

UNIVERSITY OF CANTERBURY & FRONTIERS ABROAD

# Geo-Conservation and Geo-Tourism

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Panama Rock – Banks Peninsula

Ailan Hurley, Natalie Smith, Olivia Watkins, Sam Davidson

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## **Executive Summary**

Panama rock is an exposed lava dome and dyke system located in Le Bons Bay, Banks Peninsula. The site owners, the Josef Langer Trust (JLT) are interested in conservation and redevelopment of native vegetation following early colonial de-forestation and agricultural cultivation. This geologic feature has been identified as a potential geo-tourism site. An assessment of the geologic, ecologic, historic, and recreational features of Panama Rock was undertaken as a means to formulate recommendations and any potential implications of developing the site in the future.

Physical mapping of key vegetation species was conducted alongside identifying photo monitoring locations as a means to quantify native vegetation recovery across the site. Track grade assessment was conducted to assist in identifying potential track routes around the site with minimal impacts on recovering vegetation. Current signposting was investigated and potential outdoor display panel locations were identified. Factors associated to site access were also examined, with particular reference to locations of parking sites.

This data was compiled into a GIS framework, to form a layer based geo-database which can be edited and updated for future investigation and site development. As the database is updated, a chronological record of Panama Rock's conservation can be recorded. Track grade assessment concluded existing walking tracks on the site are accessible, however show signs of poor maintenance. Mountain biking tracks were also investigated and were suggested as possible future developments on future sites. A template for photo monitoring techniques has been compiled and locations marked in the field for future image capture. Signposting locations and potential stylization methods have also been compiled. As this project has long term objectives, the findings from this investigation have been designed to assist the JLT in future design and planning at Panama Rock.

## **Introduction**

There is a community driven effort to make Banks Peninsula New Zealand's first UNESCO Geopark. The process calls for individual geosites within the region, such as Panama Rock, to be developed. The Panama Rock Reserve is an internationally significant geological exposure, an ecological hotspot, and a host to various recreational activities and so serves as a fundamental piece of the Geopark vision. This project focused on assessing the current state of the Panama Rock Reserve in terms of its historical, geological, ecological, and recreational features, as well as outlining the potential for the site as a geotourism location in the future.

## **Vegetation Investigation and Photo Monitoring**

One of the most important aspects of creating an ecological reserve is monitoring. Long-term qualitative tracking of the regeneration of vegetation in an area can be cost-effective and simple without the expenses of using a qualified field crew. A combination of photo monitoring and vegetation surveying is useful for establishing vegetation trends in an area (Wilson, 1994). In addition, photo monitoring is typically used to assess land that was or is currently exploited or affected by anthropogenic impacts (Nelson, 2000). In order to assess the current condition of Panama

Rock, aerial photos from 1952-1975 (Appendix A) were analyzed and photo monitoring points were set up for future recording.

The objectives for the Panama Rock Reserve include: begin survey of the fauna to determine conservation direction, and commence long-term photo monitoring by establishing photo points throughout the Panama Rock Reserve.

## Methods

### Vegetation Analysis

In order to assess the current vegetation condition of the JLT paddocks, a vegetation map was created as a result of two trips to the area; June 16th and August 16th-17th. The group walked started out by walking around the plot with tree identification books (Reference the books), a map board with mylar, a GPS, a compass, and a field notebook. We took a qualitative approach of getting a general assessment of the area. The team marked GPS points by any heirloom trees, areas of significant change in vegetation, and dominant species, and recorded this information in a field notebook. The method of survey was basic in that we estimated the size of the plots that we surveyed based on compass readings, GPS coordinates, and visual cues.

### Photo Monitoring

A Canon Rebel T3 digital camera and a tripod were used to take the photos, photo information and settings are located in Appendix C. 27 photo points were established in the Panama Rock Reserve (Figure 2) in August 2014. These photo monitoring points were spaced out all over the reserve to get a strategic representation of the site. All of the locations have GPS waypoints and have been compiled in a table (Appendix C). Appendix B contains all of the filing forms that were used to establish photo monitoring points. Figure 3 is an example of how some of the Photographic Site Description and Location forms were filled out. Compass bearings were taken from the photo point. In order to encourage long term photo monitoring, waratahs and witness stumps were marked for easy identification.

## Results

### Vegetation Analysis

Refer to Figure 1 for the digitized vegetation map from June-August 2014. The categories were created based on what the dominant vegetation type was in the area that was observed. The mixed species includes a combination of several different tree types with no particular dominant species. The grassland classification includes grass as the dominant species. The kānuka classification indicates that the kānuka tree is the dominant species in the area. The gorse classification indicates that the invasive species gorse is the dominant species in the area.

The quantitative results for the classifications are measured in meters<sup>2</sup> through a zonal geometry application in ArcGIS. The table below lists the area that comprises the different classifications along with their percentages (Table 1). In total 496,708.65 m<sup>2</sup> of land was surveyed. The majority of the kānuka dominant area is located at lower elevations and the majority of the mixed dominant area is located at higher elevations. The gorse dominant areas are located throughout the trust at

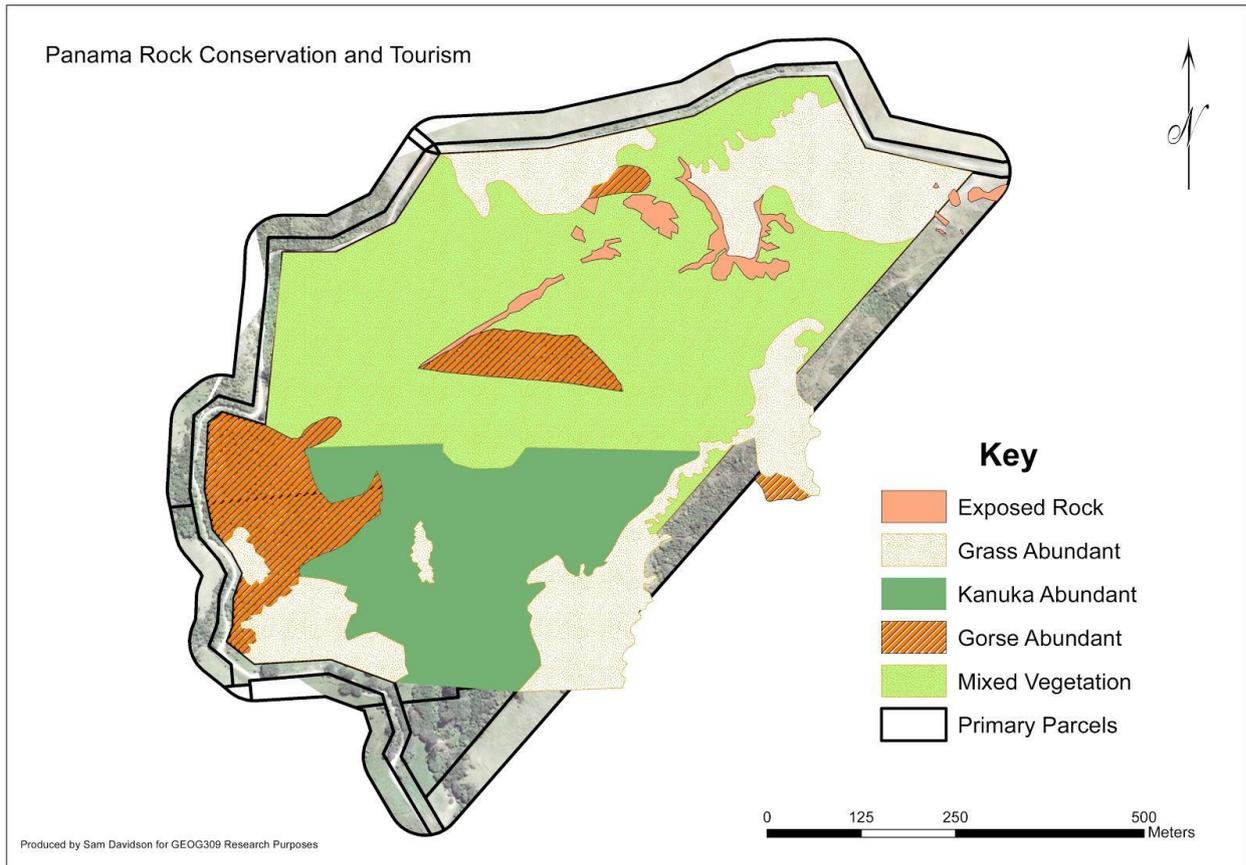
inconclusive locations and elevations. Table 2 illustrates the species that were observed within each classification. For a lot of the species, juvenile and adult versions were seen.

