Bernier and Dorre Islands vegetation cover report: 2019

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Bernier and Dorre Islands vegetation cover report

October 2020

GOVERNMENT OF WESTERN AUSTRALIA

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Acknowledgments

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Summary

The data presented in this report conclude:

- Grazing from feral goats (Bernier Island) and a fire (Dorre Island) had significant impacts on vegetation cover levels. This is inferred from vegetation cover being poorly predicted by rainfall in the period 1988 to around 1997 (see Figures 7 to 14).
- The area of sand dune on Bernier Island has declined at a near steady rate from 1973 to 2018. Dune changes on Dorre Island relate to fire impacts.
- Current vegetation cover levels on the Islands are among the lowest observed in the Landsat record (1988 to 2018) (figures 15 to 18). This is likely to be a function of the current period of extremely low rainfall (Figure 4).
- There is a strong to moderate relationship between rainfall at Carnarvon BOM station and measures at Dorre Island. Ambiguity over the strength of the relationship is due to the change in instruments used to record rainfall.

1 Introduction

This report provides an analysis of vegetation cover changes on Bernier and Dorre Island using satellite imagery. Rainfall data is also analysed as it is required to determine if changes in vegetation cover relate to rainfall variability, stock removal or fire.

Goat Eradication

The details on goat eradication were provided by Keith Morris (2019, personal communication, 27 May).

The goat eradication on Bernier Island was undertaken in May 1984. The island was inspected by helicopter in April 1985 and by ground parties opportunistically until 1990. No goats were seen on these inspections. While there was no official declaration of eradication it is believed that goats were eradicated by 1985.

Landsat Imagery

Vegetation cover assessments across BDI were carried out using Landsat satellite imagery. The vegetation cover measures are derived from an algorithm developed on Dirk Hartog Island. A Bernier and Dorre Island algorithm would certainly add scientific rigor to the analysis, but it is unlikely that it would significantly change conclusions. The likely impact would be to shift all cover values slightly up or down.

Landsat imagery used in this project was downloaded from the United States Geological Survey (USGS) online catalogue (http://glovis.usgs.gov/). Scenes capture by Landsat 5, 7 and 8 at scene path/row location 115/78 were used. The images were then corrected for variable sun angle and distance using the “Sun Correct” program (Wu and Danaher 2001).

2 Rainfall data

Rainfall data was gathered from three sources. A rainfall gauge (2007-04-01 to 2012-07-01) and weather station (2015-05-24 to 2019-03-01) on Dorre Island and the Carnarvon, Bureau of Meteorology (BOM) weather station (1945-01-01 to 2019-02-01). Monthly rainfall totals from the gauge and weather station are shown in Figure 1. Months with incomplete weather station data and those where no system was operating have been included in “no data”.

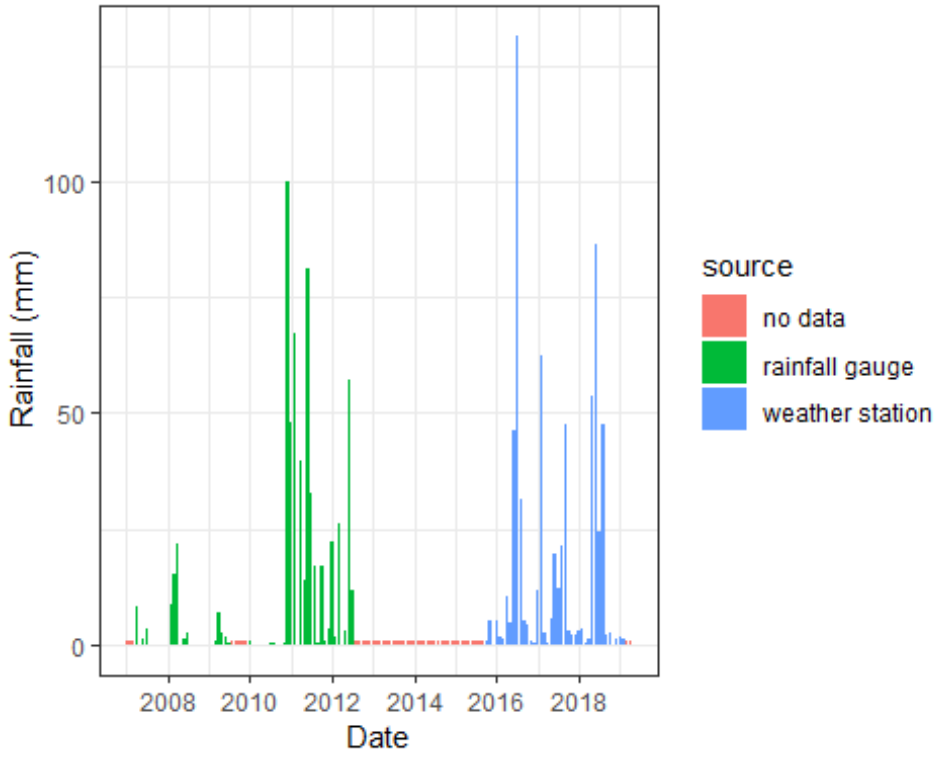

Figure 1: Rainfall for Dorre Island from a rainfall gauge (2007-04-01 to 2012-07-01) and a weather station (2015-05-24 to 2019-03-01).

To examine the strength of the relationship between rainfall recorded at Dorre Island and Carnarvon, monthly totals were regressed (Figure 2). To normalize the distribution of the rainfall data it was log transformed. This log transformed data was also regressed (Figure 3).

