Assessing the impacts of Fire Disturbance at the Pines Beach Wetland

UNIVERSITY OF CANTERBURY
GEOG309 RESEARCH REPORT

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Executive summary

on 25th of January. The bush fire that swept through the area damaged a large number of the trees that directly boarder the residential area. These damaged trees had to be removed due to safety issues with the company the owns the trees on the land getting permission to clear the healthy trees as well while the equipment was all there. The fire and subsequent clearing left behind a large are of approximately $400m^2$. Due to this it was decided to conduct research into effects that the clearing of these trees would have on the surrounding landscape

The final hypothesis being that the clearing of tees would have resulted in an increase of wind speeds and the subsequent increase in the volume of salt particles being moved inland towards the community and wetland

To test this hypothesis, we conducted two different stages of research around the area. The first study we undertook was a community survey. The reason for the survey was to gather an understanding of the communities' perspectives on the landscape around them and their understanding of what has been taking place in the area. Following on from this, with the information gathered from the survey we undertook testing on the wind and salinity movements and accumulation in the wetland.

Overall this study was able to show a connection between the protection of the trees and decreased connectivity levels in the water. This was backed up by response from the community where they too have noticed and large increase in the strength of easterly breezes with houses on the beach side of the community also mentioning the increase of salt gathering on the windows.

Due to lack of time and background data there are some major limitation and shortcoming of this work. Firstly, no time was allotted to atmospheric testing, this means the results do not show if the wind itself was leading to the movement of salt particles in the wetland of rather if it was caused by intrusion of saltwater underground. Another shortcoming was that due to time it was not possible to test change over time, this information would be crucial for the movement of salt particles.

Overall the data in this research will be useful as baseline data to be built on. This information can be revisited to check for change over time as well as general long term weather monitoring being required to see all the impacts of the loss of trees as the area has only has 18 months to settle into the new conditions.

Introduction

On the 25th of January 2021, a wildfire broke out in the Tūhaitara Forest Park, north of The Pines Beach town. The Park, which covers approximately 800ha of land along the coastline from the Waimakariri River mouth to the settlement at Waikuku Beach comprising many natural features of importance, was established as an outcome of the settlement between Te Runanga o Ngāi Tahu and the Crown with the lands being gifted to the people of New Zealand. Tūhaitara Coastal Park is comprised of complex functional habitats and biodiversity as a coastal wetland system with consistent restoration of habitat extent and quality over time.

Pines Beach is an area within the park which has experienced a fire disturbance event within the last 2 years. The fire has altered the form and function of the pre-existing habitat and the species, soil and water quality, and other such bio-geography values. However, such effects do not only fall upon bio-geographical values, but also on communities and people that surround affected areas. Opinions on the outcomes of the fire are varied among people. During the cleanup after the fire, the Waimakariri District Council engaged Laurie Forestry to complete the Coastal Harvest Programme in the area sooner than intended due to 2021 fire. As a result, a significant area of the shelter belt has been clear cut across the entirety of the wetland and half of the town Figure 1. In 2018-2019, similar blocks further inland were progressively harvested, which also occurred in Pines Beach, with the harvest of Block 8 occurring in 2018 behind Dunn's Avenue (HKB, 2018). Such blocks have been periodically planted and harvested on a cycle of 25-30 years and are on their second or third cycle (Waimakariri District Council, 2021).

Assessment of the complementarity or contrasting qualities of residents' environmental values can allow for more informed public consideration and education associated with the beneficence or disadvantages associated with fire disturbance within this specific case study. Because our brief for the assignment was to assess the effects on both ecological and community values, we decided to focus on the impacts of wind and salt spray on the wetland and the Pines Beach township. We also enabled community members to discuss any alternative ways that they have been affected by the loss of trees, and these will be considered in our discussion as well.

