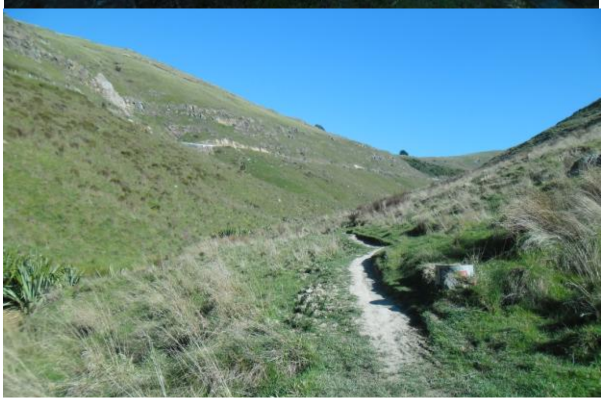
The Integration of Restoration Options for Ecological and Recreational Resources in Sumner



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Executive Summary

- With an exponentially growing global population and increasing rates of urban development, issues surrounding environmental degradation are paramount. The restoration of various ecological resources is central in providing for a healthy environment for future generations that can support the increasing need for natural, life-supporting resources.

- The research questions used to focus this report were:

    - *What are the best restoration options for the three ecological resources; coastal zone, riparian zone, and ecological corridors?*
    - *Can they be effectively integrated with each other and recreational tracks, and if so, what is the best scenario?*

- Methodology included the formation of an intensive literature base of research surrounding the focus questions. This knowledge was then applied directly to the Sumner valley through detailed observation of the current status of the various resources to be considered. Opportunities for restoration and integration were highlighted and compiled into a GIS map. Finally, a brief community survey was carried out to gauge the likely community response to the proposed scenario.

- The initial research provided a number of guidelines to form the foundation of the recommendations to be specifically applied to Sumner. The most significant component of coastal restoration was found to be in dune management; their rebuilding and re-vegetation with native, sand-binding dune plants. Similarly, riparian zones require a return to their natural state with regard to meanders as opposed to box culverts, and vegetated stream edges with the addition of buffer zones. Opportunities for the integration of these zones were found through potential greenway sites. And finally, a number of functional recommendations for sustainable track building were found to be relevant to tracks in the Sumner valley, further generating potential for an integrated network of greenways.

- Limitations for the research surrounded the broad scope of the research questions. In order to go into the detail necessary to answer them comprehensively, more time would be required, and a more thorough look at the viability of the restoration options with regard to cost benefit analyses and a more focussed community survey.

Introduction

This report takes a multi faceted approach to the questions surrounding the restoration of different ecological resources, and the integration that is central to its success. The focus is divided between investigating the restoration options for the coastal, riparian, and neighbouring terrestrial resources in the Sumner valley catchment area, and the integration of these with each other and tracks as a recreational resource.

Restoration is defined as “the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed. It is an intentional activity that initiates or accelerates ecosystem recovery with respect to its health (functional processes), integrity (species composition and community structure), and sustainability (resistance to disturbance and resilience)” (Martinez, Gallego-Fernandez et al. 2013). In current times, severely degraded environments characterise much of the earth’s surface and all of its urban landscapes. As a result, the restoration of ecological resources is imperative to the survival of all living organisms.

Greenways are defined as strips of undeveloped land in or near urban areas, set aside for recreational use or environmental protection. Within the context of this research, greenways are synonymous with “ecological corridors”, focussing on the ecological benefits of integrating otherwise isolated habitats, in order to foster the connectivity necessary for the sustainability of healthy ecosystems.

The term “integration” refers to a number of different components within this report. Firstly, the integration of physical and social science in the form of integrated resource management is an imperative component of environmental restoration in present times. It centres on management with a multidisciplinary research focus, strongly incorporating stakeholder consultation (McCoy, Osama, Roberts, Shapcott &Shurrock, 2010). Secondly, the integration of different ecological resources in their restoration capacity is imperative in promoting maximum benefits from the restoration process. For example, the gradient of change at the interface of a riparian zone and the neighbouring terrestrial environment governs the strength of interaction between the two subsystems. Thirdly, greenways, or ecological corridors, represent the key component of integration that is central to sustainable ecological restoration. The dissolving of fragmented landscapes that has resulted from deforestation and urbanization is central in promoting the connectivity between various populations of biota that is central to their reproductive health. And finally, riparian zones in their definition are in essence the integration of aquatic and terrestrial ecosystems of fresh water bodies.