Vegetation Classification	Kānuka Dominant	Mixed Vegetation	Grassland Dominant	Gorse Dominant
Area (meters <sup>2</sup> )	96913.2	230635.8	118151.6	51008.1
Percentage (%)	19.5	46.4	23.8	10.3

**Table 1. Quantitative vegetation map data.**

Vegetation Classification	Kānuka Dominant	Mixed Species	Grassland Dominant	Gorse Dominant
Species Name	Juvenile Red Beech, Juvenile Black Beech, Kānuka, Grass, Fuchsia, Ferns, Five-Finger, Horopito, Lancewood, Macrocarpa, Mānuka	Black Beech, Ferns, Fuchsia, Gorse, Horopito, Kōhūhū, Lancewood, Mikimiki, Ongaonga, Whiteywood	Bracken, Grass, Kōwhai, Gorse, Horopito, Bushlawyer, Blackberry, Fierce, Lancewood,	Bracken, Grass, Horopito, Kānuka, Kōwhai, Lancewood,

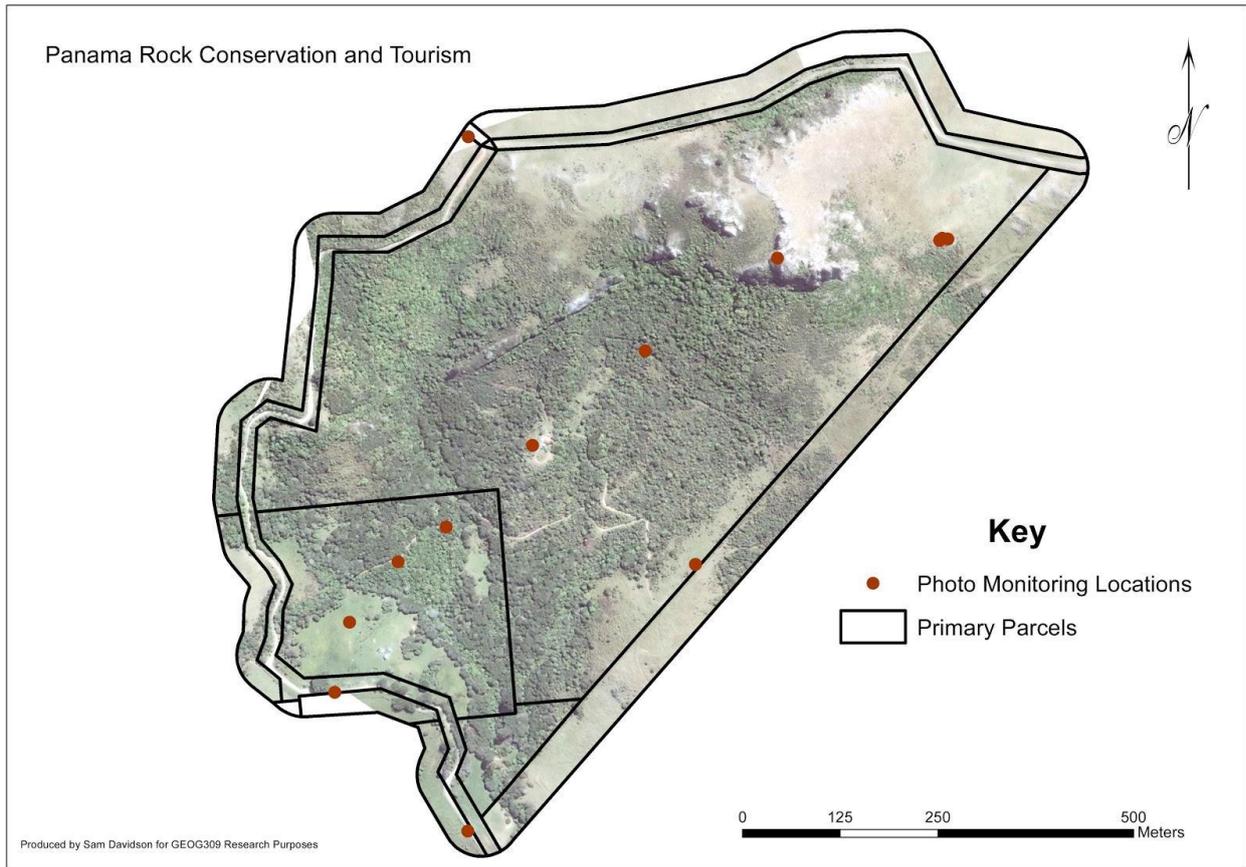
**Table 2. Species that were recorded within each vegetation classification.**



**Figure 1. Vegetation Map of Panama Rock Reserve.**

### *Photo Monitoring*

All 27 photo points can be seen in Appendix A. For some photo points, 3 photos were taken to get a left, center, and right angled view (Appendix A. Figures 3-5). Figures 3-5 represent a landslip that occurred in 2012 that would be interesting to monitor and observe the change in vegetation over a long period of time. A file with all of the photographic description and location forms, the photo points, and the photograph information will be sent to the JLT for future use.