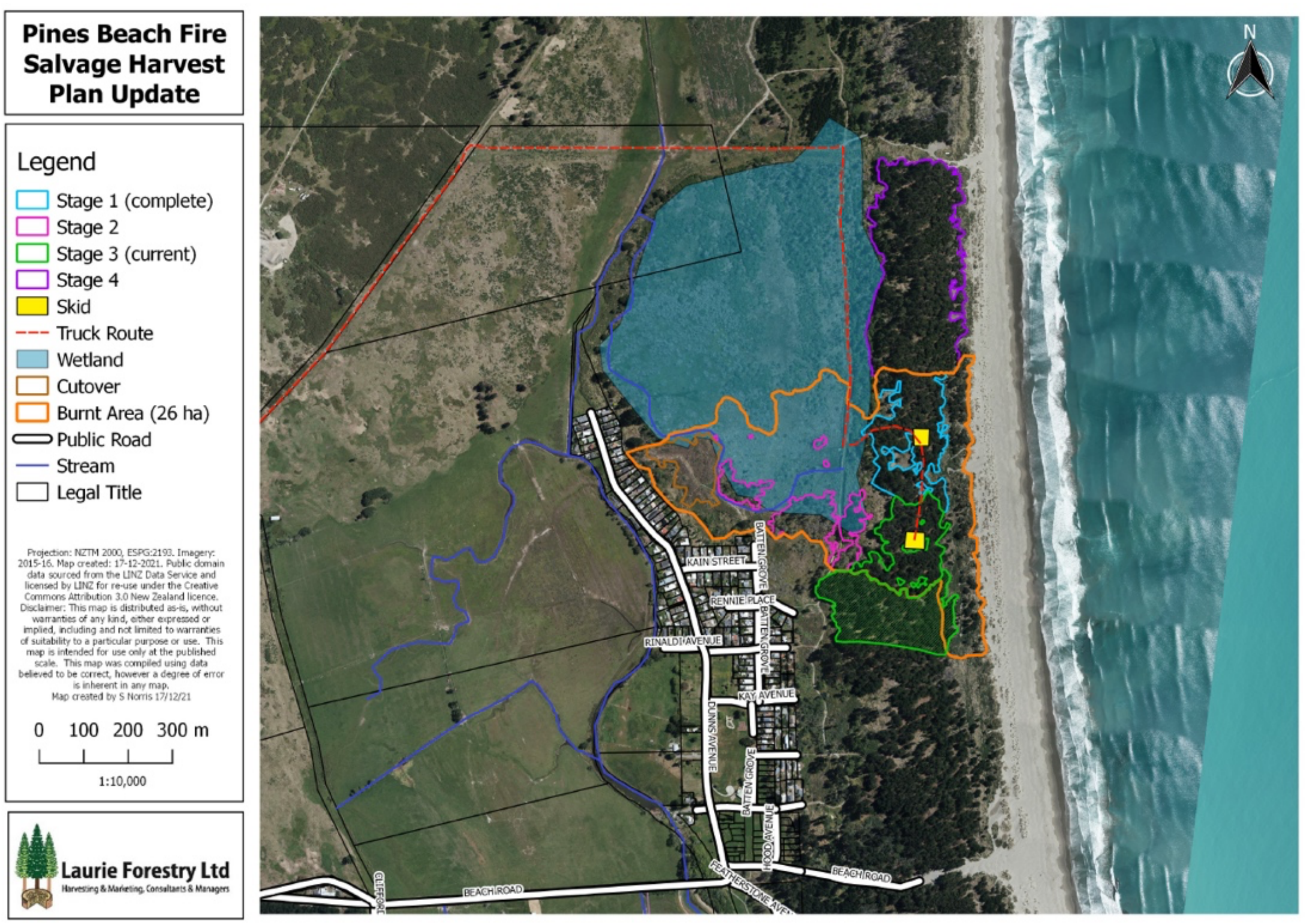

Figure 1: Pines Beach Fire Salvage Harvest Plan

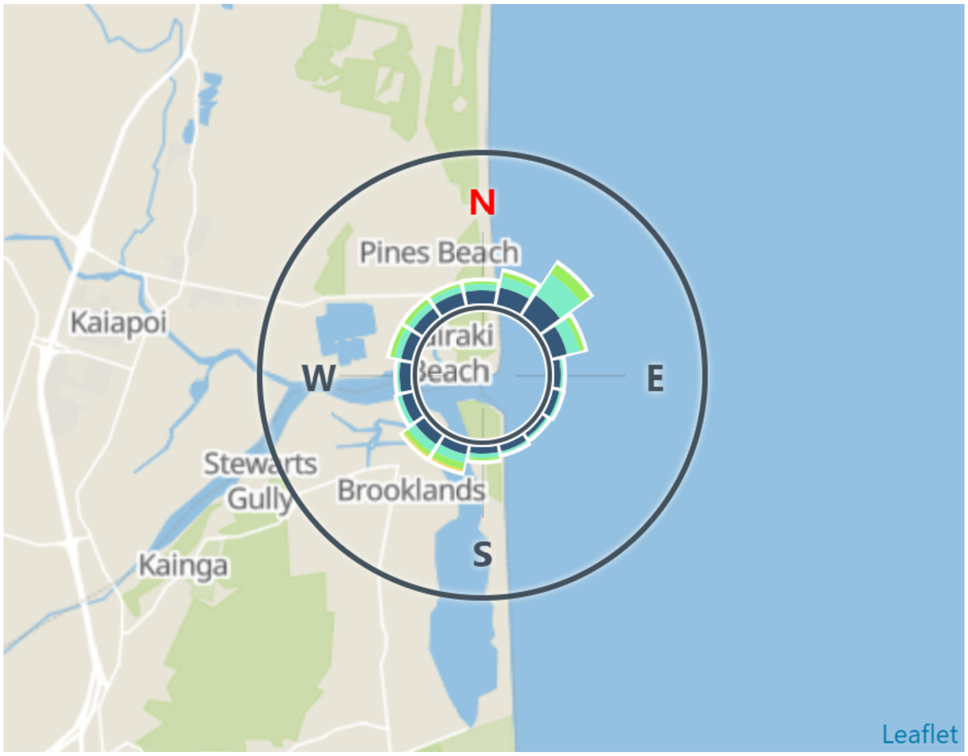

Figure 2: Wind rose showing frequency of each wind direction, with a North Easterly being the prevailing wind direction (Windy, n.d.).

Literature review

Wetland ecology and restoration

Wetland ecosystems provide services that support biota and contribute to community health/ wellness. Reduction in these ecosystems has become a great issue because of degradation and human activity (Clarkson et al. 2013). Wetlands are 'permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals adapted to wet conditions' as defined by Resource Management Act (1991). Wetlands provide important ecosystem services and are some of the most valuable and productive environments, increasing nutrients and biodiversity (Hansson et al. 2005). In 2013 wetlands only covered 1.5% of the Earth surface, however they provided a large quantity of Earth's ecological services which provide environmental, cultural, economic, and social benefits to the community. Wetlands are very important to Māori culture within New Zealand, they have provided the people a food source and materials for many years (Clarkson et al. 2013). With high biodiversity within these diverse environments, this may favor the system's ability to resist invasive species (Hansson et al. 2005).

New Zealand's substantial loss of wetland ecosystems and future damage and degradation is a result of invasive animals and plants, nutrient enrichment, drainage, and agricultural and urban development causing encroachment (Clarkson et al. 2013). Loss of wetland environments affects biodiversity of whole regions as they act as a refugia for many species with specific condition requirements such as exclusively aquatic or terrestrial (Hansson et al, 2005).

Salt spray and vegetation

The naturally distributed aerosol sea salt generally comes from sea spray being transported inland from coastal areas (Takle et al, 2006). Corrosion of assets, elevated water stress, salinization of soils in agriculture and plant growth inhibition is accelerated by the excessive salt found in coastal terrestrial environments. To reduce migration of sea salt inland, the introduction of vegetation in the coastal area plays a large role in capturing the salt aerosols and sea spray (Takle et al, 2006). Soil condition and local climate determines what species of trees would make a suitable shelterbelt in the environment. The coastal environment requires tree species that can withstand high salt concentrations, are tall with ridged branches, have strong roots and dense foliage which will all create a functioning shelter belt (Takle et al, 2006).

Environmental values and management

Our community partner, Te Kohaka o Tūhaitara, plays an important role in decision-making and the rehabilitation of the Coastal Park. It is therefore important to consider the emplaced values that communities hold with their local environment, and how this interacts with its management. Ecological restoration is two-part: it involves the utilization of objective scientific knowledge; however, the natural environment is inherently value-laden and has subjective meanings to those interacting with it (Egan et al., 2011).

The variety in values present regarding the natural environment means that some environments are more likely to be restored or protected than others as they are subjectively valued more highly. This is relevant to the local Pines Beach environment as the pine forest and the restored wetland are very different environments that are likely to be valued in different ways by residents. Fehnker et al. (2021) note that anthropocentric values are powerful motivators for people to mobilize in support of restoration, if it is believed that restoration will immediately benefit their interests and values. The frequency of time spent in nature and engaging with nature through various activities affects how people view their connection and relationship to nature, which is an ever-changing concept (Vining et al., 2008).

Research by Vining (1987) found that there was a greater association between negative emotions and the preservation of natural areas than for the development of the same areas. Because natural areas themselves evoke significant positive emotions in people, controversial decision-making surrounding their preservation evokes impassioned negative emotions. This supports the idea that management decisions must actively involve concerned parties to ensure that their values are recognized. When people are involved in decision-making in their local areas, their sense of place is strengthened as they share in the responsibility of managing their natural environment (van Marwijk et al., 2012). Of course, this consideration of individual values must be mediated with science-based recommendations as these values do not necessarily correspond to desirable ecological outcomes. However, regardless of scientific knowledge of how to best restore ecosystems, policy and management of the natural environment will not proceed smoothly without the integration of stakeholder values and their active participation in environmental decision-making.

