This work forms part of a wider project led by the Department of Conservation (DOC), who are interested in the potential application of aerial drones for the continued monitoring and management of important conservation areas around New Zealand. Dune systems have been highlighted as being of good potential for the testing of this technology as dune systems are typically relatively smaller than other conservation areas, have a simple topography and exhibit clear zonation in vegetation.

In particular, DOC are interested in the potential for aerial drone survey data to provide such information as: up-to-date vegetation classifications for the identification and monitoring of important species, the detection of non-target species impacts from spraying operation, and the characterisation of species' habitats within the dune system. This work focuses solely on two important coastal dune systems; Kaitorete Spit, a large barrier beach system which lies south of Banks' Peninsula in Canterbury, South Island, and Ocean Beach, an important dune system within the protective boundaries of the Cape Sanctuary near Cape Kidnappers in the Hawke's Bay of the North Island. Both areas are important both ecologically and culturally, yet both are also at risk from anthropogenic activity, namely on-going agricultural and recreational activities in the area.

My thesis and the work it entails have two main objectives:

1. Vegetation monitoring: Can aerial RGB and NIR imagery captured by drones be used as a reliable, low-cost monitoring and surveillance tool in coastal dune ecosystems?
2. Katipo habitat modelling: Can katipo occurrence and katipo habitat assessment in coastal dune ecosystems be made using aerial drone imagery?

The field work at both Ocean Beach and Kaitorete Spit has for all intents and purposes been completed. From these studies we now have two independent datasets detailing the vegetation communities across the dune systems as well as the habitat characteristics from a sample of the resident katipo populations at the two sites. Ocean Beach and Kaitorete Spit are very different in their ecology; Ocean Beach is a well-protected area with a dynamic physical and living environment, whereas Kaitorete Spit is by comparison very exposed to the elements with a low rolling dune

systems characterised by a large pingao population and a mix of native and non-native species that is heavily influenced by the near-by agricultural operations.

Based on the presence/absence data collected for katipo at Kaitorete Spit, habitat characterisation analysis has been carried out using the statistical program, R. Katipo habitat modelling based on katipo presence alone will be built into logistic regressing models using true presence variables and imagery-derived absence variables. Using the above processes, the ability to predict katipo presence using the imagery can be assessed. Vegetation analysis is currently underway using the statistical analysis program PC-ORD to differentiate different vegetation communities based on the data collected prior to myself beginning the project. The desired output of this process will be dendrogram and ordination diagrams showing the dominant vegetation communities, which can be used as a base reference for comparison with similar outputs based on vegetation data generated from imagery analysis.

The imagery for this project has been an on-going issue. At this point in time there exists enough imagery data to complete a complete analysis on both Kaitorete Spit and Ocean Beach; however, a comprehensive analysis of changes over time at both sites is not possible. This is due to an incomplete coverage in the point-cloud (elevation data) and NIR (Near Infra-Red) data for both sites. There still remains a considerable amount of image processing involved in the project before more in-depth analysis can be conducted. For the most part, this has arisen due to the quality issues with the imagery and associated data that was delivered by the drone company. It seems that with each progressive step I uncover more underlying issues with the data. Most issues are either from the lack of ground-control points used during image acquisition or the fact that the NIR and RGB (Red-Green-Blue, i.e. same spectrum as visible light) data was collected via two different sensors. Put simply, at the finer scale of the images, nothing lines up, nor is anything the right spot. This is fine for people who may want a series of visually accurate images, however it is rather less suitable for those who need the data to be highly accurate in a geospatial sense. At the moment I am endeavouring on with the geo-processing of the imagery and associated data, including refining the ground reference data and classification outputs. This is in order to get the accuracy of any image classifications to an

acceptable level so that the outputs of which can be confidently compared to the field data. Using the drones we were able to map the areas in 3-dimensional space. This information, when combined with other types of data will enable a much greater level of analysis of how the living parts of the environment may be affected by changes in the physical structure of the dunes. This sort of information is relatively new in small scale studies such as these, and requires a high level of detail and accuracy. This project is admittedly taking a little longer than expected, however at every turn a new opportunity to learn presents itself, regardless of any hurdles I encounter.