Literature Review

Coastal Zone Restoration Options

The reparation of sand dunes is the most significant component of coastal environmental restoration. By the early 1990s, New Zealand sand dunes had declined 70% from their original coverage (Doody, 2012), and by the early 2000s the Sumner coast had been reduced to a severely depleted sediment budget beach, absent of sand dunes and native dune vegetation (Sumner Community Group, 2013). Managing this resource sustainably in light of pressure from increasing human populations is challenging (Doody, 2012). Furthermore, the implications of climate change, sea level rise and increased storminess, make sand dune structure and stability a crucial component of coastal protection against tsunami and storm events (Dahm, Jenks et al., 2005).

The importance of dune vegetation is predominantly related to its ability to maintain effective dune form and function; namely the height of the dunes and their ability to mitigate storm events. Pingao and Spinifex are the 2 species of native dune grasses most commonly used in re-vegetation projects of New Zealand dunes due to the integrity of form and function, appropriate to New Zealand coastlines that they support (Bergin, 2008).

Dune height and continuity are the key factors at play in assessing the likely ability of a region's dunes to protect the coastline from tsunami or storm events (Hart and Knight, 2009). Christchurch coastlines have been shown to be at risk of small to medium Tsunami with wave heights ranging from 2-6m above the mean high water mark (Hart and Knight, 2009). Therefore appropriate dune height would counter this risk, and provide minimum cross sectional pathways that would interrupt the continuity of the dunes, and hinder their integrity and ability to resist erosion.

Riparian Zone Restoration Options

Riparian buffer zones can be used as multifunctional tools to aid in the health of the freshwater ecosystem and the surrounding environment due to the diffusion and filtering that takes place before sediments reach the waterway (Chardon, Kronvang & Stutter, 2012; Brennen & Culverwell, 2004). The recommended width relates to the size of the water source and its position within the drainage network (Naiman & Décamps, 1997). A grass filter strip of 5m proved to be very helpful in sediment removal in one study, while a study in New Zealand showed retired pasture buffers of 10-13 m were capable of reducing suspended sediment and particulate nutrients in channelized surface runoff by over 80% (Parkyn, 2004). Further research has shown a broad range for effective riparian buffer zones, with widths being successful from 10m to 30m depending on waterway size (Parkyn, 2004).

The significance of Greenways

Research has shown multiple ecological benefits for the spatial integration of different ecological resources, ecosystems and habitats, and the avoidance of the type of fragmented landscape that often results from human development and urbanisation (Ahern, 1995). The benefits include allowing for the movement of biodiversity between habitats, promoting genetic exchange (Ahern, 1995) and a healthy gene pool. The interaction of populations over a greater spatial extent and the connectivity that results, or the formation of metapopulations, supports population resilience (Ahern, 1995).

The use of greenways in promoting environment and ecosystem health increases the sustainability of restoration efforts through providing stability and a solid ecological infrastructure (Ahern, 1995), reducing the level of sustained human monitoring and maintenance that is often required. Their development is particularly important in urban areas where natural landscapes are typically limited, but those that do exist have habitat value that need protecting (Bryant, 2006).

The Integration of Restored Ecological Zones

The definitions of greenways and ecological corridors themselves encompass the integration of various ecological resources, due to naturally occurring corridors that exist along rivers, coastal areas and ridgelines (Fabos & Ryan, 2004). It is therefore an invaluable component of ecological restoration, to include what would have been naturally occurring connectivity between resources. The characteristics that occur at the interfaces of adjacent ecosystems are dependent on various spatial and temporal scales, and the strength of interactions (Naiman and Décamps 1997). These interactions are in turn determined by the gradient of contrasts in environmental factors (Naiman and Décamps 1997). Therefore, to minimise interactions that could be detrimental to ecosystem health, the gradient of change needs to be minimised.

Riparian zones are described as their own ecological corridors, naturally linking adjacent habitats through stream networks. However, this linkage can also be detrimental when used by invasive exotic plants in their rapid spread (Naiman & Décamps, 1997). This raises further considerations as to how best various ecologically zones should be integrated.

Flooding, storm and erosion hazards become greater threats to coastal areas when shoreline development does not maintain riparian vegetation buffers. If riparian vegetation is reduced in a coastal ecosystem, then so is the carrying capacity of the ecosystem. Studies have shown that the degradation of a coastal riparian zone has decreased coastal water quality (Brennen & Culverwell, 2004). In a coastal zone, a “buffer” is defined as a horizontal feature separating a coastal feature or resource from human activity (Brennen & Culverwell, 2004). The use of riparian buffers as pollution control in coastal estuaries was shown to be dependent on soils, geomorphology, hydrology, biological processes (e.g., microbial activity), vegetation type, steepness of slopes, annual rainfall, level of pollution, type of pollutants, surrounding land uses and buffer width (Brennen & Culverwell, 2004).