Survey methods

The population we chose to survey was the entirety of the Pines Beach township of ~126 households, aiming to give every household the opportunity to participate in our research.

We decided that door-to-door surveying was the best method to understand how residents have been affected by the loss of pines. Initially, utilizing community Facebook groups was considered, as delivering a questionnaire through an online forum is cost-effective and efficient. An example of one such group is the "Pines and Kairaki Beaches Association Inc." Facebook page. However, after discussion with our community partner, it was determined that data collected through the Facebook group would not be sufficiently accurate. This is because there is no way to guarantee that residents affected by the loss of pine trees are active participants in online forums. Regardless, to provide choice and convenience, we chose to use the online survey platform Qualtrics, and put a scannable QR code to the online form of the survey on the information sheets we handed out.

Our team surveyed households in Pines Beach as one pair on a Sunday afternoon to ensure that as many people as possible would be at home to speak to personally. The houses we did not cover were surveyed the following Monday morning. We knocked on every 5th house's door, and left surveys in the mailbox of all others.

The survey itself had 11 questions for participants to answer. Closed-ended yes-or-no and Likert scale questions were used to gauge the degree to which participants agreed or disagreed with various statements concerning their connection with the environment and opinion on the loss of pines. Both closed-ended question types were followed by open-ended opportunities for participants to explain why they chose that answer. Utilizing open-ended questions allowed the opportunity for residents to comment on values and impacts that we have not yet considered, as done in Fehnker et al. (2021). On the online Qualtrics questionnaire, we included the option for respondents to indicate the general area of their residence to gauge bias depending on location, and to determine if our responses are representative of the whole Pines area.

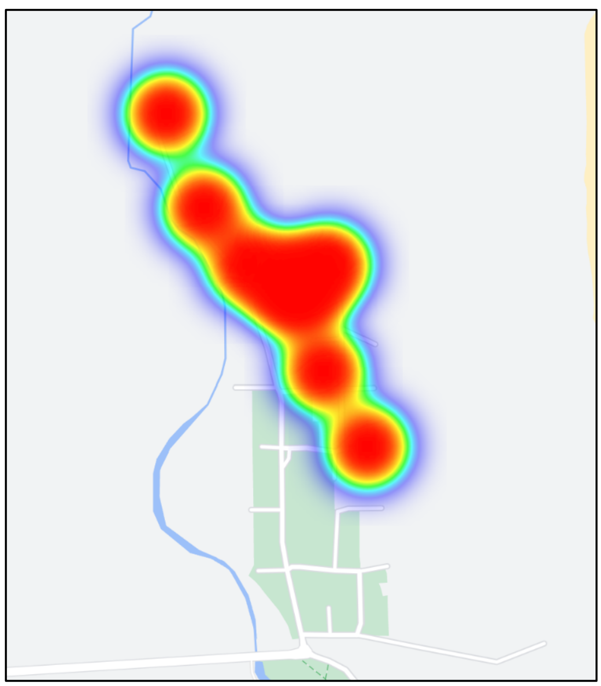

Figure 3: Heat map indicating the locations of 8 respondents from Qualtrics responses.

120 surveys were delivered to households around Pines Beach, and 39 responses were received up to 2 months after their delivery and the cut-off date for response consideration. 10 responses were received through the online Qualtrics site, and 29 were received through the post, using the return envelope we supplied. This results in a 33% response rate from the surveys delivered.

The respondents' average length of residence at The Pines Beach was 19 years. Answers specifying months were rounded to the nearest year, and answers with the format "35+ years" were counted as the minimum length of time, i.e., 35 years. 8 respondents elected to indicate their location of residence, seen above in Figure 3. Although we did not record the location of postal respondents, this data provides confidence in the spatial representativeness of our responses.

Table 1 & 2: Responses to "Please indicate how strongly you agree or disagree with the following statements:"

"I feel connected to the natural environment of Pines Beach."

Opinion	Count	Percentage
Strongly agree	33	85%
Slightly agree	5	13%
Neutral/DNA	0	0%
Slightly disagree	0	0%
Strongly disagree	1	3%
Total	39	

"The natural environment at Pines Beach is a key factor in my decision to live here."

Opinion	Count	Percentage
Strongly agree	34	87%
Slightly agree	2	5%
Neutral/DNA	3	8%
Slightly disagree	0	0
Strongly disagree	0	0
Total	39	

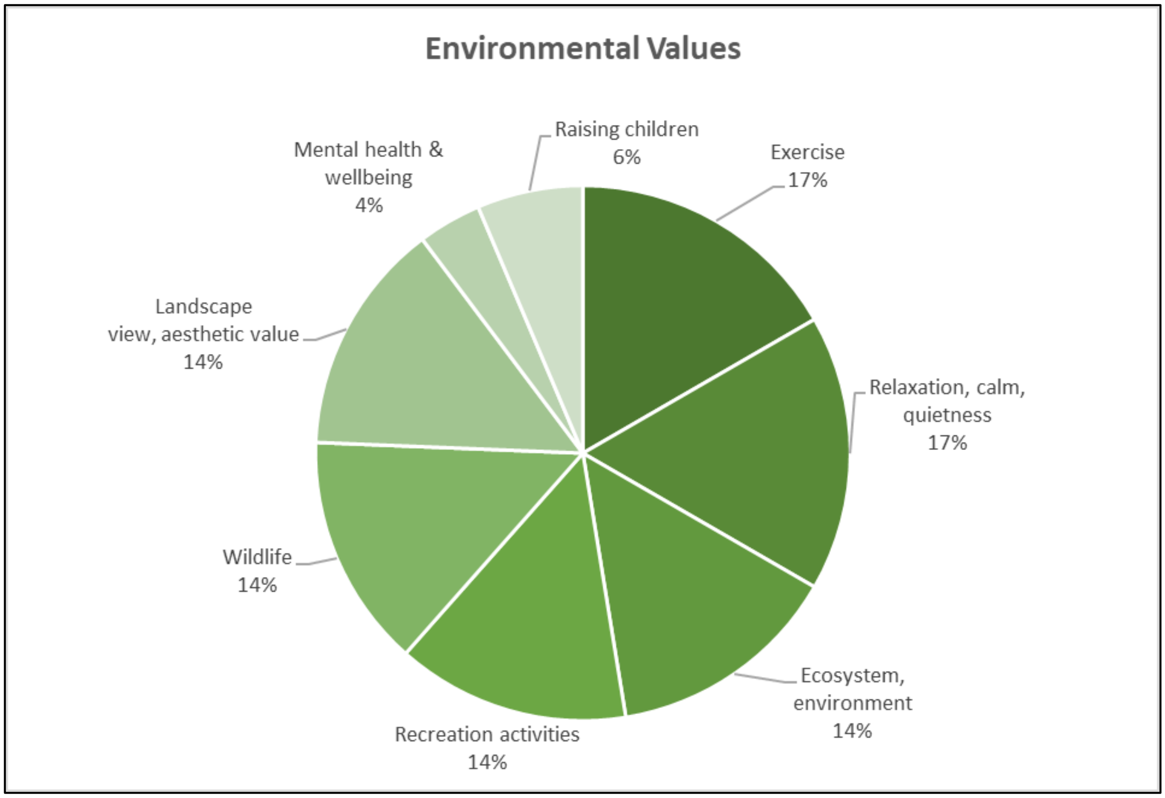

Figure 4: Pie chart showing various ways in which respondents feel connected to or place value on the Pines Beach environment. Slices of chart represent the relative frequency of each theme out of all comments centered around the environment (n=78 comments).