Figure 1 At work among the pingao at Kaitorete Spit

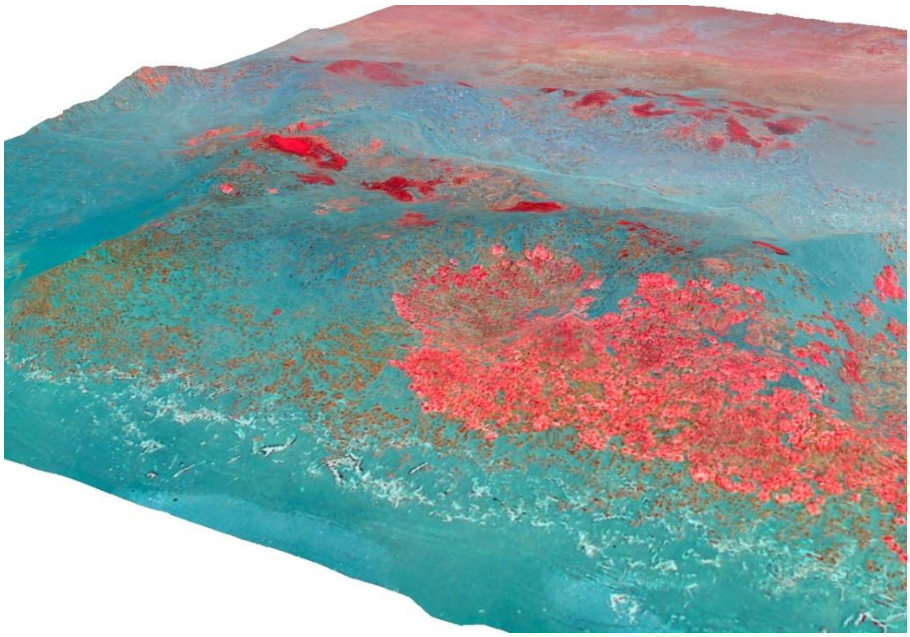

Figure 2 In this 3-d model of a section of Kaitorete Spit, NIR and RGB have been combined to create a false colour image to aid in species identification

