaikomako (Pennantia corymbosa) Kohuhu/matipo (Pittosporum tenuifolium) Koromiko (Hebe salicifolia)* Manatu/Ribbonwood (Plagianthus regius) Manuka (Leptospermum scoparium) * Mikimiki (Coprosma propinqua)* Rohutu/NZ myrtle (Lophomyrtus obcordata) Ti kouka/Cabbage tree (Cordyline australis) Weeping mapou (Myrsine divaricata)	Horopito/pepper tree (Pseudowintera colorata) Kakaha/Bush Lily (Astelia fragrans) Kohuhu/matipo (Pittosporum tenuifolium) Rough pigfern (Hypolepis ambigua)
Terrace **>2-3 m from stream**	Horoeka/Lancewood (*Pseudopanax crassifolius*) Houhere /Lacebark (*Hoheria Angustifolia*) Karamu (Coprosma Robusta)* Kapuka/broadleaf (*Griselinia* littoralis) Kohuhu/matipo (*Pittosporum tenuifolium*) Kowhai (*Sophora microphylla*)* Manatu/Ribbonwood (*Plagianthus regius*) Matai/black pine *(Prumnopitys taxifolia*) Mikimiki (*Coprosma rubra/virescens*) Rohutu/NZ myrtle (*Lophomyrtus obcordata*) Ti kouka/cabbage tree (*Cordyline australis*) Totara (Podocarpus totara) Whauwhaupaku/five finger (*Pseudopanax Arboreus*)	Horoeka/Lancewood (P*seudopanax crassifolius)* Houhere/lacebark *(Hoheria angustifolia*) Turutu/ink berry (Dianella negra) Karamu (Coprosma *robusta*)* Kapuka/broadleaf (*Griselinia* littoralis) Kohuhu/matipo (*Pittosporum tenuifolium*) Poataniwha (*Melicope simplex*)

6.7 Limitations

Throughout our project there were limitations we came across which could be considered for future work on the St Albans stream.

1. The lack of experience in measuring the MCI value in the stream could much improved. This was evident in identifying species, as was the case in site 3 where a caddisfly was misidentified as a stonefly species.
2. The water quality parameters we measured were only reflective of the streams' conditions on the day they were taken, extrapolation of results is inaccurate. More measurements need to be taken to consider the different weather, seasons and activity affecting the stream.
3. The limited research and literature on St Albans stream also made it difficult to find any sources reference from. Research by Blundell-Dorey et al. (2022) is the only literature available on St Albans stream water quality.
4. While we contacted Mana Whenua, we only received an email reply from Rehua Marae and were unable to meet with Rehua Marae or Ngai Tuahuriri members. Much of our community engagement was extrapolated from previous surveys. Therefore, community perspectives may be missing from this report.

7. Recommendations

7.1 Planting

We have split the sites into zones along the stream. This includes sites three and four, which are well vegetated and sites one & two, which are poorly vegetated. Plants would be partitioned between three zones based on distance from the stream (Figure 3). This includes the margin (<0.5 m from stream), lower bank (0.5-3 m from stream) and terrace (>3 m from stream).

After examining the current riparian conditions of St Albans Stream, we recommend planting efforts focus on sites one and two. Comprehensive riparian planting across the three buffer zones is needed to remedy low vegetation cover. Sites three and four have established vegetation, meaning additional understory plants are recommended to reduce erosion and bank instability issues.

We recommend making the riparian buffer 5 m wide. Sites three and four already have wide enough buffer zone on both sides. However, the right tributary at sites one and two cannot have a 5m riparian buffer due to the gravel driveway. We recommend using as much space as possible to maximise effectiveness (Parkyn, 2004).

7.2 Water Monitoring

Water quality testing confirmed the poor ecological state of the stream. Riparian planting will have the greatest impact on biodiversity and bank stability, as it has at comparable sites where enhancement projects have been undertaken (Suren & McMurtrie, 2005). To assess whether riparian planting is improving stream health, it is advised to continue monitoring the MCI and physical parameters. Improvement can then be detected by comparing it to baseline data. The MCI is the better method and can be done annually. However, physical parameters are an easy alternative, provided measurements are conducted seasonally. Continued monitoring could involve the community, building awareness and increasing the value placed on the stream within the local community.

7.3 Planting and maintenance methods

Effective preparation, planting techniques and long-term maintenance is essential to the success and longevity of the riparian planting at St Albans Stream. Preparation for the lower half should be mulching the soil, while the upper half will need spot spraying to remove weeds and have vegetation cleared to make space for new planting. The most effective method of planting is to use native seedlings for understory plants. Whip cuttings are effective for trees and larger shrubs to have access to groundwater.

For maintenance, weeds should be spot sprayed using a biodegradable herbicide. Diseased plants should be replaced with new species to maintain density and diversity in the riparian buffer. A temporary fence could be installed to minimise trampling from animals and people. Maintenance of the riparian zone is of high priority, as to ensure the best survival rates for the plants and reduce time and resource needs into the future.

7.4 Engagement

In future, our project should increase engagement with the St Albans community. They should be offered opportunities to volunteer, especially in the initial planting stage. There is potential to share the research with the community. Residents could give feedback on the recommendations made in the report. This could even promote stewardship in the park. This could be done through social media, or information from the community centre.

Dialogue and communication with Rehua Marae, council, SARA and the community should be strengthened. This is to improve expert knowledge on decisions regarding the stream, maintain support for the project and increase awareness of the St Albans Stream contribution to the Avon-Otakaro catchment.

8. Future Research

Questions raised by this project that could be the aim of future work include:

- Measure bank conditions parameters e.g., compactness, soil order, soil pH.
- Expand water quality parameters measured e.g. salinity, nitrates
- Investigating public perception of exclusively native planting in a heritage park
- Improving the instream habitat with other stream enhancement techniques

9. Conclusions

We have recommended native riparian planting methods that should be applied in Abberley Park to improve St Albans stream health. This includes plant species and methods to maintain them. We conclude that site one and two should be of highest risk of erosion and bank instability. It is recommended that species selection match shade and water tolerance by stratifying over the three riparian zones. We recommend site preparation and maintenance techniques essential to increasing plant survival and supress weeds and disease. Future water monitoring procedure is acknowledged to measure water quality objectives. The work done for this report is dependable, but there are limitations, especially regarding water quality and MCI measurements. Information on species and planting methods is very reliable as there has been extensive external research on the topic.

Acknowledgements

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