Table 3 & 4: Responses to "Has the loss of pine trees affected you at your place of residence through: Wind? Salt Spray?"

Wind at place of residence

Affected?	Count	Percentage
Yes	32	82%
No	7	18%
Total	39	

Salt at place of residence

Affected?	Count	Percentage
Yes	14	36%
No	20	51%
Unsure/DNA	5	13%
Total	39	

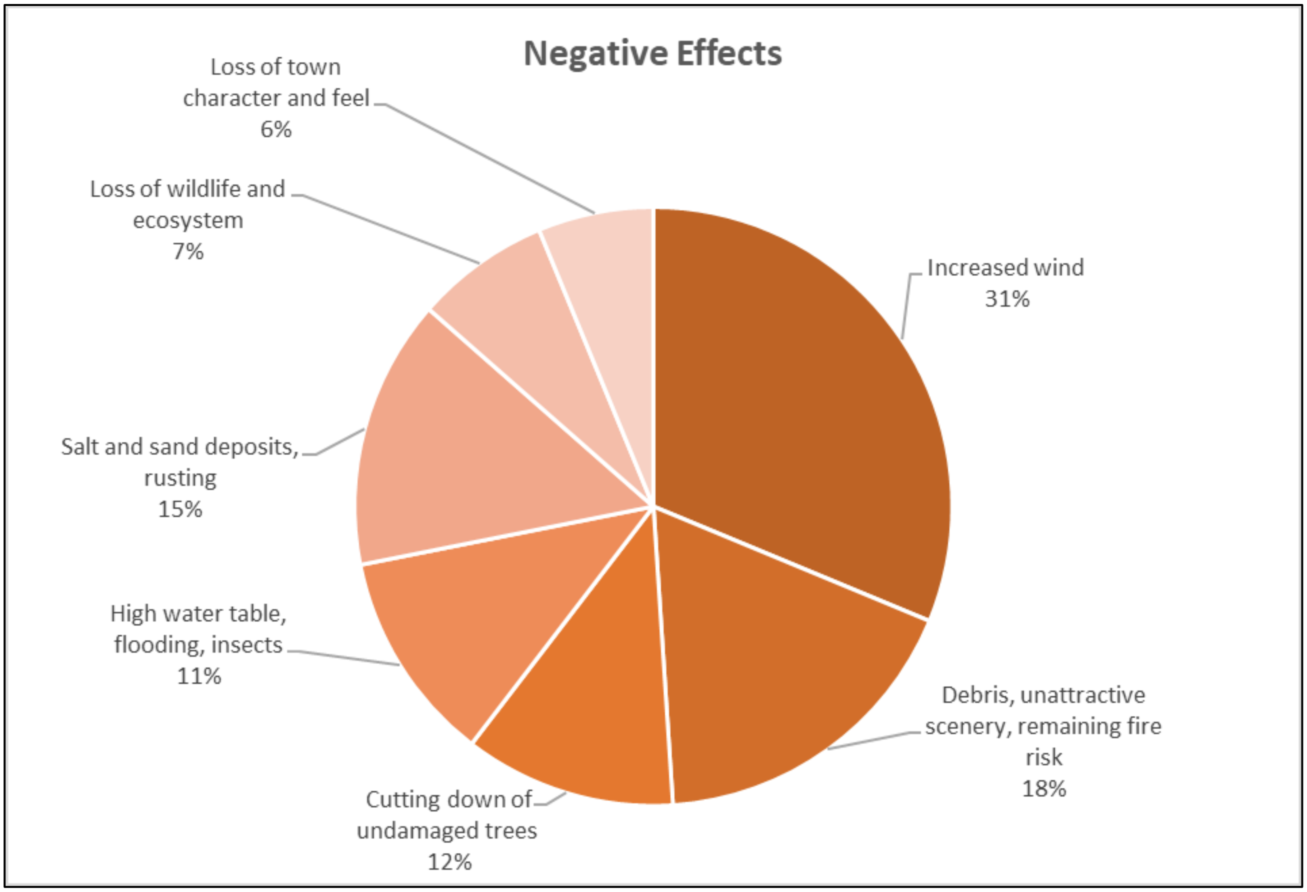

Figure 5: Pie chart showing themes of negative effects of the loss of pines identified by residents. Slices of chart represent the relative frequency of each theme out of all comments on negative effects (n=96 comments).