Overall Impacts of tracks on the environment

The impacts of tracks on the surrounding environment are wide and varied, and range from the impacts of the initial track construction, through to the sustained impact of trampling as a result of track use. Impacts include: littering, soil compaction, increased runoff and erosion, reduced nutrient flows, reduced vegetation height and cover, exposure of roots, change in composition of species, and spreading of noxious weeds (Priskin, 2003). Excessive erosion can degrade soil properties and can lead to stream sedimentation which can bury vegetation, homogenize stream features and habitats, and increase stream turbidity (Lanehart, 1998).

Trampling associated with "avoidable" off-trail traffic can quickly break down vegetation cover and create a visible route that attracts additional use. These informal trails then widen with use, increasing the overall impacts on the environment. Triggering of off-trail traffic includes the presence of wet trails resulting from improper drainage and trail design, causing users to find alternative routes (Lanehart, 1998).

Impacts of tracks on Coastal and Riparian Zones

Tracks have been shown to have negative effects on both coastal and riparian zones. The impacts of tracks on sand dunes are likely to be more severe in areas within which fore dune vegetation has been disturbed and destabilization has occurred, or dunes are undeveloped (Priskin, 2003). Mean annual height, species richness, and species diversity were found to be adversely affected by a small degree of measured trampling of dunes along a designated trail, together with increased soil compaction, loss of organic/soil matter and moisture contents (Kutiel, Eden et al., 2000). High traffic routes have been found to have significant negative effects on the environment. However, provided the trail is well marked, the damage can be confined to the narrow trail corridor. In contrast, low traffic routes tend to be less defined and result in off-trail traffic and the damage being extended beyond the trail boundaries (Kutiel, Eden et al., 2000).

With regard to riparian zone, effects are in part due to the increased sediment load instilled on streams due to the erosion that results from track use (Richardson, Naiman & Bisson, 2012). It is recommended that any tracks present are outside of the immediate riparian zone due to both the increased sediment load, and the overall negative consequences of tracks on vegetation (Kenwick, Shammin & Sullivan, 2009). Tracks could perhaps be more successfully integrated with riparian zones if a mechanism for diverting sediment run off away from the stream could be employed (Richardson, Naiman & Bisson, 2012). However, the remaining detrimental effects for vegetation would have numerous flow on consequences for such a fragile system.

Recommendations for Environmentally Sustainable Track Building

Track design and management are much larger factors in environmental degradation than the type or quantity of use. Many studies have demonstrated that poorly designed or located tracks are the biggest cause of negative impacts. Erosion is an indirect and largely avoidable impact of tracks and tracks use. Avoidance of erosion is possible through construction of a track with a slightly crowned or out-sloped design, with an emphasis on flat terrain. Track design can also control the degree of soil compaction, which while detrimental for some vegetation types, aids greatly in reducing erosion. Drainage features should be designed to divert water at a speed sufficient to carry the sediment load below the track, where vegetation and organic litter can aid in filtration (Lanehart, 1998). It is recommended that tracks have a gradient of less than 15 percent, as steeper slopes result is faster flowing water and increased erosion. However, 30 percent gradients for short sections are permissible. When a track must ascend a steep slope without covering much lateral distance, switchbacks must be employed to maintain appropriate gradients, while being constructed to avoid the likelihood of short cuts being taken (Lanehart, 1998).

The need for Community Involvement

Public perception and community involvement is an important part of planning any kind of ecological restoration for a number of reasons. Firstly, viable sites often include both private and government owned land, requiring collaboration over land use decisions (Fabos, 1995). Furthermore, user attitudes and perceptions of the impacts that recreational activities have on the environment is important for understanding the extent of the effects that a recreational area could be expected to have (Priskin, 2003). For example, a study on user perceptions showed that when perceived impacts are low, complacency results in exacerbated levels of human induced degradation. In contrast, when users perceived their impacts to be more substantial, more care was taken to avoid degradation (Priskin, 2003).