**Figure 2. Photo Monitoring Point Locations on Panama Rock Reserve established August 2014.**

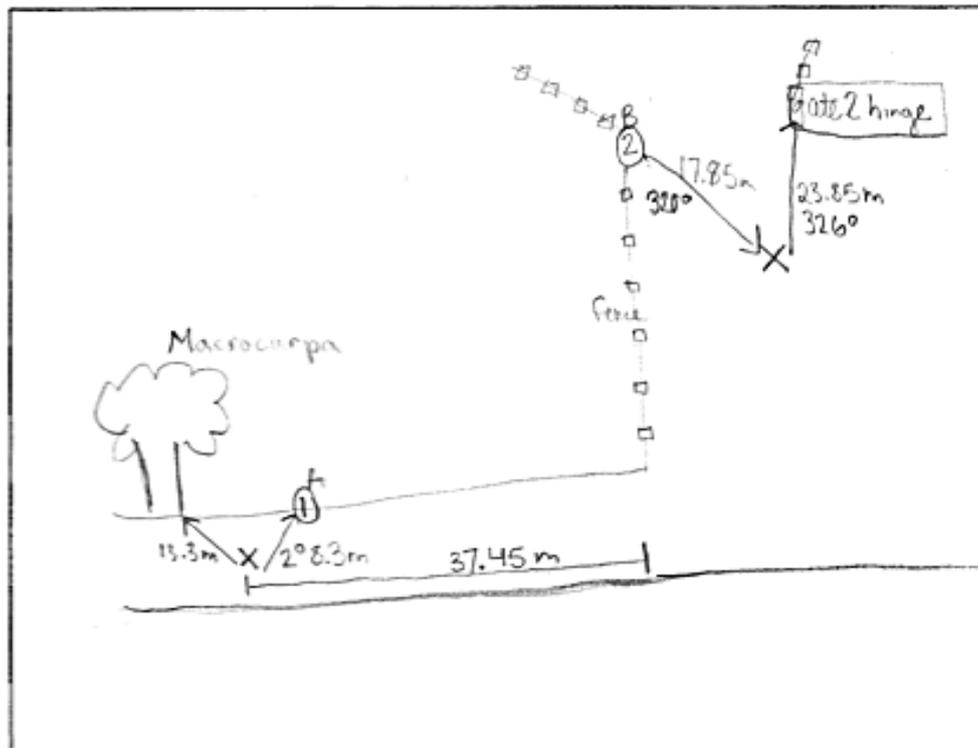
**PHOTOGRAPHIC SITE DESCRIPTION AND LOCATION**

Date 11/21/14 Area Banks Peninsula  
 Unit Barrow Rock Observer: Oliver W + SAM D  
 No. of Camera locations: 2 No. of Photo points: 2 1A16082014 + 1B16082014  
 Plant community all types grassland in foreground  
 Location: T.        R.        Sec.         
 Location description       

Photo purpose: landscape photo of Barrow Rock from road + gate

Discussion:       

**MAP**



Use back of sheet for additional details.

X = camera location  
 I = witness stump/waratah  
 A = photo point

Figure 3. Photographic Site Description and Location for Photo Points A and B.

## Discussion

One of the main limitations that we came across was portraying the vegetation composition on our map as specifically as possible. Due to the transitional nature of the vegetation, specifically in the 'Mixed Vegetation' classification, making more specific classifications was something that could not be done in GIS. With this map that we have, we can start to characterize the Panama Rock Reserve and start to form predictions about the current ecological and successional stages that the reserve.

It is too early in the surveying and trending process to determine what vegetation trend the Panama Rock Reserve is headed towards. However, based on observations from the aerial photos over the 60 year period, the trend of Panama Rock is headed towards an increase in vegetation coverage with an increase in forest type vegetation.

For the next future steps for the JLT, we recommend for them to continue vegetation map and photo monitoring with the help of future Frontiers Abroad students. For photo monitoring, a file of pre-existing photo points, filing forms, camera locations, and instructions will be provided for them. We also suggest to the JLT to begin assessing the quantity of detrimental pest species such as rodents, possums, and goats. In addition, we recommend to the JLT to establish a minimum interference conservation approach and focus on eliminating as many invasive fauna and flora which will help the area independently recover.

## Recreational Investigation

### Guiding Question:

What is the current state of the tracks and climbing features of Panama Rock, and what improvements/additions can be made in order to support Panama Rock as a potential site for recreational activity?

Investigating the recreational potential of Panama Rock is integral to providing a framework for further development of the site as a Geotourism destination. Recreation can be a driving force in getting people out into nature, thus exploration into this aspect is essential for creating a notable Geotourism site. Having spoken to the *JLT* community representative and been to the site prior to any intensive research, it was determined that there are three recreational activities to be investigated: tramping, mountain biking, and rock climbing. As both tramping and mountain biking require a track or trail, it became evident that understanding the current condition of the existing tracks and looking into the possibility of building new tracks would be a necessity. Additionally, there would also need to be an examination of the existing and potentially new climbing features.

### Methods

There are three tracks that needed to be examined for their recreational potential by marking important areas for remediation, measuring track grades, and inputting their information into a

digital database for mapping and storage. The three tracks are: Keller Track, Dyke Track, and Langer Link track (Figure 4)

An Abney level and two equal length poles were used to measure track grades. For each track, grade measurements were taken at every grade change that was determined by the surveyors. To assist in our use of the Abney level to measure track grades, we referred to the comprehensive instructions in *Appendix 8 of the DOC Track Construction and Maintenance Guidelines (2008)*<sup>1</sup>.

A handheld GPS unit was also used to map the tracks as well as mark important areas for remediation. Waypoints were marked at every grade change in tandem with measuring the specific grade percentage using the Abney level. The data collected using the GPS and Abney level was organized into a spreadsheet with comments on areas that will need remediation. The GPS data was then plotted onto a geo-referenced image of Panama Rock on ArcGIS (Figure 4). The spreadsheet (digital copy available) and map were made with the thought of further work being done on Panama Rock, thus the ability to easily transfer and make additions to our foundational work is a priority.

Semester two 2014 Frontiers Abroad students and staff (i.e. the authors) along with the help of some semester one 2014 Frontiers Abroad students created the Langer link track. The track was created via the clearing of vegetation (primarily gorse) as a way to connect the Keller and Dyke Track forming a loop. An image of the clearing can be seen in Figure 6.