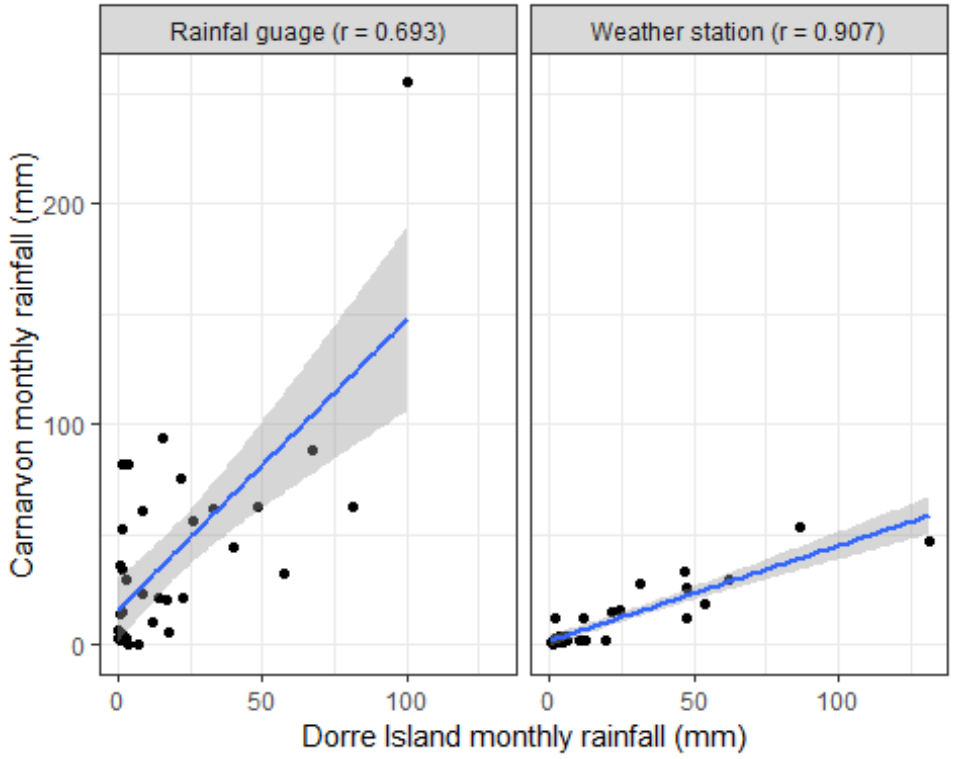

Figure 2: Correlation of monthly rainfall data from Carnarvon and Dorre Island.

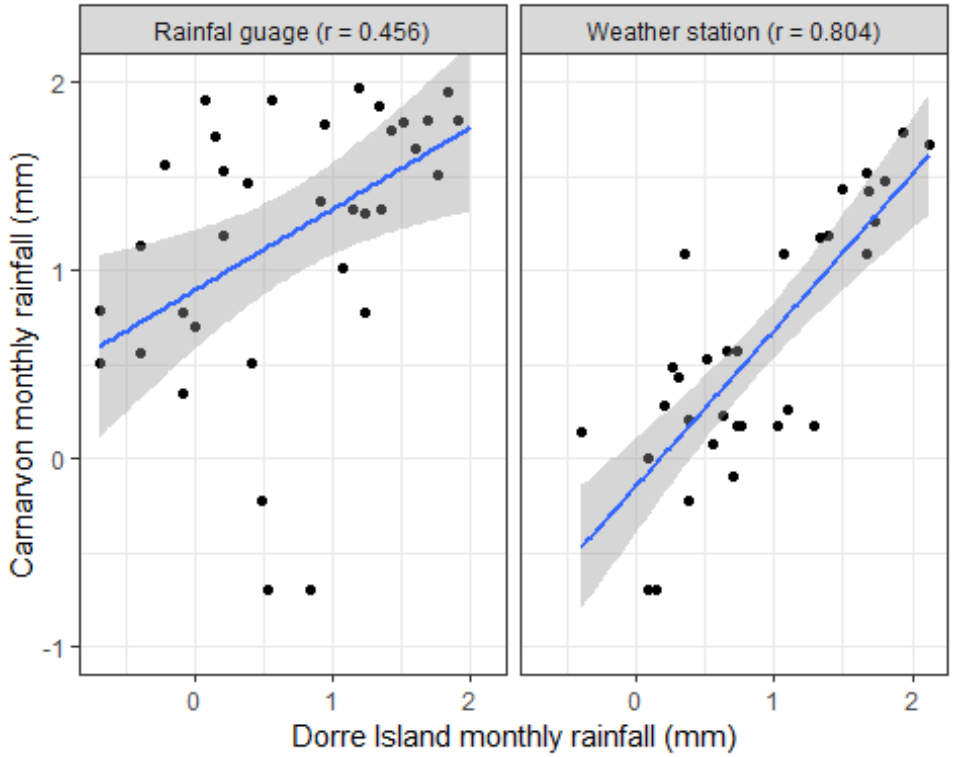

Figure 3: Correlation of log transformed monthly rainfall data from Carnarvon and Dorre Island.

The rainfall from the weather station recorded strong relationships in both untransformed and transformed (r = 0.907 and 0.804). Rainfall from the gauge recorded moderate relationships (0.693 and 0.456). We cannot discern however if this difference in relationship is due to the accuracy of the gauge, or the nature of rainfall in the period the gauge was in operation.

Monthly rainfall totals, with a running mean from the 5 previous years, for the Carnarvon BOM station are shown in figure 4. The running mean values indicate a decline rainfall from 2011, and drop considerably in early 2016.