Furthermore, while communities want to contribute to decision making, studies by Bryant (2006) show that community participation, such as in stream and riparian restoration programs, citizen monitoring, and private land stewardship, have more positive results for the environment that an uninvolved community. The introduction of restoration projects to urban areas is a valuable tool for educating communities on the need for environmental awareness. For example, the implementation of greenways has been shown to be one of the most successful community conservation strategies (Bryant, 2006). These observations highlight the need for community involvement and education to ensure that restoration efforts are sustainable and successful.

Methods

Methods for this report were divided into 3 components. Firstly, an in depth literature research base was formed on all elements of the focus questions. This research looked into the theory behind the need for restoration throughout the coastal, riparian and terrestrial ecological zones, and the best approaches to implementation. It also thoroughly investigated the environmental impacts of tracks as a recreational resource, and recommendations for sustainable building and restoration.

This research base was then applied to Sumner directly in the second component of methodology. Field work was carried out to investigate appropriate sites for potential restoration options as sourced from the literature. Detailed observations were made of the various sites through the Sumner Valley catchment area, with factors surrounding the viability of implementation and the various concepts of integration being taken into account. This information was then collated into a map using GIS techniques, representing the viable scenario of integrated restoration options.

Finally, in the third component, community perspectives were surveyed through the use of short interviews, targeted at users present at different times throughout the various identified sites for potential restoration.