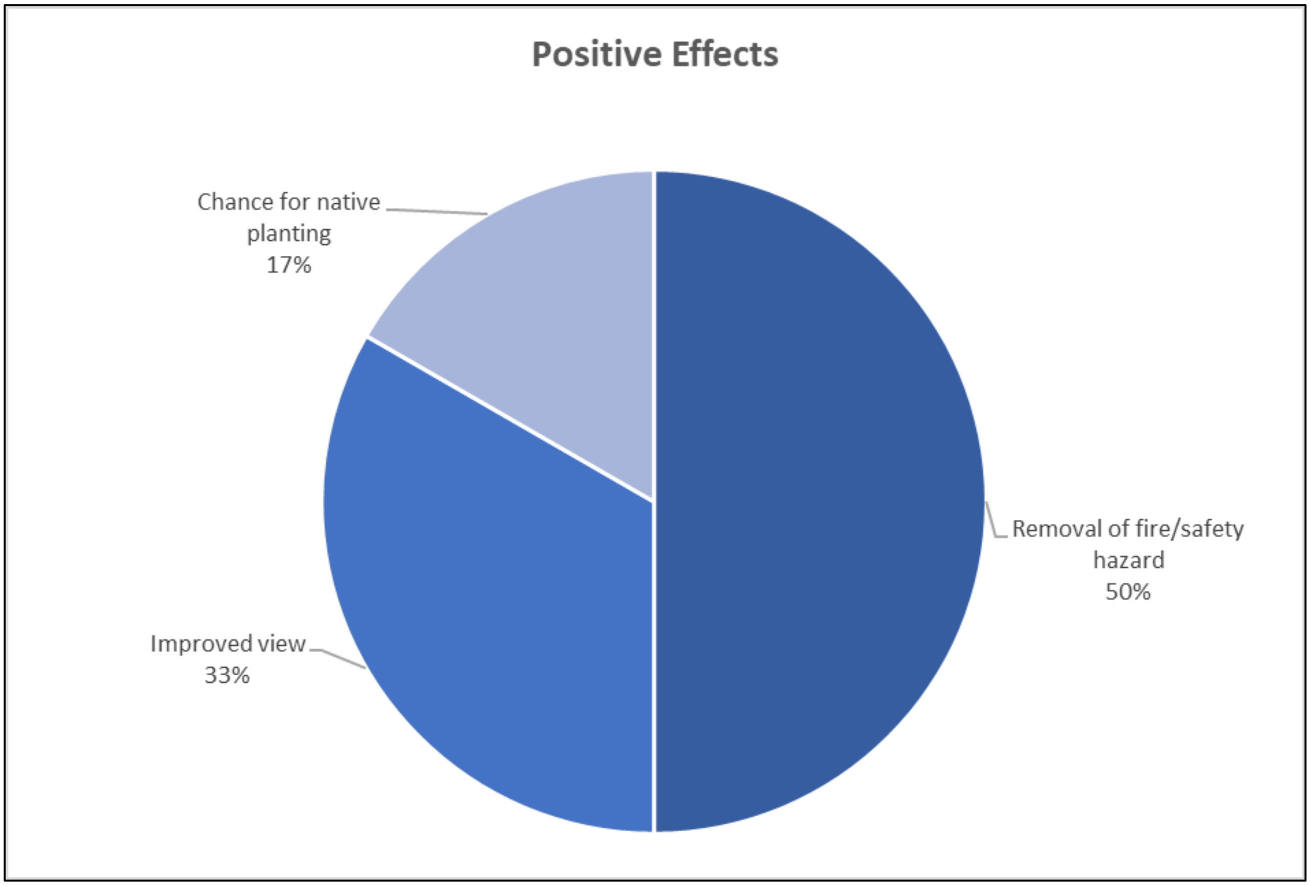

Figure 6: Pie chart showing themes of positive effects of the loss of pines identified by residents. Slices of chart represent the relative frequency of each theme out of all comments on positive effects (n=6 comments).

Table 5: Responses to "Do you think that the absence of the pine trees as a result of the fire is, overall, positive or negative?"

Opinion	Count	Percentage
Negative	24	62%
Slightly negative	2	5%
Neutral	5	13%
Slightly positive	2	5%
Positive	4	10%
DNA	2	5%
Total	39	

Table 6: Responses to "Do you feel that the gap in the pine tree shelter belt should be restored?"

Opinion	Count	Percentage
Yes	34	87%
No	1	3%
DNA/Unsure	2	5%
Total	39	

Table 7: Responses to "Do you feel that you are sufficiently involved and considered in management and decision-making regarding the Tūhaitara Forest Park?"

Opinion	Count	Percentage
Yes	6	15%
No	30	77%
DNA/Unsure	3	8%
Total	39	

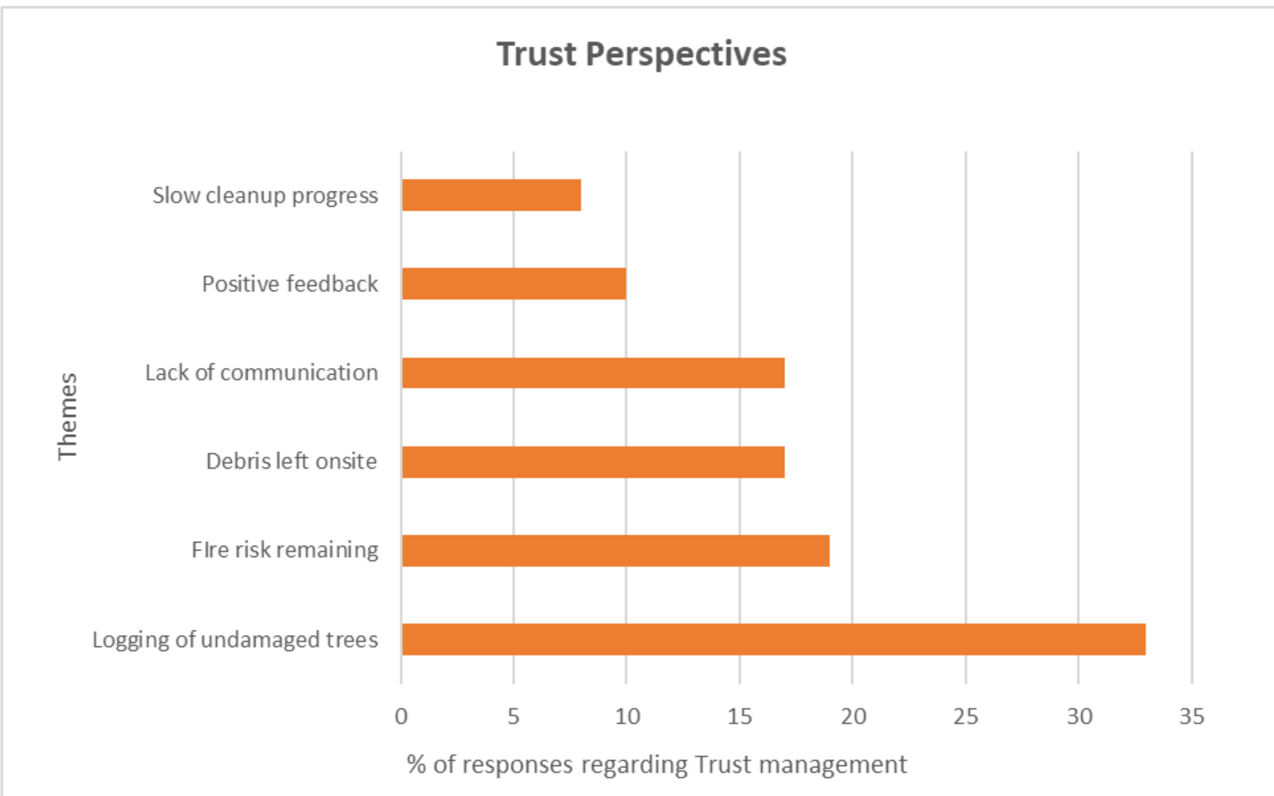

Figure 7: Bar chart showing the themes of comments surrounding Te Kohaka o Tūhaitara, or the general management of the Forest Park area concerning the fire. The bars represent the proportion of each theme out of all comments regarding management.

Table 8: Responses to "Would you like more input into environmental decision-making in your local area?"

Opinion	Count	Percentage
Yes	33	85%
No	2	5%
DNA/Unsure	4	10%
Total	39	

Results

Environmental values

Tables 1 and 2 show the degree of connection respondents feel to their environment, and how much this impacts their decision to live at Pines Beach. 85% of respondents strongly agree that they feel connected to the natural environment, and 13% slightly agree. Only one respondent strongly disagreed, and this is because due to the fire and loss of pines, she now felt disconnected. 87% of respondents strongly agreed that the natural environment was a key factor in their decision to live in Pines Beach. No respondents disagreed with this statement. Figure 4 shows the main identifiable themes and ways in which respondents feel connected. These themes were gleaned from all open-ended questions asked in the survey, as respondents tended to make value-based comments in a variety of sections. The dominant environmental values held by respondents are the use of the environment for exercise (17%), and the quality of calm and relaxation present in the natural environment (17%). The naturalness of the environment, recreation such as fishing and swimming, wildlife, and aesthetic value also featured frequently (14% each).