## Results and Discussion

### Keller Track

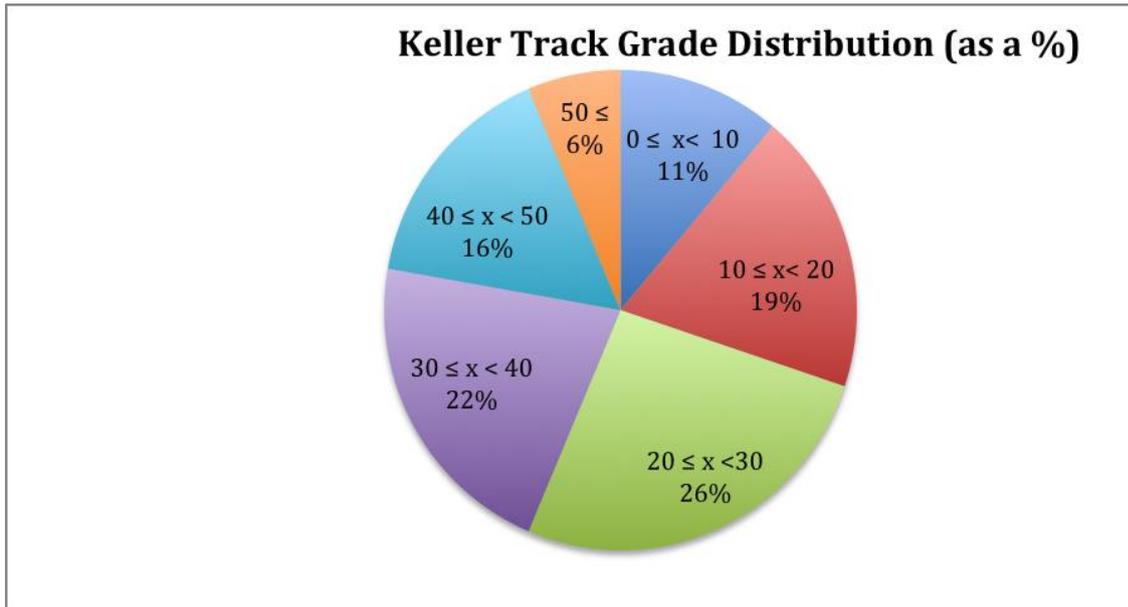
General Field Comments<sup>2</sup>:

Minimal remediation is needed on the Keller Track. There will however need to be regular maintenance of overgrowing vegetation. Due to the high grades of the track (shown in Figure 4), the amount of construction and maintenance necessary to be suitable for mountain biking, and the restoring vegetation, the Keller track is most suitable for tramping and not for mountain biking.

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<sup>1</sup> Devlin, P., Dobbie, B. (2008). Track Construction and Maintenance Guidelines. Wellington, NZ: Department of Conservation

<sup>2</sup>For specific track notes and remediation recommendations for all three tracks, refer to the spreadsheet.



**Figure 4<sup>3</sup>:** Shows the distribution of track grades throughout the Keller Track in ten-percentage intervals. Six percent of the Keller track has grades between zero and ten percent; nineteen percent has grades between ten and twenty percent; twenty-six percent has grades between twenty and thirty percent; twenty-two percent has grades between thirty and forty percent; sixteen percent has grades between forty and fifty and the final six percent of the track has grades above fifty percent.

**Dyke Track:**

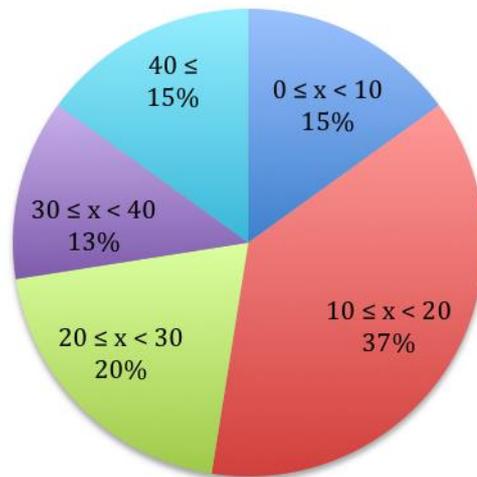
General Field Comments:

Lots of remediation is necessary if there is to be more active use of the track. There are sections along the track that reach above eighty percent, and thus stairs would be necessary. There are areas where the track is very narrow and safety ropes should be put into place. This track is not suitable for mountain biking due to the dangers of high grades (as shown in figure 5), the narrowness of the track, and the vast amount of regenerating vegetation, however tramping should be highly encouraged after more safety measure are put into place.

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<sup>3</sup> The percentage of track within a certain grade range does not refer to the literal amount of track distance with that grade; rather it refers to the percentage of track sections (sections vary in length) within a certain grade range.

### Dyke Track Grade Distribution (as a %)



**Figure 5<sup>4</sup>:** Shows the distribution of track grades throughout the Dyke Track in ten-percentage intervals. Fifteen percent of the track has grades between zero and ten; thirty-seven percent has grades between ten and twenty percent; Twenty percent has grades between twenty and thirty percent; thirteen percent has grades between thirty and forty percent, and fifteen percent has grades above forty percent.

#### Langer Link Track

General Field Comments:

The Langer Link Track does not have any outstanding areas that need immediate remediation, however the track will need regular maintenance of vegetation overgrowth (especially gorse). This track should serve ideally as a tramping track that connects the Dyke and Keller Tracks, forming a small loop that allows for an easy transition across the reserve. The Langer Link Track, serving the other two studied tracks, should as well be exclusively for tramping.

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<sup>4</sup> The percentage of track within a certain grade range does not refer to the literal amount of track distance with that grade; rather it refers to the percentage of track sections (sections vary in length) within a certain grade range.



**Figure 6: An image of the cleared vegetation (note the chopped stumps at the bottom left) on the Langer Link Track.**

## **Limitations and Future Work**

### **Climbing**

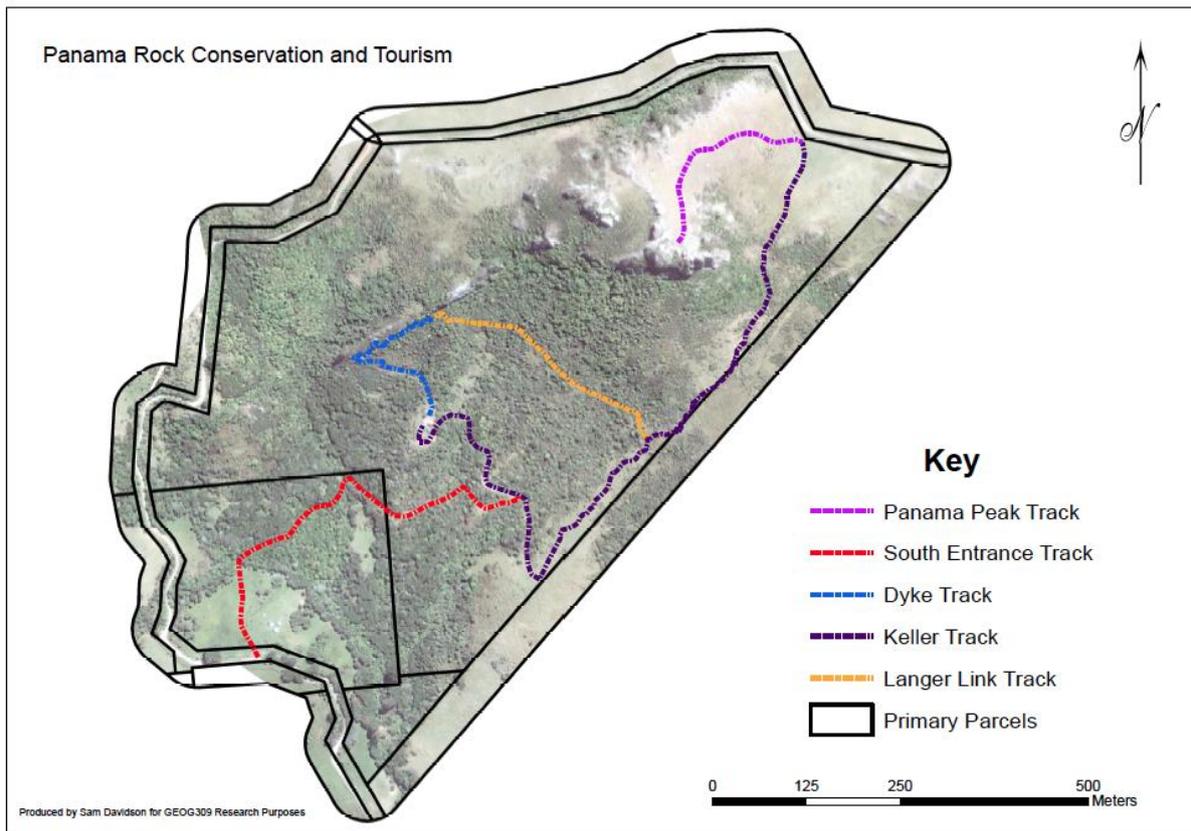
Due to the limited time at the Panama Rock reserve, investigations into the climbing features of the area have not been done. Mapping and clearly marking out the starts to all the currently existing climbing routes on the reserve should be completed in the future.