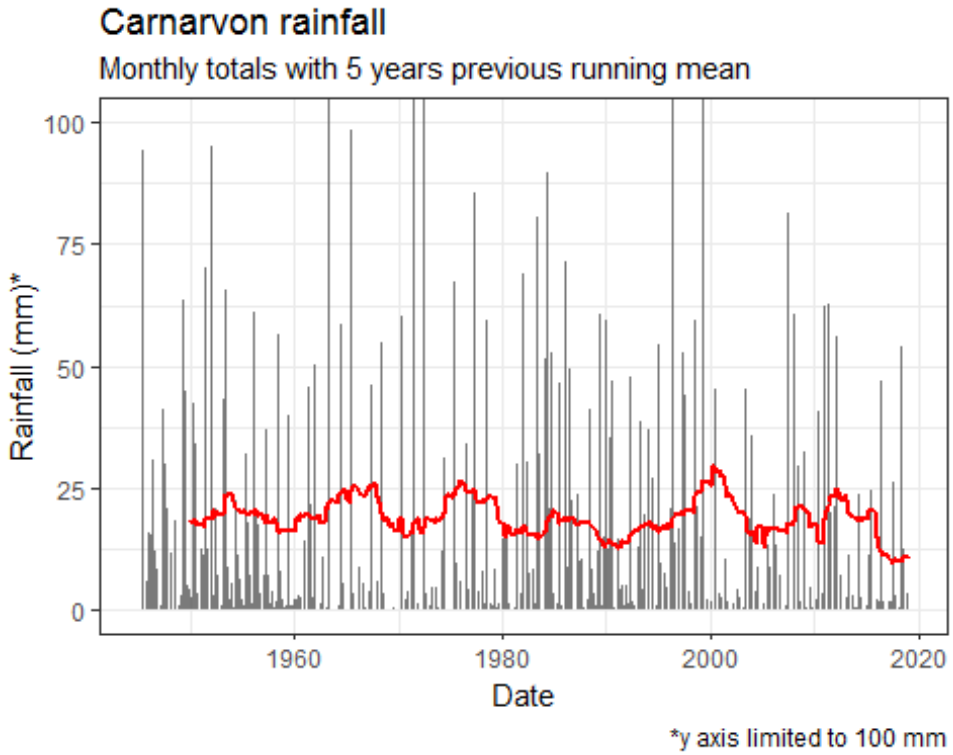

Figure 4: Carnarvon rainfall 1945-01-01 to 2019-02-01 with a running mean from the 5 previous years.

3 Vegetation Cover

Landsat time series

To provide a summary of change across the Islands over time the mean cover values for each Island was extracted from the Landsat imagery and graphed. Statistically significant break points in the vegetation cover time series were added using the “strucchange” package within the R statistical environment (R Core Team, 2014). Trend lines were also added between each break point.

The data shows that vegetation cover on both Islands follows a similar pattern (Figures 5 and 6). Cover generally increases between 1988 and 2000, then was relatively flat to 2011, before steadily declining.

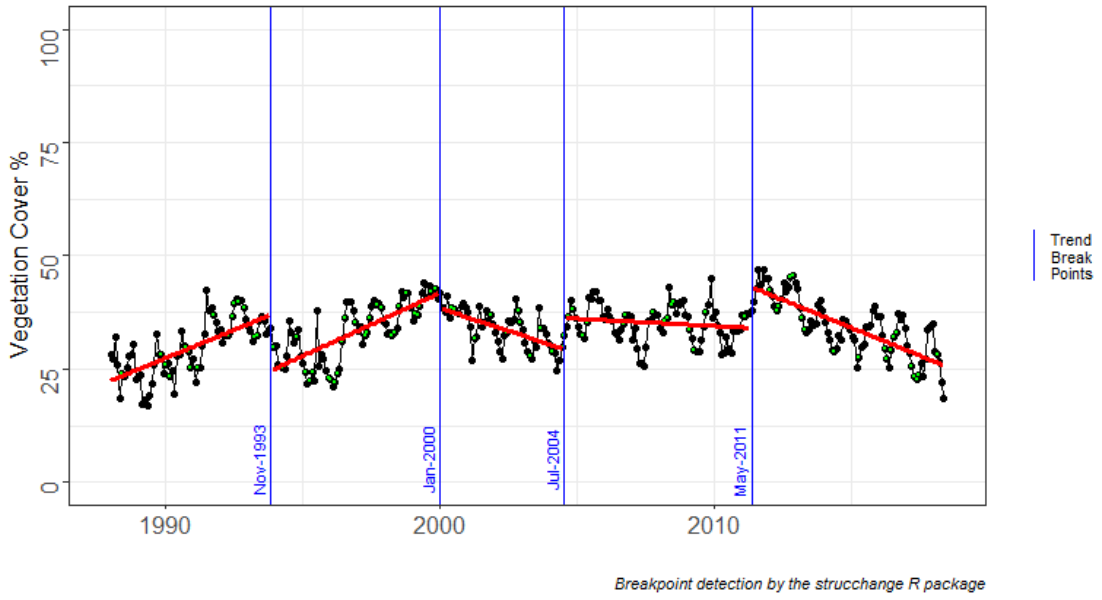

Figure 5: Mean monthly vegetation cover values for Bernier Island. Blue vertical lines indicate break points and red line show trends between breaks.