Effects

Tables 3 and 4 focus on the main effects in our hypothesis of wind and salt spray. 82% of respondents are affected by wind at their place of residence. 36% are affected by salt spray. The most significant negative effects beyond our research focus are remaining debris onsite (18%), the cutting down of undamaged trees (12%), and the heightened water table (11%) (Figure 5. Some positive effects were noted by residents, with 3 comments relating to reduced fire hazard, 2 concerning the improved view, and 1 respondent commenting on the chance for native planting on the site (Figure 6).

Regarding the overall impact of the loss of pines, 62% of respondents perceived the effect to be negative (Table 5). 13% considered the event to be neutral, and 15% considered the loss to be slightly positive or positive. Table 6 shows that 87% of respondents would want to see the shelter belt restored.

Trust perspectives

We asked only two questions regarding environmental management, shown in Tables 7 and 8. 77% of participants do not feel sufficiently considered in the management of their local area, and 85% would like more input and consideration than they have presently. Although these are closed-ended yes-and-no questions, almost every respondent commented on the decision-making around both the cutting down of the pines after the fire, and many mentioned the Trust directly. These comments were most often incorporated into other open questions above. Comments relating to the Trust, or the management of the Forest Park were categorized into major themes, shown in Figure 7. By far the most significant comment regarding management of the area is the logging of trees that were not damaged by the fire through the forestry program (33%). However, it is important to note that almost all respondents did not appear to be aware that this logging occurred due to a planned forestry harvest being brought forward, which is significant.

Discussion

Overall, the results from our work were able to find clearly display. One of the key areas in which we tried to outline the community's perspectives was through how they deemed themselves connected to the environment. Now environmental values are not about how one sees the environment around them but rather how they see themselves as part of the environment (Dutcher, 2007). However, these limited questions are not able to decipher people true opinions on whether they see themselves as a part of the environment around them, or rather they see it as a material commodity. However, our work was able to grant a better understanding of activities and aspects that the community particularly enjoyed. This shows a level of understanding and enjoyment for the world around them but could be linked to 'surface ethics' which if a phrase coined by Wilson (Wilson, 1984) showing a form of human's general survival instincts and a rather marital understanding and thoughts towards the environment. This is shown by people key environmental values being activities and other self-pleasing activities. This is then backed up by the largest number of concerns that were out of the original scope being based upon the 'beauty' of the land and how it now looks today. However, inside our research scope many respondents did agree with the statement that they have noticed an increase in the amount of wind and salt spray that had been hitting their homes giving us clear reasoning to undertake the next step of

On the community's perspectives on the Trust and overall management of the area. There was a large amount of angst towards the management directions, However, this is a good example of response bias. As there was only a 33% response rate, most respondents are people with strong opinions on the issues that are taking place in the area around them. Following on from that the largest concern from the community was to do with the removal of healthy trees from the working pine forest. This shows a breakdown in communication and understanding of what the land around the community is for, who is running it and the general direction that the area is headed. There needs to be an improved avenue for communication between the community and the trust/council. This could be done through more open meeting or improved signage about ownership, or easily accessible documentation of District Plans and projects being undertaken in the land.

data collection Methods

Data collection Wind

Taking understanding from previous studies (Applying porous trees as a windbreak to lower desert dust concentration: Case study of an urban community in Dubai), the decision was made that the best approach to understanding the velocity of wind movement would be to take point measurements of the wind speed. Using a handheld weather station, at a height of 1.8m, a wind period of five minutes was measured, with data being recorded at each minute interval. This process was then repeated at each location shown below in Figure 8*.* In the figure it is possible to see that a total of eight points that were used to collect data from, this resulted from the desire to understand the differences in wind velocity between the open clearing and the area sheltered by the pine trees. We were able to repeat this process two sperate times on two different days.

Data collection Connectivity

Testing connectivity turned into a challenge compared to the wind measurements. For this process it was harder to find spots with even spacing from the coast, this was the case in both the sheltered and the unsheltered area. Of particular concern in the sheltered area, due to the drainage enabled by the porous sandy soils and presence of the pine trees to aid in the removal of water, the choice in water bodies amongst the sheltered area is rather limited. This meant the locations we choose, shown in Figure 9 in orange, were restricted along the narrow corridor in which the trees run.

Similarly, to the Wind testing, For the connectivity testing a total of six locations being chosen half sheltered and the remaining being unsheltered. One other location was used as a base line measurement, this was taken in the ocean to take the measurement of sea water. Another spot should have been used to test freshwater connectivity reading however this was overlooked.

With the data collected from all the points, it became a matter of comparing the relationship between all the points. To do this we used a direct comparison of each points locations through the general average collected from the locations. For the wind data the direct comparison was rather easy as each point has a paired location that was in the other environment. This enabled an easy comparison on the average. This information is displayed in Figure 10 and 11. Through the use of a line graph. A similar method was used to compare the result of the connectivity test, However, the point in the connectivity test are less of a paired analysis and follow more of a clustered distribution as only accessible locations where chosen.

Figure 8: Google earth image indicating wind location sites

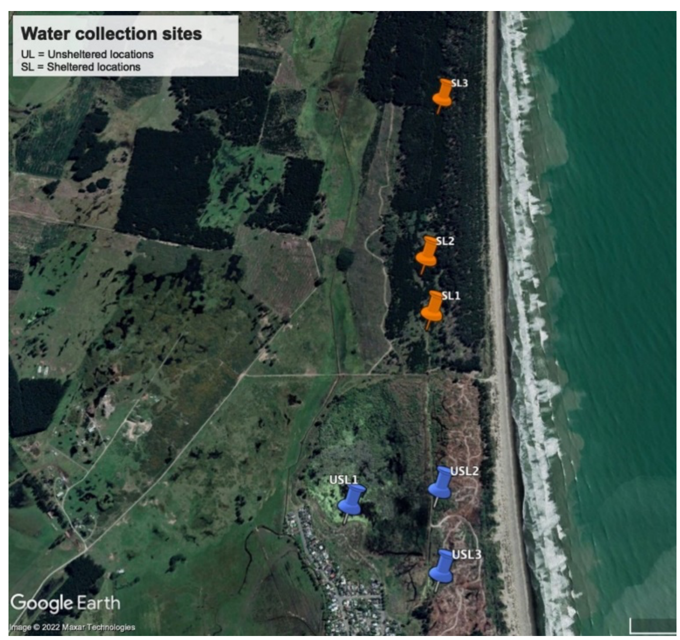

Figure 9: Google earth image indicating water location sites

Results

Wind measurements

Figure 10 shows the average wind speeds around the Pines Beach wetland on the 14th September. The unsheltered areas are represented by the blue line and the sheltered areas are represented by the orange line. Location one (SL1 and UL1, figure 8) show average wind speeds that are similar, 1.92m/s and 2.04m/s. Location two shows the biggest difference with 1.38m/s between the averages for SL2 and UL2 (figure 8), with unsheltered having higher windspeeds. Location three shows that on average unsheltered areas have higher wind speeds. Although, most surprising was location four, where sheltered locations have slightly higher wind speeds on average than unsheltered areas. The prevailing wind direction during this data collection was a south westerly, these wind conditions can be described as not optimal as this is not a sea breeze which is the main concern within the area. This indicates why at location four the sheltered area is displaying higher readings as, like we hypothesized, the pine trees are unable to act as a shelter belt.