### **Mountain Biking**

The potential for mountain biking on our studied part of the reserve is very low, as shown by the high track grades and the necessary alterations to make the tracks suitable for biking. However, as indicated in (Appendix D), the potential for mountain biking is not completely gone, as the JLT has acquired two adjacent blocks of land that will need examinations into recreation (along with the other studied aspects of the report).

### **Tramping/ Track Mapping**

On all the studied tracks, tramping should be encouraged. It is recommended that future student groups implement the track remediation recommendations from the recently created database spreadsheet, and continue by performing similar track analysis (determining track grades, providing recommendations for track improvement, and possibly creating new tracks) and recreational exploration on the newly acquired JLT plots of land.



**Figure 7: Shows the mapped tracks on Panama Rock. The three fully investigated tracks are the Keller Track (dark purple), Dyke Track (blue), and the Langer Link Track (orange).**

## Interpretive Materials

When initially visited, it was seen that Panama Rock did not have any type of interpretive materials on or for the site. Interpretive materials are vital for any geotourism location as they are used as a way to communicate with and educate the public. Interpretation is meant to communicate the significance of an area, object, or person while also bringing interest and enjoyment to visitors. Interpretive materials are especially important for the Panama Rock Reserve because of the missions of the site's stakeholders, the HGP and the JLT. The HGP is interested in the formulation of the first Geopark in New Zealand and creating an international identity of Banks Peninsula under the UNESCO Geopark/Geosite framework. The JLT is interested in promoting sustainable management and conservation of natural areas with a focus on education and public interaction with protected sites. In order for either of these goals to be advanced or achieved, individual sites such as the Panama Rock Reserve need to be more developed. Interpretive materials are an important part of this development.

With no previous work done on developing interpretive materials, there was a clear need for ground work to be laid. Objectives for interpretive materials were to: propose specific locations and information for interpretive materials, outline a pamphlet for the site, and propose specific site and general design for the visitor center. The hope was that these would serve as a strong a foundation for any geotourism site and its interpretive materials for the future.

## Methods:

The first step in creating interpretive panels for the Panama Rock Reserve was to do an literature review. In a case study about interpretive panels from Iguassu National Park in Brazil was used. The case study highlighted the public's response to specific interpretive features using focus groups and interviews scout out locations for where the panels would be. The second step of the process was to scout out locations for prospective panels. This was done by walking the trails with a GPS and marking a waypoint at each location of interest. As seen in **Figure 5**, each sign posting location has an outline for the information that can be featured on the respective panels. There are 13 total panel locations with 15 signs, and together they cover some of the most important ecological, historical, geological, and conservational information for the site.

After scouting the locations and outlining the general information that would be featured on the panels, research about creating and designing interpretive panels was needed. The United States has a large but intricate national park system. Many of the parks in the system have manuals that people can reference and follow in order to keep consistency throughout the country. There are also detailed reports and manuals from geotourism sites all over the world. This provided a standard for interpretive materials. The guidelines set by park systems around the world were generally very specific in the process of creating interpretive materials, especially interpretive panels. These guidelines highlighted that there should be three levels of objectives addressed for every interpretive panel. These are educational, behavioural, and emotional levels; what does the Panama Rock Reserve want visitors to know? What does it want visitors to do? What does it want visitors to feel? The guidelines also took into account various aspects of design such as colour, images, key words, type sizes and styles, height and angle, and reading level.

## Results:

It seemed necessary that a pamphlet be outlined for the Reserve as a source of information at the entrance areas. The pamphlet would be most productive if it outlined some interesting activities and features of the site, provided a map with important facilities like entrance areas, toilets, and the hut, as well as all of the trails. It was also important to the JLT that the pamphlet have an area designated for information concerning donations. The resulting pamphlet is shown in the appendix. The pamphlet was created mimicking the design and colouring of a pamphlet created by the Frontiers Abroad group. Some feedback noted that the colours of the pamphlet may need to be changed, but that can be done easily. The outside features a picture of Panama Rock and the logo for the Reserve. The logo features a silhouette of Panama Rock and it will help to create an identity for the reserve. The logo can be placed on all kinds of interpretive materials and help to form recognition of the Reserve among the public. The inside of the pamphlet contains the map of the Reserve along with prominent features and trails as well as a site's disclosure. This piece of the pamphlet will also serve as the template for the entrance panels so that when visitors come, they know is available to them and where to go.

The main interpretive panel created in this process is centered on the history of Le Bon's Bay (**Figure 6**). The panel is set to be 32 inches X 24 inches. The main text of the panel is Verdana font in size 48 and the captions are in size 36. There are three pictures of Le Bon's Bay history and the overall colour theme of black, creme, and brown correlates with a historical feel. The background is meant to look like old paper in order to keep with the theme.

## Discussion:

There were multiple limitations throughout the process. Firstly, there was no graphic designer working on the project, so although there are clear standards for general design on interpretive panels, it still requires a high level of creativity and expertise in the area. Along with a lack of professional aid, time was a big restraint. To a graphic designer, the process of creating a pamphlet and interpretive panel might have been very small feats, but without the experience, the process probably took significantly longer. Another limitation was gathering information from other members of the group to feature on the panels. The job of outlining and creating interpretive panels meant that interesting information about the site's important aspects needed to be featured. This process meant that the design of the pamphlet was dependent on the information gathered, sometimes slowing down the creation process. Despite these limitations, progress was made.