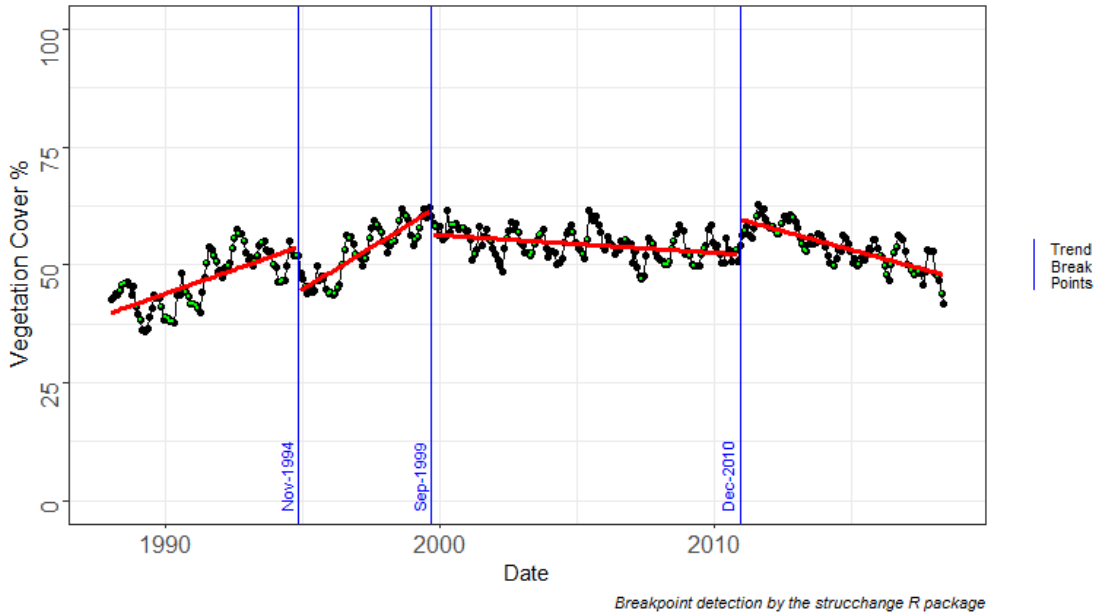

Figure 6: Mean monthly vegetation cover values for Dorre Island. Blue vertical lines indicate break points and red line show trends between breaks.

Correlations with rainfall data

To smooth out annual variability a rolling annual mean was applied to the vegetation cover time series. The correlation between the annual mean and rolling rainfall means from 1 to 60 months, at lags from -22 to 22 were tested. The best predictor for vegetation cover on Bernier Island were the mean rainfall from a period of 35 months at lag of -3 months (r^2 = 0.725). For Dorre Island the best predictors were 47 months at a lag of -2 months (r^2 = 0.639).

Monthly rainfall with the optimal rolling mean and lag and vegetation cover with a 12-month rolling mean for Bernier Island is shown in Figure 7 and for Dorre Island is shown in Figure 8.

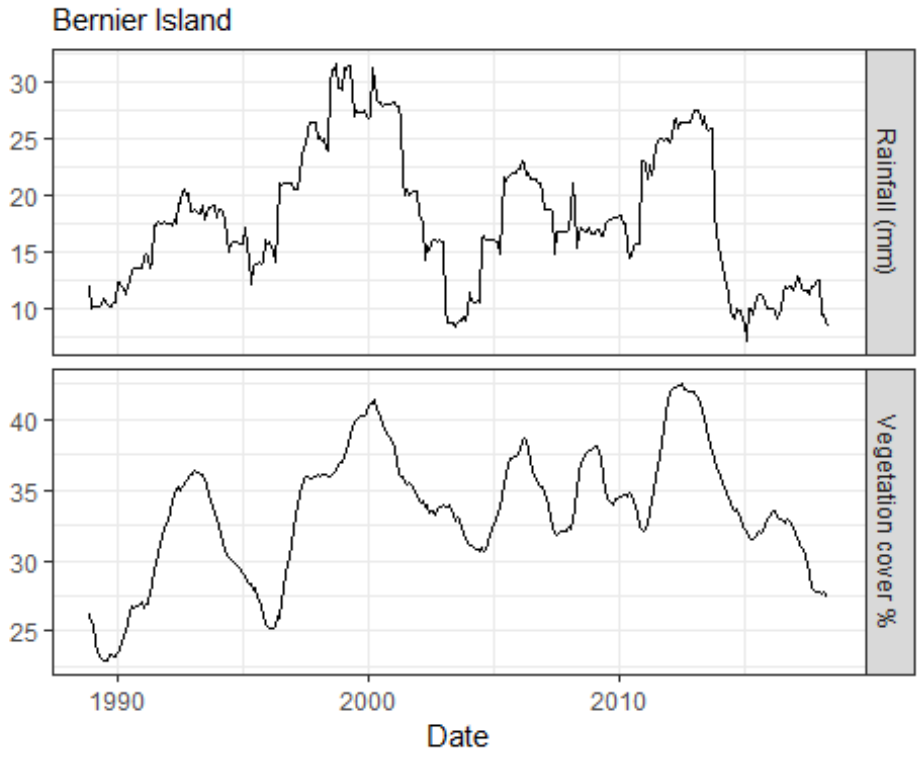

Figure 7: Monthly rainfall with a 35 month rolling mean and vegetation cover with a 12 month rolling mean for Bernier Island.