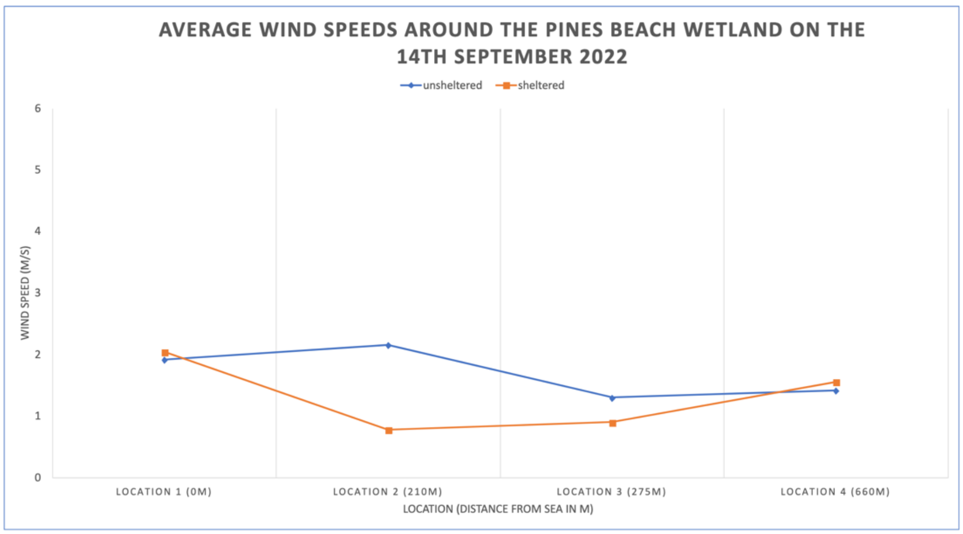

Figure 10: Line graph indicating average wind speeds around the Pines Beach Wetland on the 14th September 2022

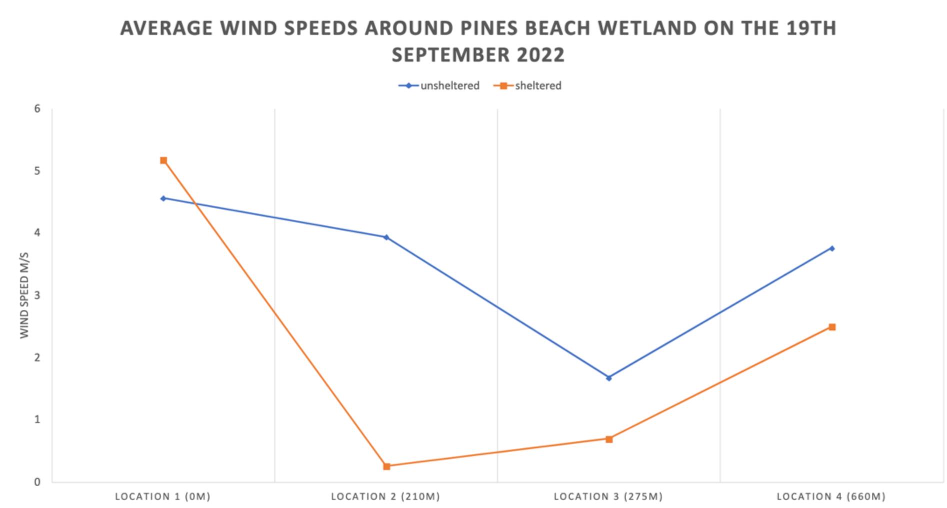

Figure 11: Line graph indicating average wind speeds around the Pines Beach Wetland on the 19th September 2022

A second set of wind data was collected on the 19th September (figure 11). On this day the predominant wind direction was a north easterly, this produces the sea breeze that was hypothesized to disturb the residents of Pines Beach after the 2021 fire. Like previously, location one (SL1 and UL1, figure 8) is similar. These measurements are a lot higher than previously; this is a direct result of the change in wind direction from the previous day. Location two showed the largest gap with an average of 0.26m/s for the sheltered area and 3.94m/s for the unsheltered area. Location three and four both presented lower wind speeds in sheltered areas with around a 1m/s difference between the sheltered and unsheltered areas.

Electrical conductivity measurements

It was expected that increased wind speeds, or areas that are more vulnerable to wind, like the wetland would experience higher salinity levels. Results for the unsheltered water bodies (wetland) are shown as averages in figure 12. Location one (USL1, figure 9) has an average water conductivity of 871.4 µS/cm. Location two (USL2, figure 9) **has** an average water conductivity of 968.4 µS/cm, and location three (USL3, figure 9) has an average water conductivity of 1669.2 µS/cm. Land Air and Water Aotearoa states that values greater than 500 µS/cm indicate concentrations high enough to affect the taste of water (LAWA, 2022). This emphasizes that salinity levels are quite high within the wetland, particularly because it is a freshwater wetland.

Figure 13 shows the averages for water conductivity in isolated locations within pine trees (the sheltered locations). Location one is showing similar values to those of unsheltered locations, after analysis this has been put down to its connectivity to the neighbouring wetland. Identified by SL1 in figure 9 the measurements were taken from a stream that feeds into the wetland and is suggested that the average reading of 1265.8 µS/cm is this high because of the same circumstances as in the wetland. Location two and three (SL2 & SL3, figure 9) are more representative of freshwater systems. Both are biota nodes located within pine trees. However, the average readings of these locations (272.8 µS/cm and 243.6 µS/cm) are still considered high by LAWAs standards.