This is just the foundation for creating interpretive materials for the site but much work still has to be done. The rest of the interpretive panels still need to be designed and implemented. In order to maintain consistency, the rest of the panels, other than the ones at the entrances, should also be 36 inches X 24 inches. The recommendation is that all of those panels should be mounted at hand height and at a 45° angle for ease of reading and rain runoff. Panels should be made out of polycarbonate with a matte velvet finish to reduce scratching. The material is inexpensive but strong and ultraviolet stabilized. The general font and sizes used for the history of Le Bon's Bay should also be maintained throughout the site. The entrance panels should be 36 inches X 48 inches and made out of the same materials, though with a curved shelter built overhead in order to reduce maintenance. The rest of the panels will need to be maintained biannually and replaced about every five years. Another recommendation for the future is to monitor how well the interpretive materials are received by the public. It is important that they be interesting to the public and well used. The monitoring could be done by survey, focus group, or interviews in the years to come.

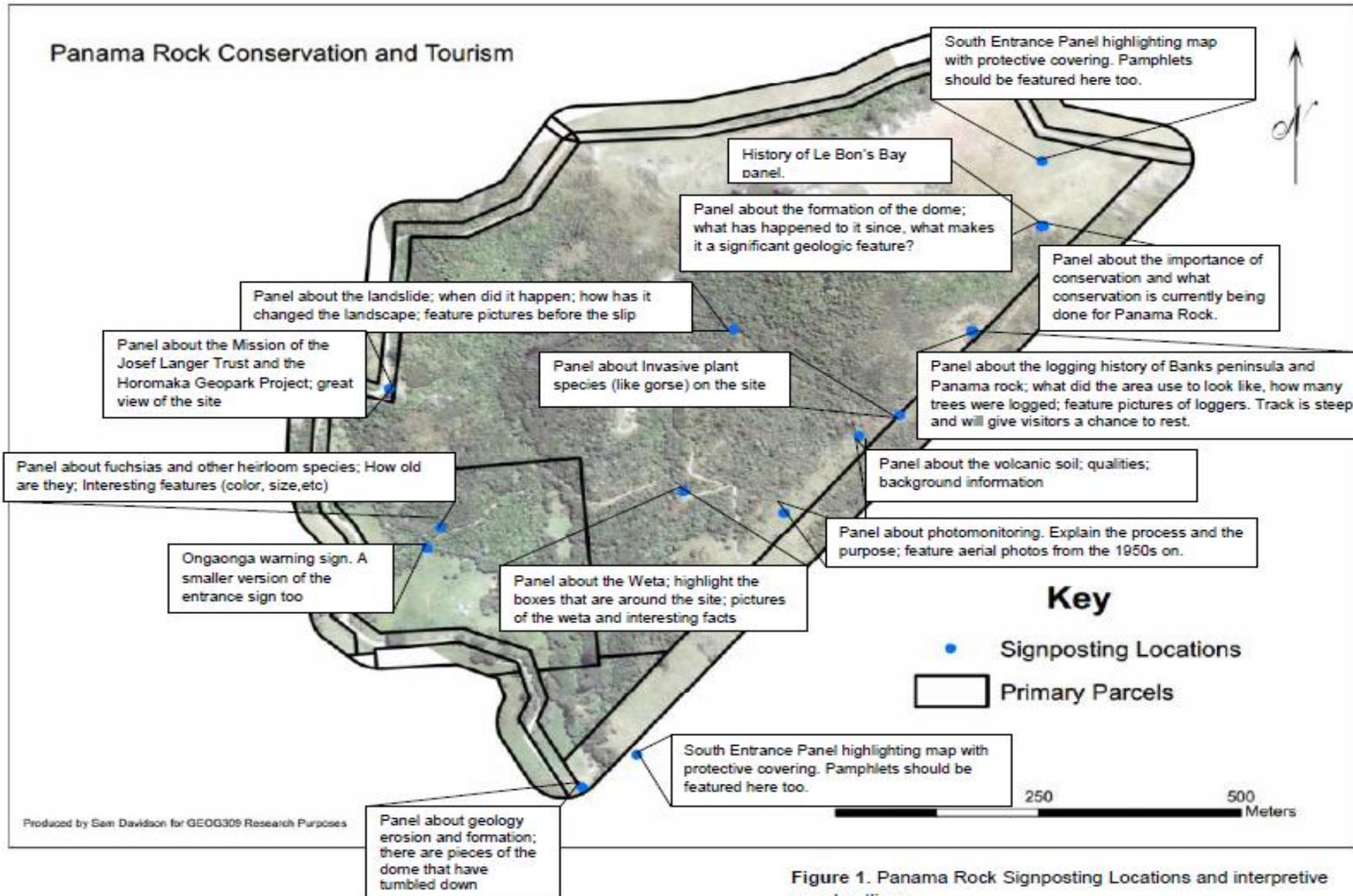


Figure 1. Panama Rock Signposting Locations and interpretive panel outlines.

# Le Bon's Bay

## The Early Years

Le Bon's bay was settled much later than most of the other bays of the Peninsula. In 1856, the first settler, John Cuff, arrived in the bay. At that time, the area was covered with dense bush and heavy timber. Cuff established a sawmill with William Cuddon, and the bush covered areas were gradually

Men standing in front of the cocksfoot, grass seed, harvest of Le Bon's Bay. 1910.



John Cuff, (1805-1869)

Publican, mill owner, and politician. He moved to the area with his wife and eight of their 13 children from London. He ran the steam sawmill from 1857 to 1861.



The Zion Congregational Church, Built by Edward Morey of Akaroa and opened in 1870.

With the success of the mill came an influx of settlers to the bay. Eventually the bush was exhausted, and people turned to farming. The settlers kept sheep and cattle, cultivated grass seed, dairy farmed, and maintained a butter factory. The town also built a church, school, and post office to meet growing needs.

Figure 3. History of Le Bon's Bay Interpretive Panel

## Data Integration and Geo-Database Formulation

Data quality is only as practical as how it is conveyed to its target audience. If the data presented is difficult to understand and interpret, then planning measures and future recommendations may be incorrect. In order to address this, investigations into data integration and presentation aimed to assess what method of data presentation would suit both the JLT and the HGP for the interpretation of findings and future data addition at Panama Rock. A geodatabase using a GIS platform was decided upon as the most suitable for the project as it allowed for geo-referencing of all data collected in the field, along with an incorporation of base imagery and qualitative data sources such as primary parcel information and past information already gathered by the HGP. ESRI ArcMap was decided as the platform to use as base maps had already been produced by the HGP, and rendering software for visualization purposes could easily be integrated in the form of ESRI ArcScene.