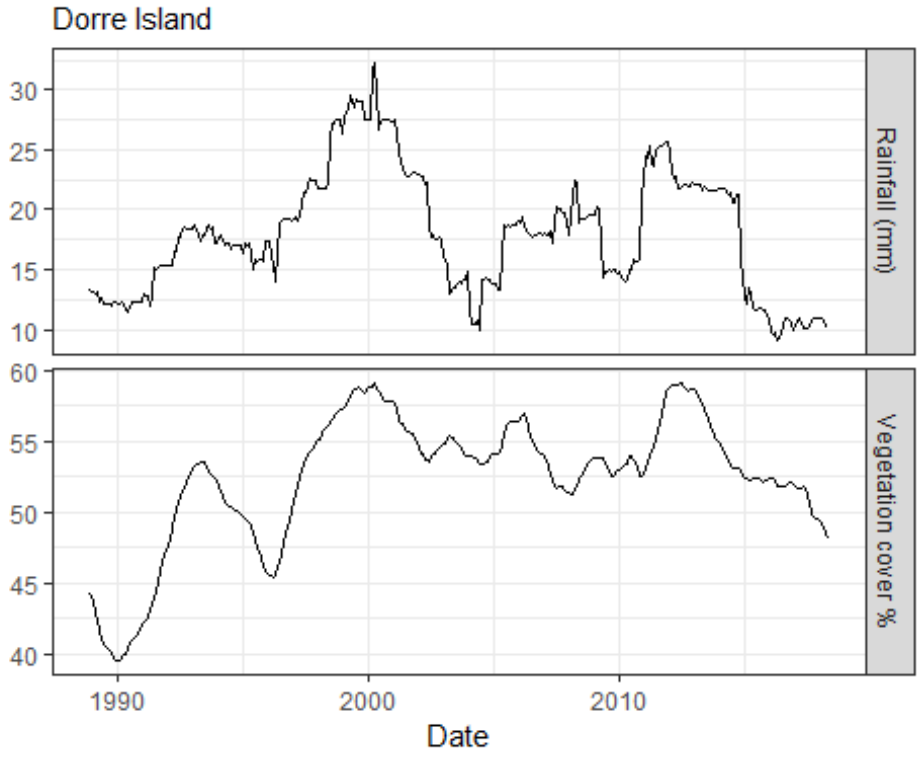

Figure 8: Monthly rainfall with a 47 month rolling mean and vegetation cover with a 12 month rolling mean for Dorre Island.

The scatter plots of monthly rainfall with the optimal rolling mean length and lag against vegetation cover for Bernier and Dorre Islands are shown in Figures 9 and 10. In both figures, from the colouring of the points, points from around 1988 are clustered around the lower corner of the plot.

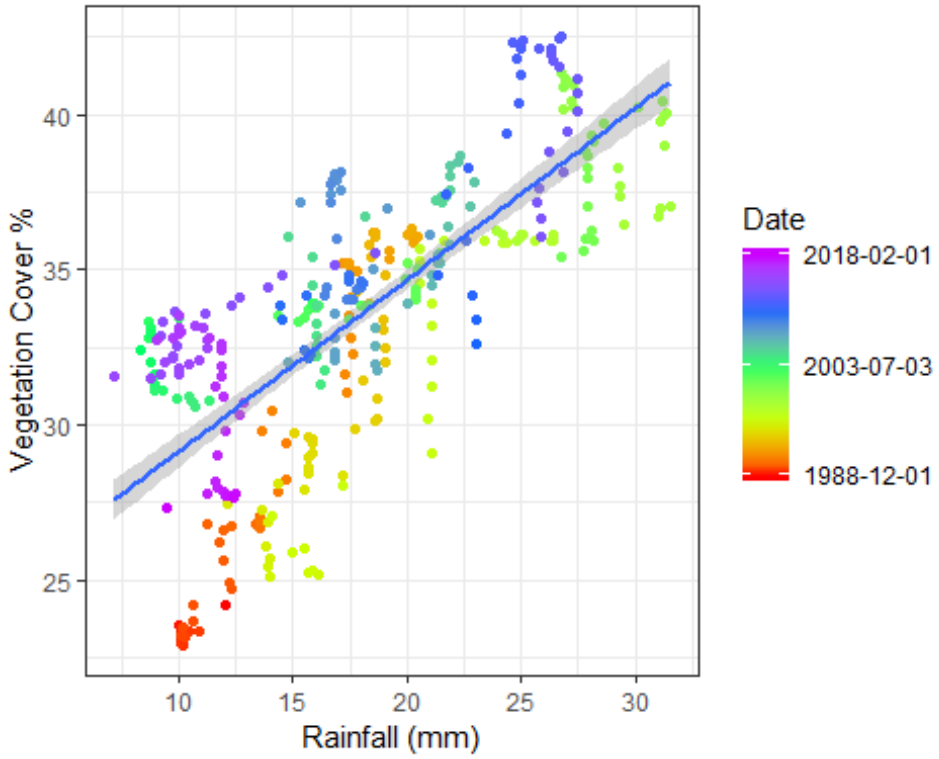

Figure 9: A scatter plot of monthly rainfall with a 35 month rolling mean and lag of -3 and vegetation cover with a rolling mean of 12 months for Bernier Island (r^2 = 0.725). The points are colored by date.

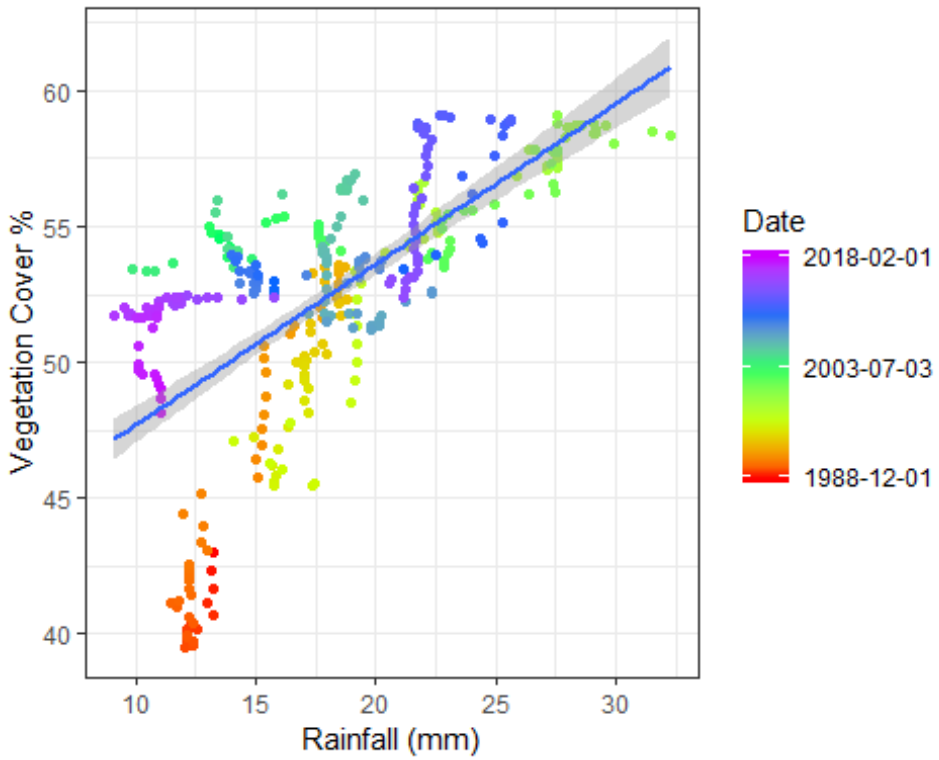

Figure 10: A scatter plot of monthly rainfall with a 47 month rolling mean and lag of -2 and vegetation cover with a rolling mean of 12 months for Dorre Island (r^2 = 0.639). The points are colored by date.