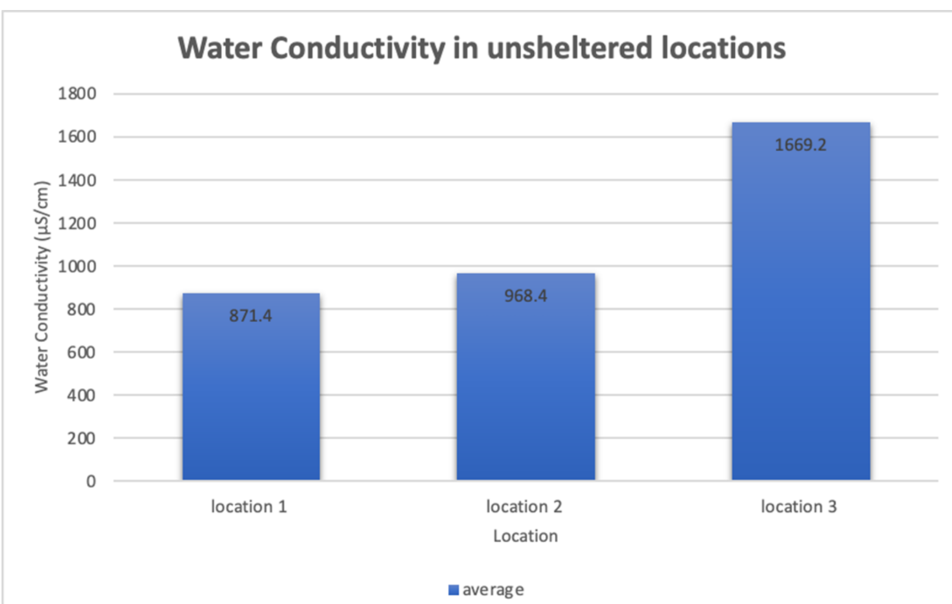

Figure 12: average water conductivity measurements for unsheltered locations

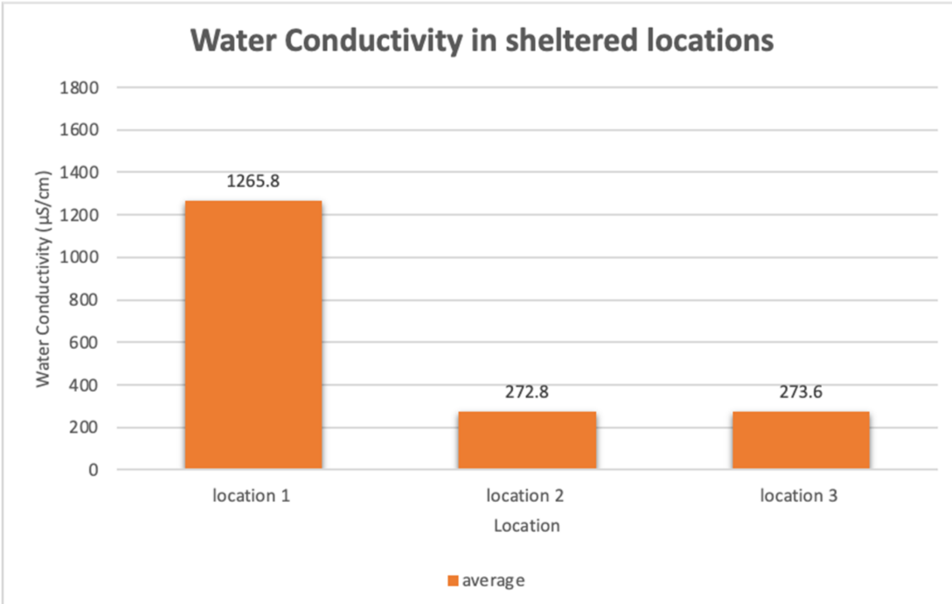

Figure 13: average water conductivity measurements for sheltered locations

Discussion

Coastal wetlands and salinity

The Pines Beach is a vulnerable ecosystem that has the challenge of integrating indigenous and exotic fauna. Having a wetland in close proximity to the ocean makes managing these areas even more challenging, particularly as climate change is estimated to worsen the exposure of many coastal regions (Noor & Abdul Maulud, 2022). The trusts 200-year plan aims to rehabilitate the coastal park, in which Pines Beach Wetland is located, back to an indigenous ecosystem that supports a diverse range of native flora and fauna (Te Kōhaka o Tūhaitara Trust, n.d). Although, the data collected projects that the loss of the pine trees negatively affects the environment. A difference between freshwater ecosystems has been identified. Higher electrical conductivity averages were obtained from within the wetland which we identified as an unsheltered area. Land, air, water Aotearoa (LAWA) identifies groundwater near the coast will be more saline due to salt spray, so the elevated levels seen within our data is not unexpected. However, it can be concluded that the pine shelter belt minimises the effects of salt spray on freshwater ecosystems.

Enhancing wetland health with native plantings is one of the initiatives the trust has implemented. Replanting of the pine is not within the scope of the trust, as they aim to conserve and rehabilitate indigenous ecosystems. Regarding wetland health, planting indigenous vegetation is in the best interest of the area, as pine forests draw water away from ground water systems leaving depleted supplies (Department of Conservation, n.d.). however, this will not help mitigate the increased sea spray from the loss of pines.

Wind

Increased wind within the area does not pose a huge environmental impact on the wetland. This was mainly hypothesized as a social issue, causing a disturbance to residents living within the area. The houses within the area are more exposed to wind particularly sea breezes (NW and NE), but data collected shows that the pines created a sheltering effect regardless of the wind direction.

Limitations

For the residents' survey, although we had an excellent response rate of 33%, this could have been improved by giving a longer period for residents to respond, and by sending out reminders after the delivery of the surveys. Additionally, on the second day delivering surveys, we ran out of information sheets and due to time constraints, could not return at a later date, and so around 10 households were not canvassed (Monks Parade and Chichester Street).

The online survey site Qualtrics has a heat map feature that allowed us to examine how representative our returned surveys were of the wider community. Given the chance to repeat this research, we would have expanded this to the postal surveys to get more of an understanding of which areas may notice effects more than others.

The biggest limitation to this project was time. Our project was limited to 12 weeks from start to completion, which made our data collection period very short. To understand more about the wind patterns, more repetition of measurements would have been required. Wind measurements were also subjected to seasonality, measurements were taken in September, within the season spring, typically referred to as the windiest season (Hessell, 1988). Our data does not account for this variation. Salinity measurements had the same limitations as wind. Repetition of events would create more sound data to determine whether there is a constant difference in salinity levels The biggest limitation is that it can only be assumed that due to the loss of pine, more wind is bringing sea salt aerosols into the wetland, but this is not necessarily the case. To determine these measurements would need to be taken of a long period of time, to see if there is a salinity increase.

Sampling methods within this project were limited to convenience sampling. Dense vegetation made some areas hard to access, specifically in the wetland we could only sample areas that we could reach. For electrical conductivity testing in sheltered areas, we were limited to small water bodies that were spread out, hence convenience sampling.

Conclusions

Through communication with the community and the collection of field data we can conclude that there has been increased wind within the Pines Beach wetland and community since the fire and removal of the pine shelter belt, with most residents stating that they have been affected by wind. The wind and water field data supports the residents' statements as the data collected indicates a difference in wind speed and salinity in unsheltered areas. Our surveys provided insight into how community values are affected by the mismatch in communication between the community, the Trust and the District Council. To evaluate the ecological effects, further testing would be required and therefore more time to explore the issue further.

Acknowledgements

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