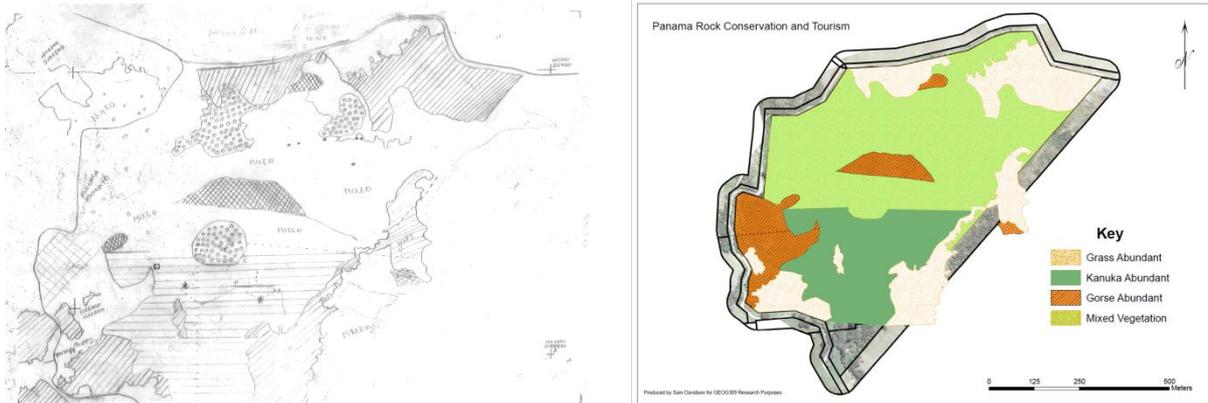
### Methods:

#### ArcMap and Geo-Databases

ArcMap and ArcScene were used for database formulation/map digitization, and 3-dimensional visualization respectively. These two software packages required different methodologies to create the desired outputs. ArcMap is a software package from ESRI which is designed to create layered templates of geospatial data. This data can then be edited and manipulated to derive trends or highlight subtle features. The purpose of using ArcMap for the formulation of a database of Panama rock was to conveniently store geospatial data which can be manipulated by the HGP in future research projects. As HGP currently has access to an ArcMap license, it was the most practical choice of geospatial interface to store data in rather than to learn new software such as QGIS, another GIS platform.

In order to create a geodatabase in ArcMap, base satellite imagery was required. Base satellite imagery encompasses: true colour ground surface expression, hill shades to represent topography on a 2D surface, a Digital Elevation Model (DEM) which could be used to represent topography in either 2D or 3D, and primary parcel information to indicate property boundaries and any legal constraints. All data for the base imagery was provided courtesy of the HGP as they had already begun work on a database themselves. The base imagery was at resolutions of ~8m x 8m square ground surface, however there were no issues with imagery ownership and copyright infringements.

After all base imagery was uploaded; data gathered during field-work was uploaded into the database. This was done through digital upload from GPS units into Excel spreadsheet files which were compatible with ArcGIS, and digitization / geo-referencing of maps made in the field. GPS data tabulated into Excel spreadsheets was organised into each respective target interest (photo-monitoring, track grade assessment, and signposting) and incorporated into ArcGIS separately to create separate layers for each interest target. Digitization of field vegetation maps required high definition scanning to create a base .jpg file. This image was then uploaded into ArcGIS and geo-referenced to ensure map details recorded were in correct locations. In order to create an interactive layer for each vegetation type recorded, polygons were created to trace around the reference features which would then create the final visual output (See Figures 10 and 11 below).

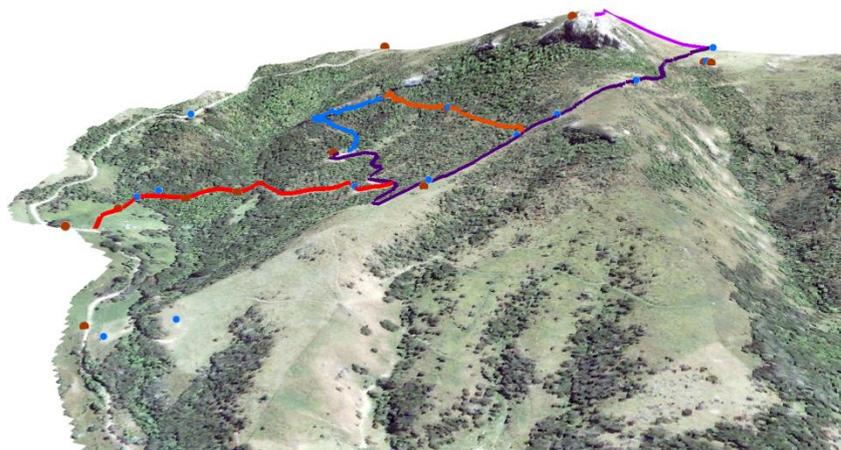


**Figures 10 and 11: Digitization of Field Vegetation Map and Geo-Database Result**

### **ArcScene and 3-Dimensional Visualization**

Following the production of the geodatabase, visualization techniques were investigated using 3-Dimensional DEM's and ArcScene. ArcScene is another ESRI software package which can upload base imagery derived from ArcMap in order to display vertical co-ordinate data (Z co-ordinate data). This is primarily done through the use of DEM's and extrapolating z co-ordinate data to create a base 3-dimensional mesh over which all layers of interest are draped.

This involved the creation of a new file and to upload the key database layers to be visualised. Issues associated to incorporating the data into a 3D model were primarily associated to the base DEM. The initial DEM supplied by the HGP was of resolution in excess of 10m x 10m, this resulted in severe distortions in true topographic relief of the Panama Rock Site. An updated DEM at a smaller resolution was used to counter act this issue and assist in display quality/realism. As figure 12 shows, topographic representation of the field area can be used as a method of contextualising the data presented in the geo-database.

