What are the main indicators of forest health in Riccarton Bush and how can they be assessed and monitored?

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Future work could include the development of an index specific to Riccarton Bush, to provide a long-

-year-old remnant

kahikatea forest located

(Janssen, 2006). The protection of these indigenous forests is important, not only for their environmental value, but also their cultural, spiritual, and social importance for New Zealanders.

Our group was asked by the Riccarton Bush Trust to investigate methods of measuring bush health

existing kahikatea forest research was unable to be directly applied to the site, therefore, interpretation and adaptation of research was required. We aimed to explore the topic with romote the natural and cultural

heritage values

vertices of the track and was recorded as a line shapefile. Due to public foot traffic, the instrument was placed on the right-hand side of the track and angled to be directly above the edge of the foot path, as viewed in Figure 3. To ensure consistency this method was conducted at every vertex point. Lastly, the track features were captured as a point shapefile, and was separated into different feature classes. Measurements were conducted by placing the GEO7X either above or in front of each feature, as observed in Figure 3.

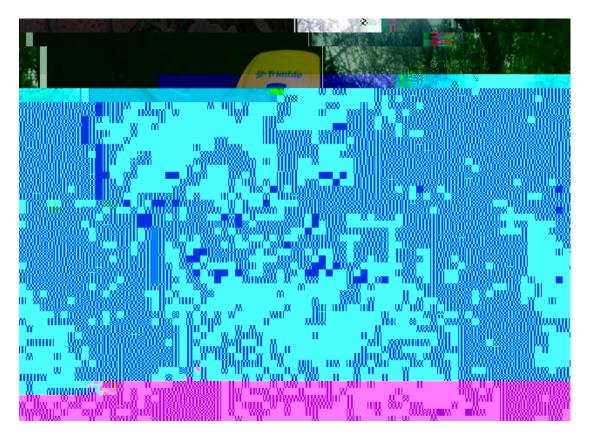


Figure 3. Trimble GEO 7X being used to collect track features (left) and the track (right)

In all instances, the instrument remained stationary for at least 2 minutes until accuracy fell below 1m. However, accuracy diminished within some sections of the bush due to the poor satellite signal beneath the forest canopy. Subsequently, when accuracy did not fall below 1m, the instrument was left for a maximum of 5 minutes to reduce the accuracy error. Once the data points were collected, the data was converted into a shapefile in the WSG 1984 projection format using ArcMap. The predator fence perimeter was compared against satellite imagery and corrected accordingly (Figure 4).

photographs of the track at each location, like the right hand-side figure 3.

Figure 4: Showing GNSS error data of the perimeter fence compared against the satellite corrected perimeter fence

The implementation of two secondary sources of data were included into the final base map. The first was from Molloy (1995) which were soil and vegetation type maps. They were digitised, manually georeferenced, then traced to create shapefiles within ArcMap. The second was sourced from Perma

biodiversity and population changes over time (Canterbury et al., 2000). Healthy bird and insect numbers can indicate biodiversity and structural complexity in a forest. The diets of many NZ native kahikatea forest, and variation in

their numbers can be used to indicate the healthy seeding and fruiting processes of kahikatea trees. Conversely, high numbers of pests like rats, stoats, and possums, which often prey on birds, bird eggs and eat native plants, can indicate a decline in forest health. Assessment of soil and water includes nutrient levels and contamination, soil moisture and water table levels. These are heavily interrelated and hugely important for vegetation growth. Pollution and excess nutrient levels in water can leach into soil and have detrimental effects on plants themselves, and overall soil quality. Poor quality soil can have low soil organic matter, compaction, poor structure04 Tf1 0 0 1 347.59 658.78 Tm0 g0 G()[TJETG0.0000887

 Table 2: Two sample t-test assuming unequal variances for the incoming shortwave (SW) data between the damp & dry weather station sites.

| | Damp Site | Dry Site |
|---------|-----------|----------|
| Mean | 19.78 | 4.51 |
| p-value | 1.71E-52 | |
| t-stat | 15.68 | |

Figure 5

Table 3: Two sample t-test assuming unequal variances for the wind speed upper data between the damp & dry weather station sites.

| | Damp Site | Dry Site |
|---------|-----------|----------|
| Mean | 0.16 | 0.33 |
| p-value | 6.54E-36 | |

Table 4: Two sample t-test assuming unequal variances for the soil temperature data between the damp & dry weather station sites.

| | Damp Site | Dry Site |
|---|-----------|----------|
| l | | |

Mean

Table 5: Two sample t-tests assuming unequal variances for the air temperature data between the damp & dry weather station sites.

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Damp Site

Dry Site

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Appendix A

Table 6: Two sample t-test assuming unequal variances for the incoming shortwave (SW) data between the damp & dry weather station sites.

| | Damp Site | Dry Site |
|--------------|-----------|----------|
| Mean | 19.78 | 4.51 |
| Variance | 1456.11 | 42.98 |
| Observations | 1660 | 593 |
| Df | 1908 | · · |

| t Stat | -13.18 | |
|---------------------|----------|--|
| P(T<=t) one-tail | 6.54E-36 | |
| t Critical one-tail | 1.65 | |
| P(T<=t) two-tail | 1.31E-35 | |
| t Critical two-tail | 1.96 | |

Table 8: Two sample t-test assuming unequal variances for the soil temperature data between the damp & dry weather station sites.

| | Damp Site | Dry Site |
|------------------|-----------|----------|
| Mean | 9.19 | 9.04 |
| Variance | 1.08 | 0.91 |
| Observations | 1638 | 583 |
| Df | 1109 | |
| t Stat | 3.33 | |
| P(T<=t) one-tail | 0.00045 | |

Table 9: Two sample t-test assuming unequal variances for the air temperature data between the damp & dry weather station sites.

| | Damp Site | Dry Site |
|---------------------|-----------|----------|
| Mean | 7.32 | 6.38 |
| Variance | 14.92 | 13.89 |
| Observations | 1660 | 593 |
| Df | 1077 | |
| t Stat | 5.20 | |
| P(T<=t) one-tail | 1.22E-07 | |
| t Critical one-tail | 1.65 | |
| P(T<=t) two-tail | 2.45E-07 | |
| t Critical two-tail | 1.96 | |

Appendix B

Figure 12: Map of Riccarton Bush, showcasing the tree species and location layer, sourced from Permanent Forests NZ LTD (2017). The original