Results and Discussion

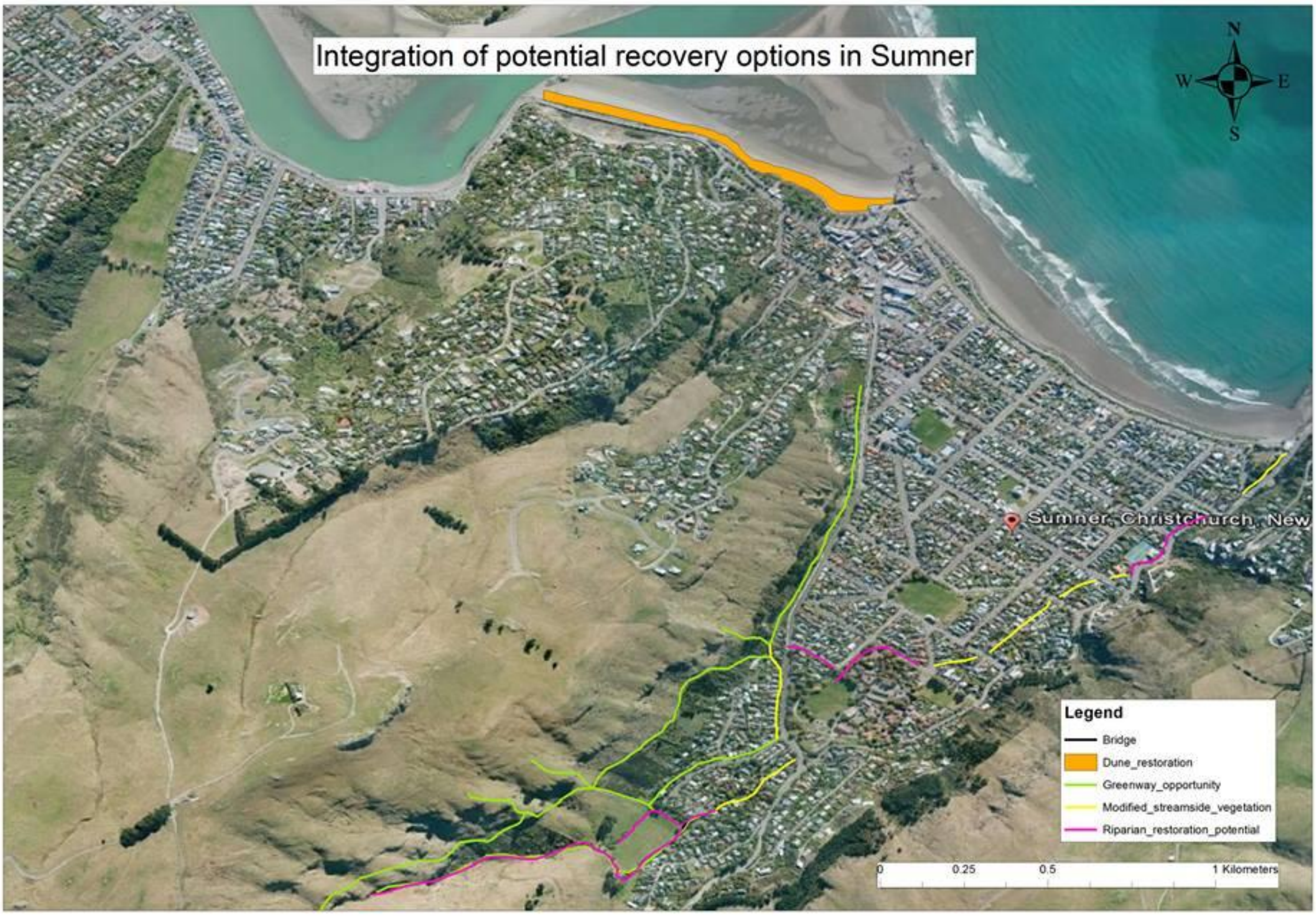

Fig. 1. GIS Map of Compiled Restoration Options and Opportunities for Greenways in the Sumner Township.

Coastal Zone

As shown by Figure 2, restoration of the coastal zone is limited to areas with less human modification. From Cave Rock, along the length of the esplanade to the eastern extent of Scarborough, the beach is heavily modified by concrete revetments and rock walls. West of Cave Rock, between "On the Beach" Cafe, and the pre-earthquake site of Sumner Surf Club, dune restoration is currently underway by the Sumner Community Group. The dunes have been partially re-vegetated with native species and fenced to avoid excess foot traffic. Between the surf club and the western extent of Sumner beach at the estuary mouth, the upper reaches of the beach, where dunes previously would have stood, have been engineered with a small rise of 1-1.5m to the road. The rise consists of a rock wall, with windblown sand and a mix of native and exotic vegetation.

Fig. 2. Dunes Currently Present in Sumner.(Sumner Community Group 2013)

Recommendations for dune restoration in Sumner depend heavily on the sediment budget of the beach. Sumner is known to have a dramatically fluctuating beach composition, at times with sediment supply appearing abundant and at other times greatly eroded. Therefore, more research would need to be carried out as to the volume of sand nourishment that would be required to support the development of larger dunes in a sustainable manner. Literature on neighbouring Pegasus Bay beaches stated areas of dune height <8m, and/or with discontinuous long shore profiles, to be vulnerable to small to medium tsunami, characteristic of the region (Hart and Knight, 2009). Therefore, it would be assumed that similar height recommendations would apply to Sumner, with the potential to allow for the moderate sheltering effect of Banks Peninsular from southerly swells. However, the current state of Sumner beach, with high levels of human modification, high levels of recreational activity, and coastal property, indicate that complete restoration would not be feasible. Consequently, further research is needed is order to determine a viable height for dune restoration, taking into account community perspective, cost-benefit analyses, and the degree of sediment nourishment that would be required to support larger dunes. However, an idealistic judgment call aims for the development of 2-3m dunes, as a step towards restoration. Examples of the proposed added dune height follow in Figures 3 & 4 with a comparison between the current state of the partially restored dunes, and an addition of 2-3m in height, with native re-vegetation of pingao and spinifex. Figure 1 highlights the area for potential dune restoration as highlighted in orange, reaching from the current area of restored dunes next to "On the Beach" cafe, to the estuary mouth at Shag rock. However, this again would require more research due to the dynamic nature of the sediment budget surrounding the estuary mouth.

Fig. 3. Current State of Dunes.

Fig. 4. Proposed Dunes.

Riparian Zone

The Sumner stream is the one dominant waterway running through the township. Its source is a spring located in the upper catchment area near the junction of Evans Pass and Summit Road. Near its origin, there are some small pockets of restored native vegetation as visible in Figure 6. Its upper section flows through rural agricultural land, predominantly sparsely vegetated sheep pasture, with the addition of streamside native flax, planted as part of current restoration projects underway by the Christchurch City Council (CCC). As it reaches the outskirts of the Sumner township, it is well vegetated with riparian zones also restored by CCC. However, after this section, as the stream reaches the urban environment, its banks are heavily modified either by concrete or wooden box culverts, and general stream health deteriorates quickly. Upon reaching the coastal zone, after a short underground section of concrete piping, the stream discharges at Scarborough beach as a storm water drain outlet.

Previous research on the health of Sumner stream at different intervals along its length confirm the gradual deterioration of both water quality and riparian communities as the stream progresses through the urban environment. Using the Riparian Quality Index (González del Tánago, M., García del Jalón, D, 2011), the Scarborough beach stream end scored badly with a 9, due to the high levels of human modification preventing the natural functioning of the riparian environment in any capacity (Allan, Huggins, Lewis, Miller & Maloney, 2012). Further up the catchment at the Van Asch School and Cascade Place, conditions were shown to improve slightly with a score of 21 and 29 respectively (Allan et al., 2012). However, this is still considered a "bad" score on the scale, with a majority of the natural conditions altered. Opportunities for restoration of riparian zones are highlighted in Figure 1.