Vegetation cover values for Bernier and Dorre Islands and predicted values, using rainfall data and the linear model from Figures 9 and 10, are shown in Figures 11 and 12.

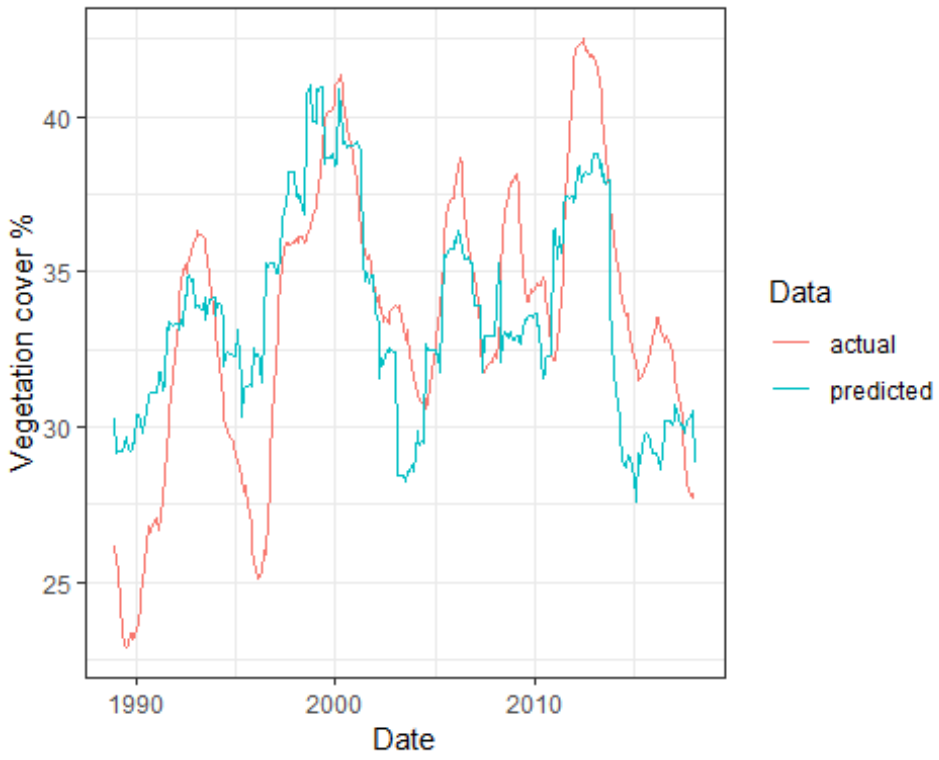

Figure 11: Measured vegetation cover and vegetation cover predicted from rainfall for Bernier Island.

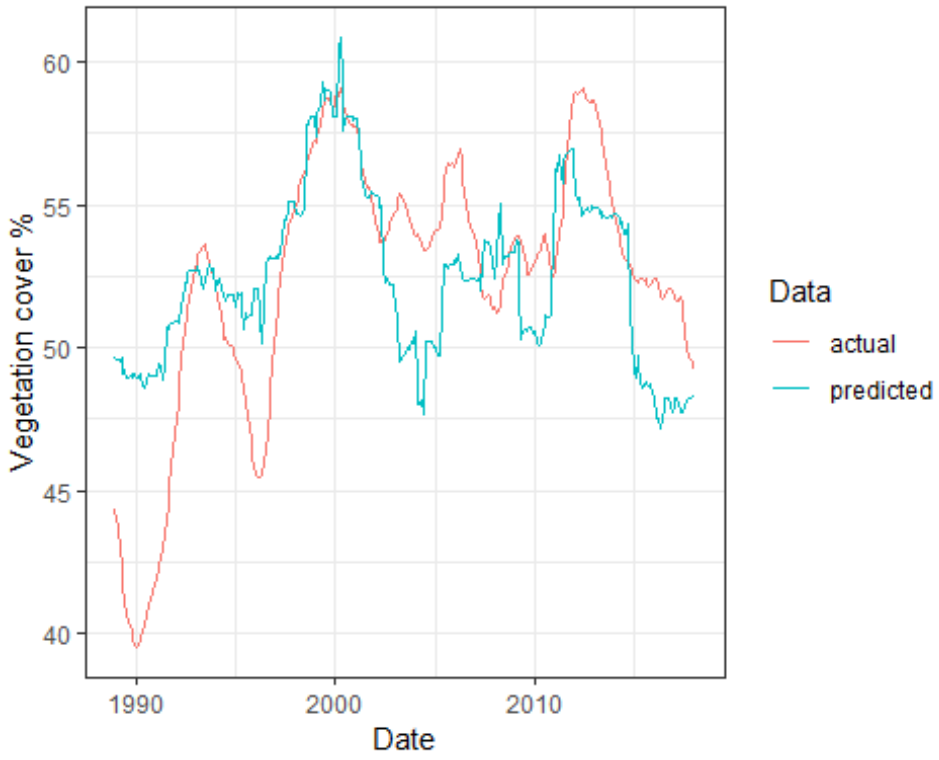

Figure 12: Measured vegetation cover and vegetation cover predicted from rainfall for Dorre Island.