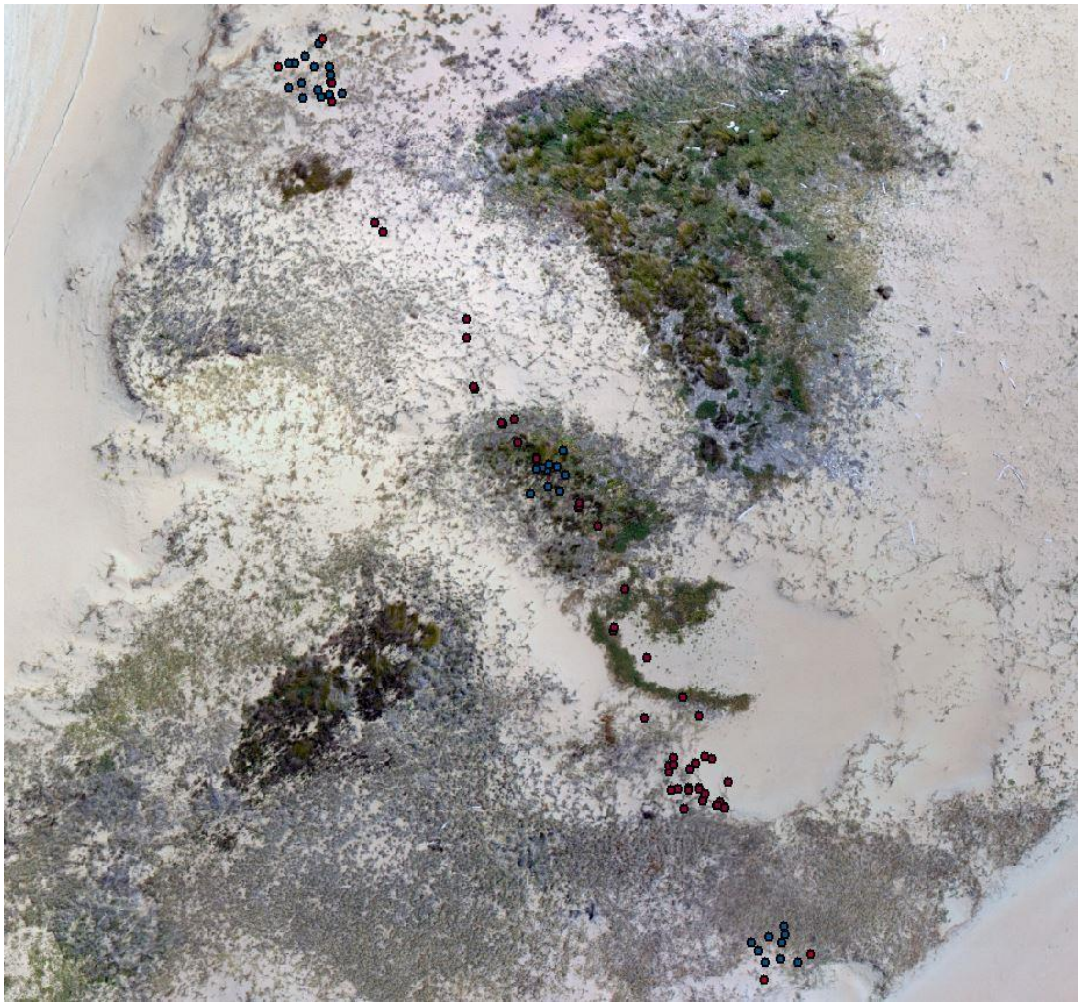

Figure 3 Vegetation (blue) and katipo (red) data across a transect at Ocean Beach, represented in a GIS

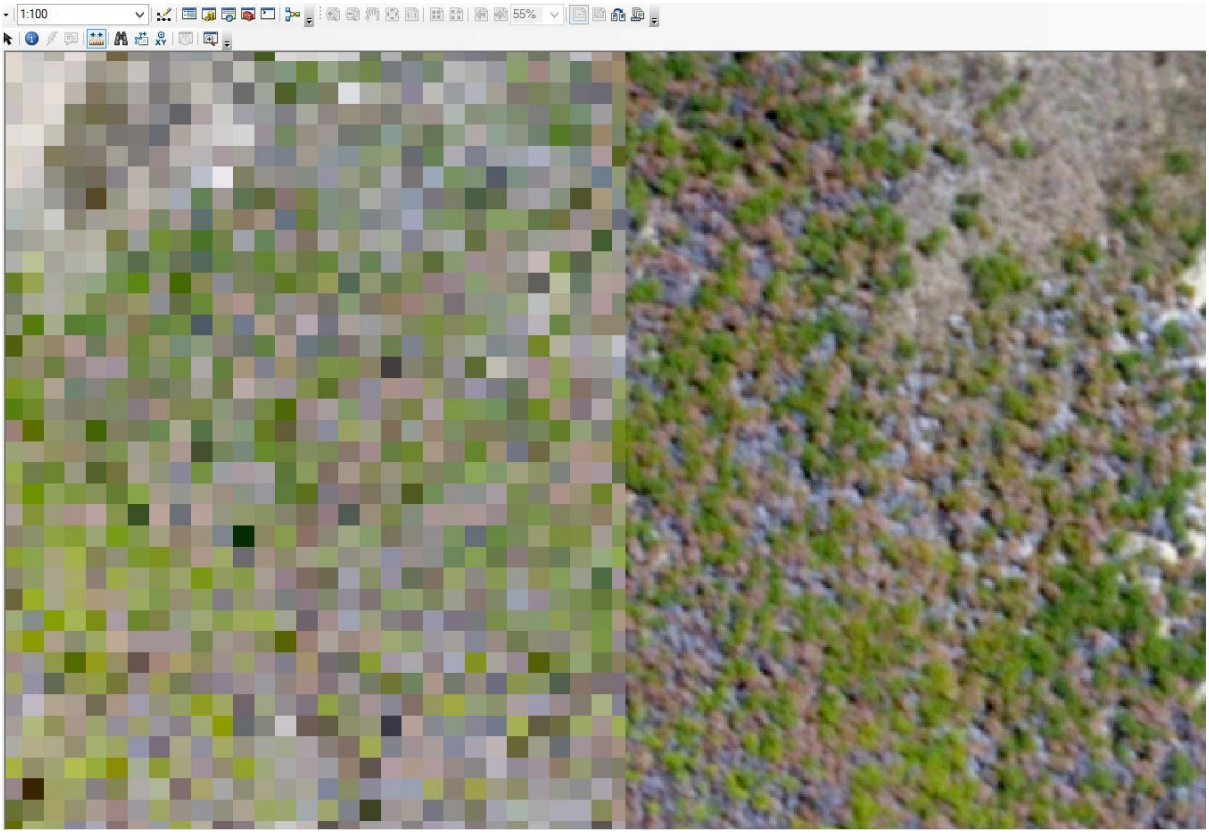

Figure 4 The effects of moving from 0.5m resolution (left) and 0.1m resolution (right) is clear in this image of mixed bracken- fern scrub at Ocean Beach

Figure 5 A female Kaitpo sits near a spent egg sac at Kaitorete Spit.