Specific restoration options raised by a previous research group include the addition of swales, filter strips and substrate as initial steps towards restoring natural characteristics. More aggressive recommendations include returning the waterway to its naturally meandering form and removing the hard engineering that is currently present such as concrete and wooden box culverts (Allan et al., 2012). However, while these recommendations are unlikely to be implemented in a developed urban setting, at least in the short term, riparian buffer zones are a recommended addition to any water way restoration project, aiding in protecting the fragile riparian habitat, and allowing for the effective integration of riparian and terrestrial zones.

In the heavily urbanized environment that is the Sumner Township, the addition of buffer zones raises challenges. For example, much of the stream, aside from being confined within artificial banks, runs through residential property with limited space for the incorporation of buffer zones of any size, and leading to problems of consent and private land management. However, from the Van Asch School site and upstream into the upper catchment area, opportunities for buffer zones become more abundant. Specifically, sites for potential restoration would include the addition of a buffer zone, and the re-vegetation of this zone with native plant species. An example is represented by Figure 5, in the photograph taken of the section of stream adjacent to Van Asch School, on Paisley St. The most effective width of buffer zone was found to be 10 – 20 m for areas where space allow in the more rural setting of the upper catchment, with a compromised minimum of 5m for urban areas.

Fig. 5. Example of a Riparian Site Suitable for Potential Restoration through addition of a Buffer Zone.

Opportunities for Greenways and the Restoration of Tracks

The majority of the tracks in the Sumner Valley are completely un-vegetated at their edges, passing predominantly through sheep pasture. This raises a number of concerns from an environmental standpoint including increased erosion, lack of habitat and connectivity between other habitats for native species, and the potential for users to veer off trail where lack of vegetation fails to restrict foot traffic to the track itself. There are however many positive signs of restoration initiated by the CCC, including the planting of native Harakeke (*Phormium tenax)* along the length of the stream and 3 large fenced areas of native regenerative forest surrounding areas of the tracks. Recommendations therefore include re-vegetating the track edges in the formation of a greenway and in doing so, linking areas of current vegetation into ecological corridors capable of promoting native birdlife. These greenways extend further, beyond track edges, linking to the riparian buffer zones recommended previously, both in the rural upper catchment, and urban areas.

Figure 6 displays potential greenway locations running the length of the Captain Thomas track, linking each of the areas of native forest and the riparian zones. Further recommendations surrounding these greenways would be the implementation of fencing in order to remove the negative impacts of grazing, the need for a corridor of at least 10m wide to optimize the ecological benefits and the use of plant species native to the area to ensure the best chance for pollination/dispersal, succession and regeneration in the future.

The port hills is home to a number of native and endemic plant species, some found only on Banks Peninsular (CCC, 2013). As a result, the generation of greenways, linking the pockets of native vegetation already present, has the potential to promote these species. They include the Banks Peninsular Hebe (*Hebe strictissima*) and the Banks Peninsula blue tussock (*Poa colensoi*) (CCC, 2013). Native birds that will inhabit the forested areas of Banks Peninsular include bellbirds, fantails, silver eyes, grey warblers, shining cuckoo, and South Island tomtits (CCC, 2013).