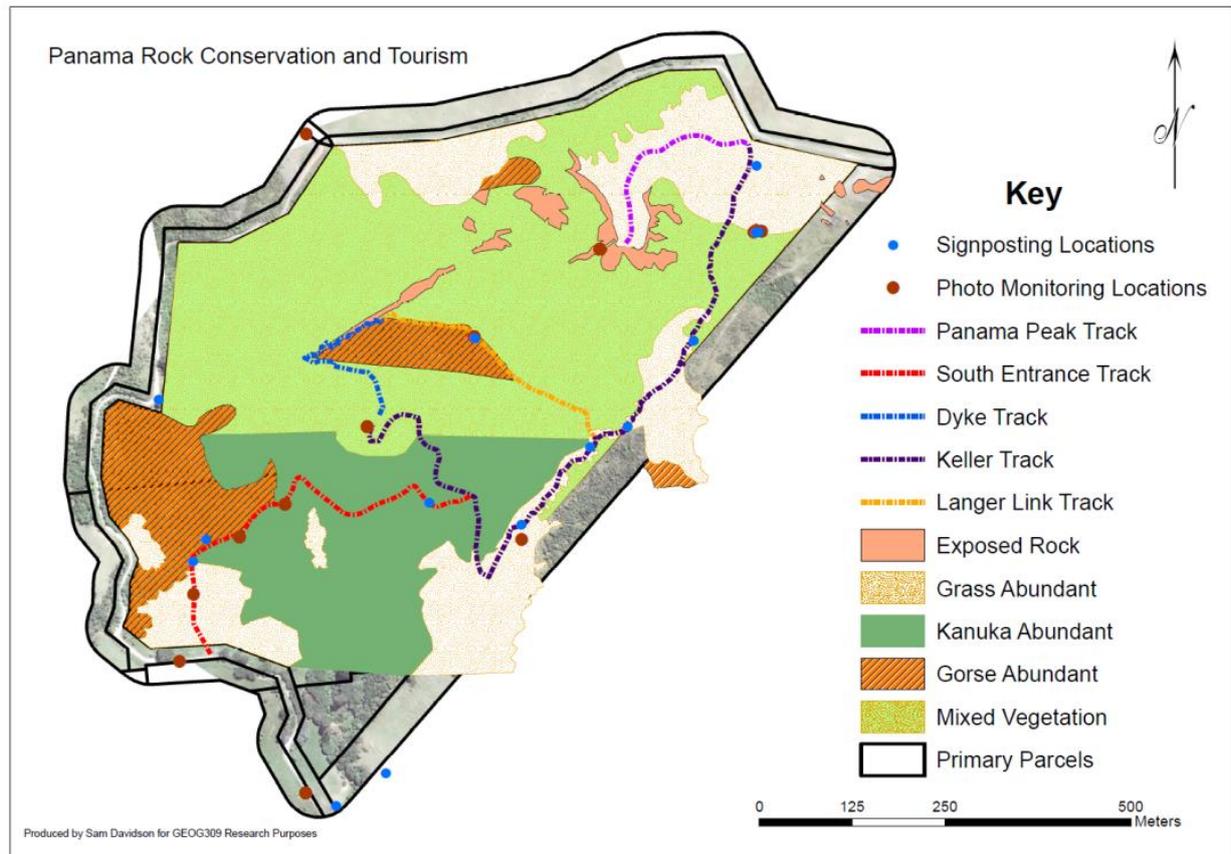


**Figure 12: 3-Dimensional Representation of Walking Tracks and Signposting/Photo-monitoring Locations**

ArcScene has also been used to create a fly-through of Panama Rock and all key locations associated to studies undertaken during this project. This has allowed the JLT, HGP and any potential future partners to gain a more convenient insight into the results of this project without needing to travel to the site directly.

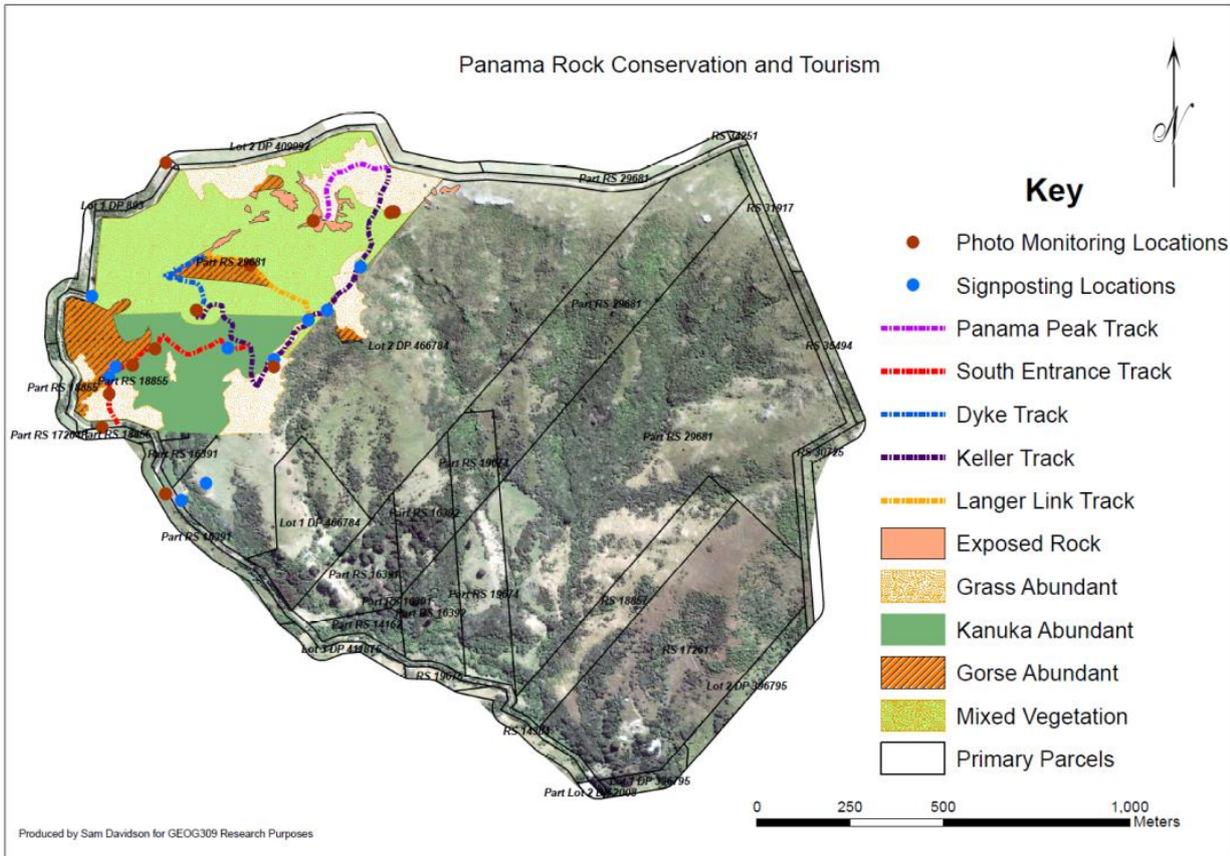
## Results:

The final output map is represented in the figure below (Figure 13). This collation of data is designed for the JLT and the HGP to use as reference for future developments and research across the Panama Rock field area. This map represents current vegetation coverage across the field area investigated, locations of photo-monitoring sites, locations of educational/recreational sign-posting, and tramping tracks to be further developed.



**Figure 13: Final Geo-Database Representation of Panama Rock**

A second map (Figure 14) with the entire field extent was also produced to assist in spatially orienting the project and allowing both stakeholders to plan future research. These maps are designed to be in both physical and digital forms, with digital copies sent to both stakeholder groups. The data captured in these two maps are simple and effective; they are designed to allow the user to easily interpret the information without skewed viewpoints.



**Figure 14: Field Extent Representation of Geo-Database of Panama Rock**

## Conclusion

This report is an effort to create a framework for future work done on the Panama Rock reserve to eventually establish the site as a UNESCO Geotourism Park. We have highlighted and investigated four important aspects of the reserve: vegetation and photomonitoring, recreational potential (track quality, biking and climbing potential), interpretative materials (signs and brochures), and Geo-database creation and storage. The three physical and tangible aspects investigated (vegetation and photomonitoring, recreation, and interpretive materials) are fluidly integrated via the Geo-database that will be passed on and amended by future Frontiers Abroad/ Geography 309 university groups.

## References

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