The temporal distribution of residuals (difference between the actual and predicted) are also shown in Figures 13 and 14. Most extremely low residuals are found prior to 2000. This is likely to be due to the previous impacts of fire on Dorre Island and feral goats on Bernier Island.

The results here fit the narrative of vegetation cover on Bernier Island being in a "recovery" phase following the removal of feral goats in 1985, and vegetation cover on Dorre Island recovering from fire. In both cases the dates prior to around 1997 are poorly predicated by rainfall and have many large negative residuals. This indicates that the actual cover values are below what is predicted by rainfall. This suggest another influential factor – goats on Bernier and fire on Dorre.

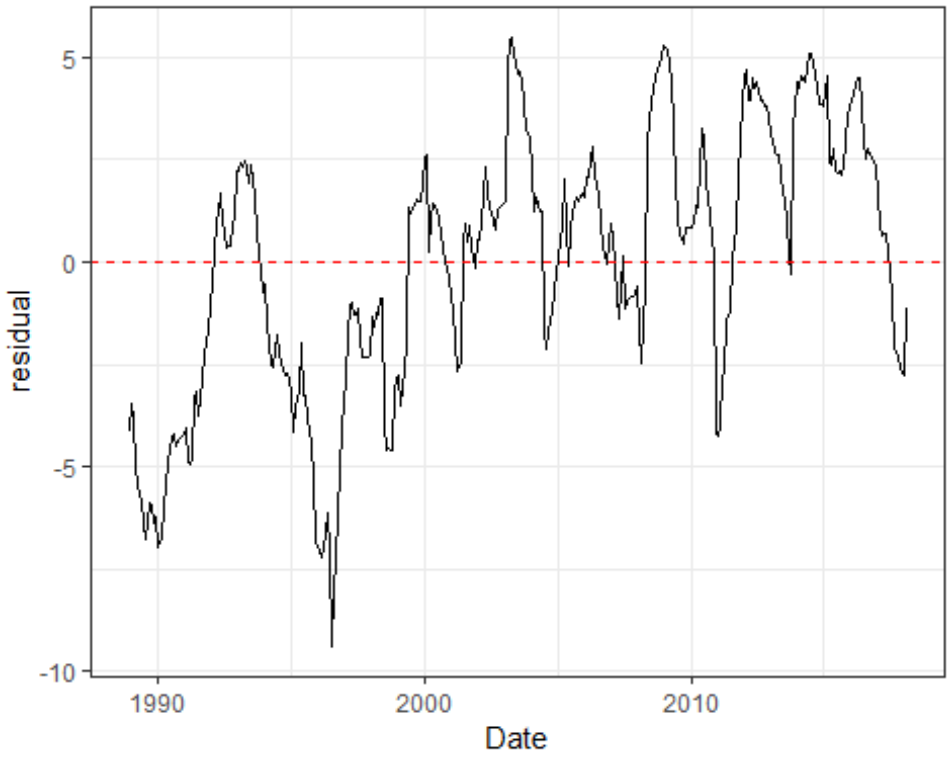

Figure 13: Residuals from the vegetation cover prediction from rainfall data on Bernier Island.

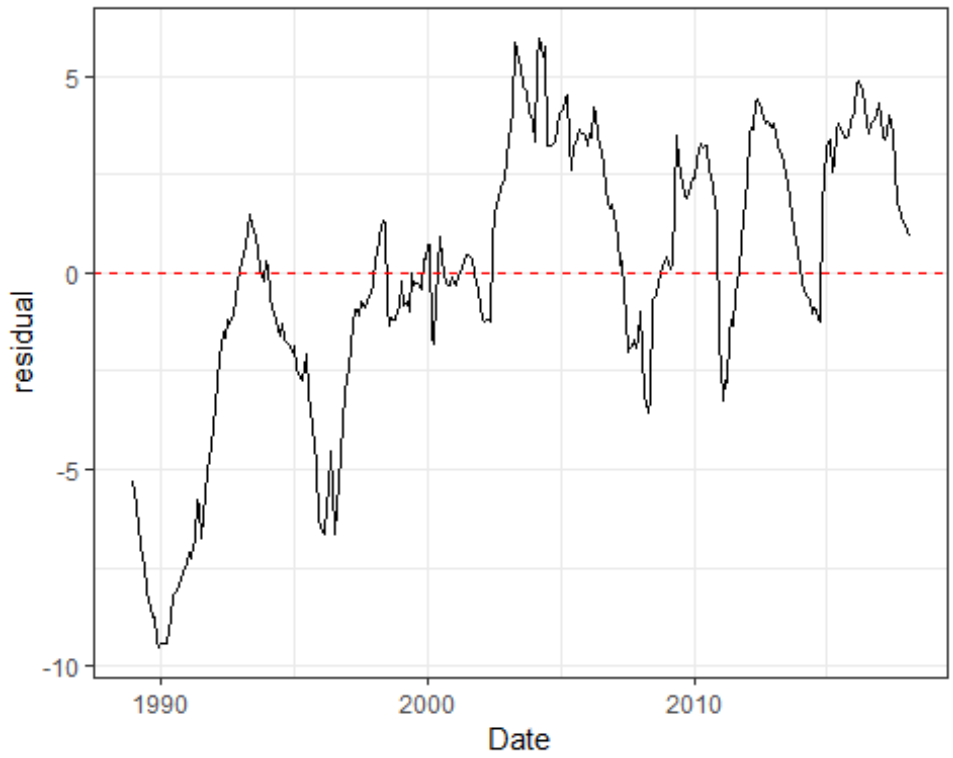

Figure 14: Residuals from the vegetation cover prediction from rainfall data on Dorre Island.