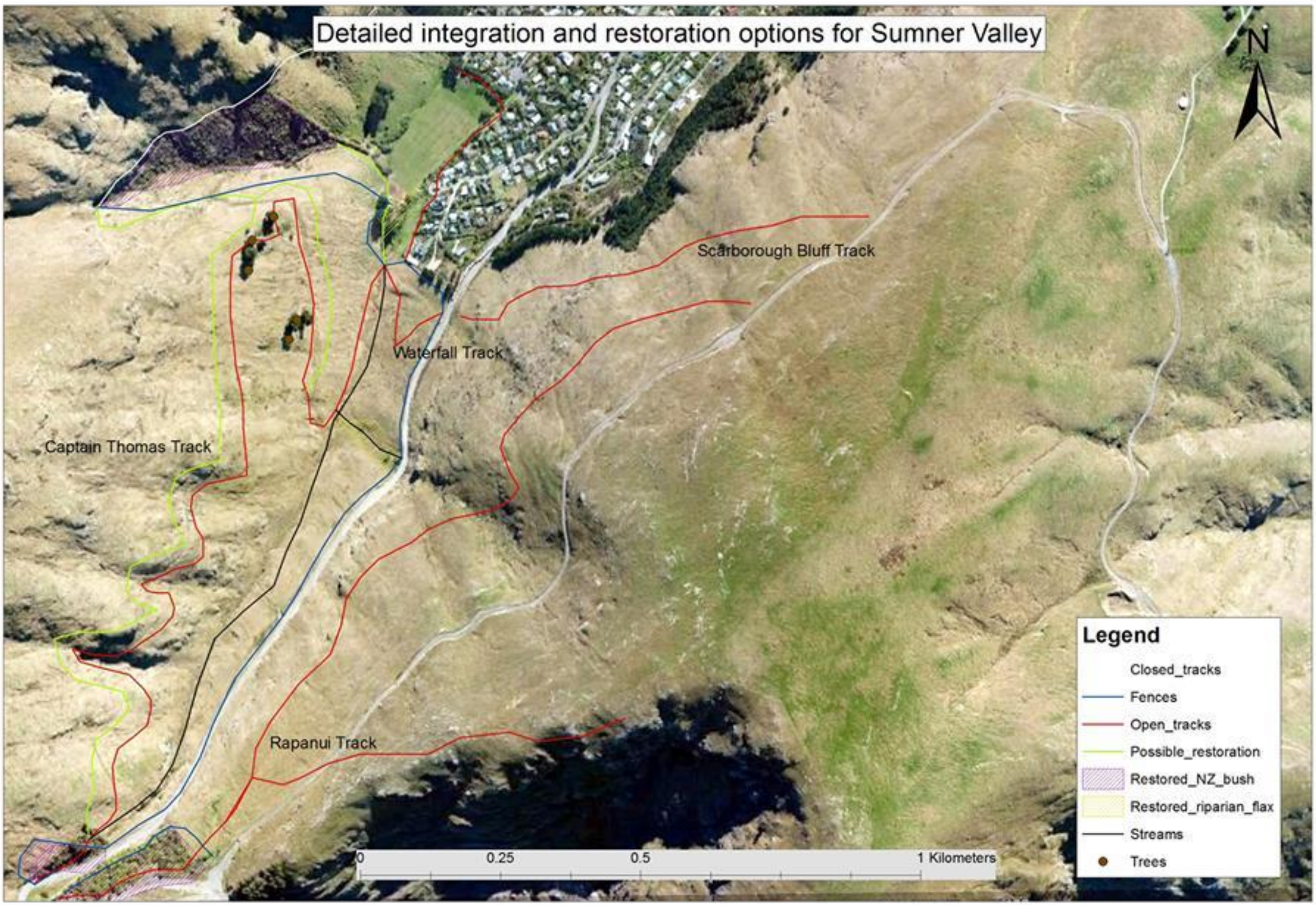

Fig. 6. GIS Map of Compiled Restoration Options and Opportunities for Greenways in the Upper Catchment

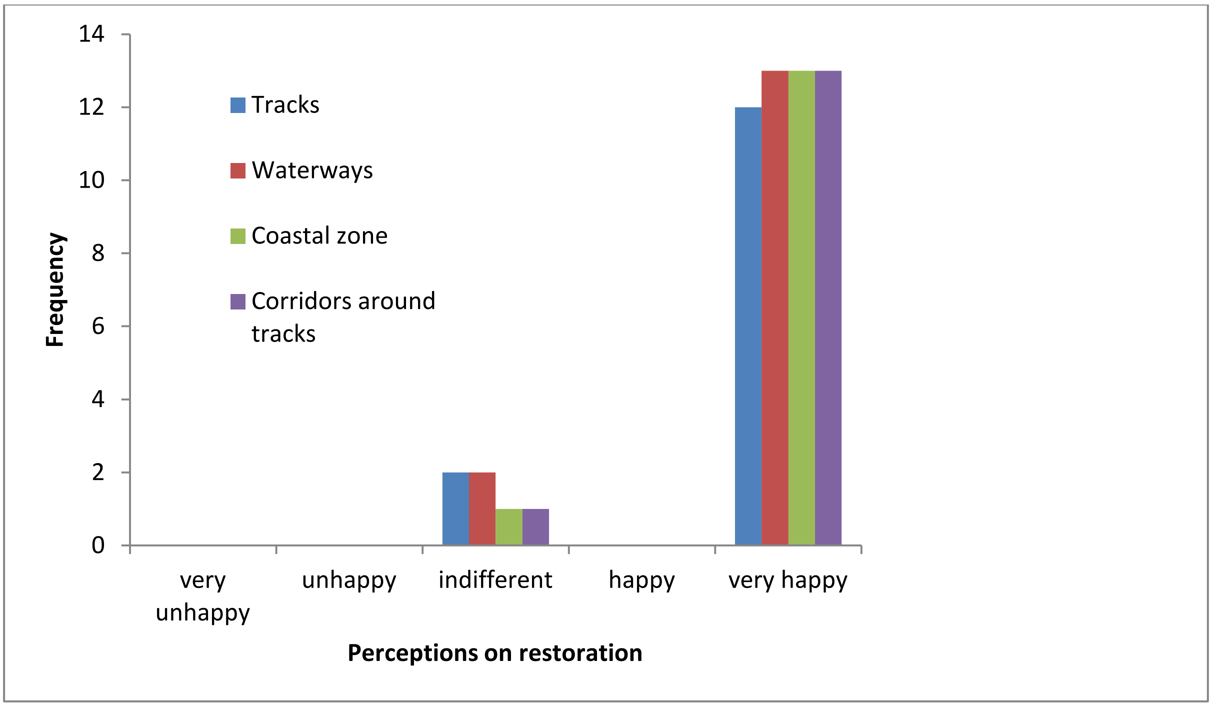

Fig. 7. Community perceptions of restoration projects.

Informal interviews with each participant indicated that while visitors to the area were generally indifferent to the concepts of restoration, Sumner locals were enthusiastic. However, an overall theme was that many didn't know what was currently being done, or what the current states of the various ecological resources are, and hence the need to restore them. Consequently, views were polarised between being indifferent, and enthusiastic about the potential for restoration.

Conclusions

The initial literature based research provided an extensive foundation of theory from both national and international case studies, that was able to be applied to Sumner in combination with field observations. A body of recommendations for the specific restoration options available to the coastal and riparian zones, and recreational tracks was compiled. These recommendations were then integrated into a scenario that was most viable for the Sumner Valley catchment area, taking into account land availability, and the specific sites deemed most conducive to, or in need of restoration. The key component of this integration was the sourcing of sites appropriate to the formation of greenways, linking recreational tracks and riparian buffer zones. No opportunity was found in Sumner to integrate the coastal zone with riparian buffer zones or greenways, due to the extent of human modification of the waterway, and barriers such as roads. Specific recommendations of the restoration options included the nourishing of Sumner beach and development of 2 – 3m vegetated dunes, re-vegetating of riparian zones and the introduction of 5 – 20m buffer zones between stream and track, or other modification, where possible, and the re-vegetation of recreational track edges with native species.

Further recommendations include the education of the community on the importance of restoration projects. This allows any restoration projects that are carried out, to be sustainable and effective from both an ecological and community perspective. Ideas include the use of signs at restoration sites and trail heads, explaining the relative ecological importance of each site, and its restoration. Further information could be provided on an easily accessible website, with details as to how community members can become more involved with various restoration projects. The website will also give the public the ability to contribute to the monitoring and upkeep of projects by calling to attention new issues.

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Appendix

Community Survey

1. **Have you heard of Habitat Sumner?**

Yes	No

2. **If yes have you ever been involved with any of their projects?**

Yes	No

3. **Do you ever use any of the recreational tracks in/surrounding Sumner Valley?**

Never	Occasionally (yearly)	Often (monthly)	Very often (weekly)

4. **If you do use the tracks, which tracks do you use most frequently?**

Beach/Coastal zone	Captain Thomas/ Rapanui	Other (list)

5. **Which mode of transport do you use on these recreational tracks?**

On foot	Mountain Bike	Horse	Other

6. **How would you feel about:**
   a) **The restoration of tracks?**

Very unhappy	Unhappy	Indifferent	Happy	Very happy

   b) **The restoration around waterways?**

Very unhappy	Unhappy	Indifferent	Happy	Very happy

   c) **The restoration of the beach/coastal zone?**

Very unhappy	Unhappy	Indifferent	Happy	Very Happy

d) The regeneration and formation of native corridors around tracks?

Very unhappy	Unhappy	Indifferent	Happy	Very happy

7. Are you a Sumner local?

Local	Visitor

8. Which age bracket do you fit in to?

<18	19-29	30-39	40-49	50+

9. What is your gender?

Male	Female

10. Any extra thoughts or comments?