Current vegetation cover

The current level of vegetation cover on the Islands was assessed by ranking the current level against previous years. It is proposed that this could be a proxy for Island condition. A set of annual summer (January to May) Landsat images, captured between 1988 and 2018, was used. The set contained 30 images. A rank of 30 indicates that for the given year the area had the highest cover level in the set, a rank of one indicates the lowest. The vegetation cover rank for levels in 2018 is shown in Figure 15. In 2018, across most of the both Islands, vegetation cover levels were ranked as among the lowest in the 1988 to 2018 time period.

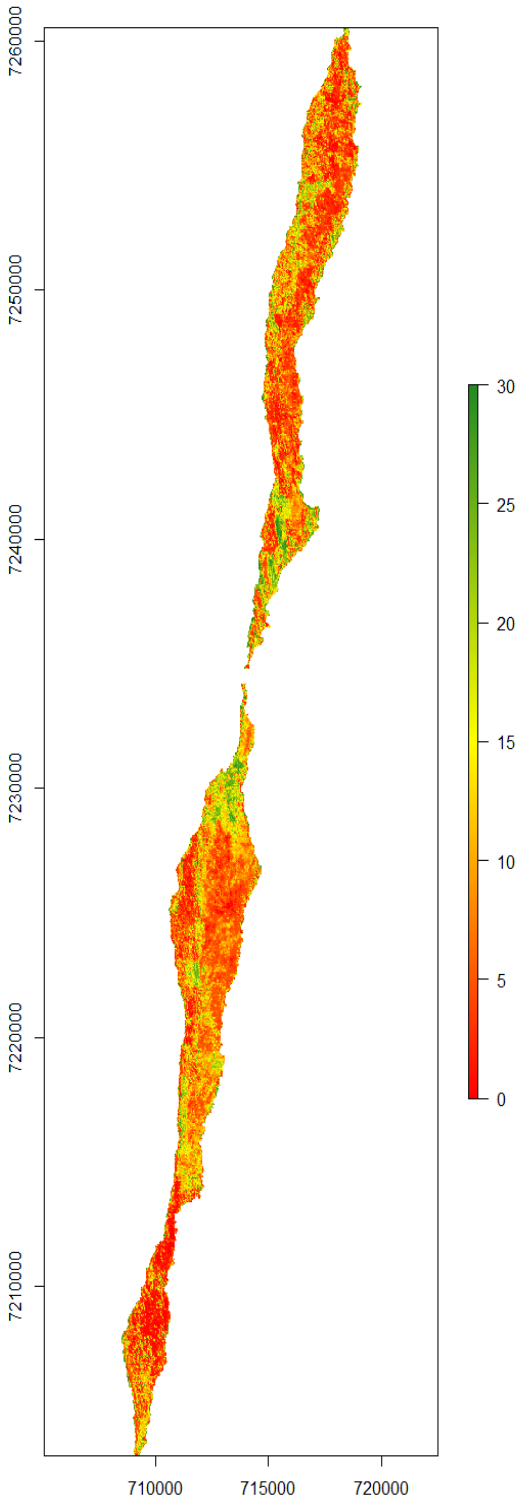

Figure 15: Vegetation cover rank for 2018 from the 1988 to 2018 time period.

A histogram of the vegetation cover rank values from the 2018 image used in Figure 15 is shown in Figure 16. The result for 2018 (Figure 16) contrasts with 2011 (Figure

17), where most cover values have the highest rank, and 2004 (Figure 18), where the cover values are mid-range.

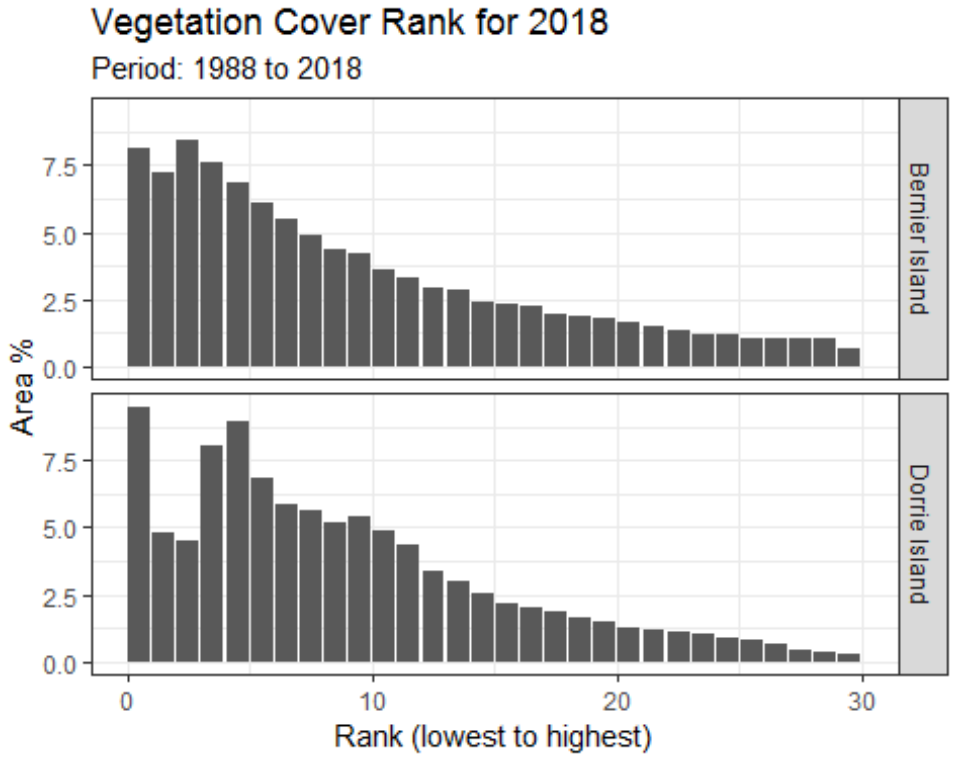

Figure 16: A histogram of vegetation cover rank values for 2018 for the 1988 to 2018 period.

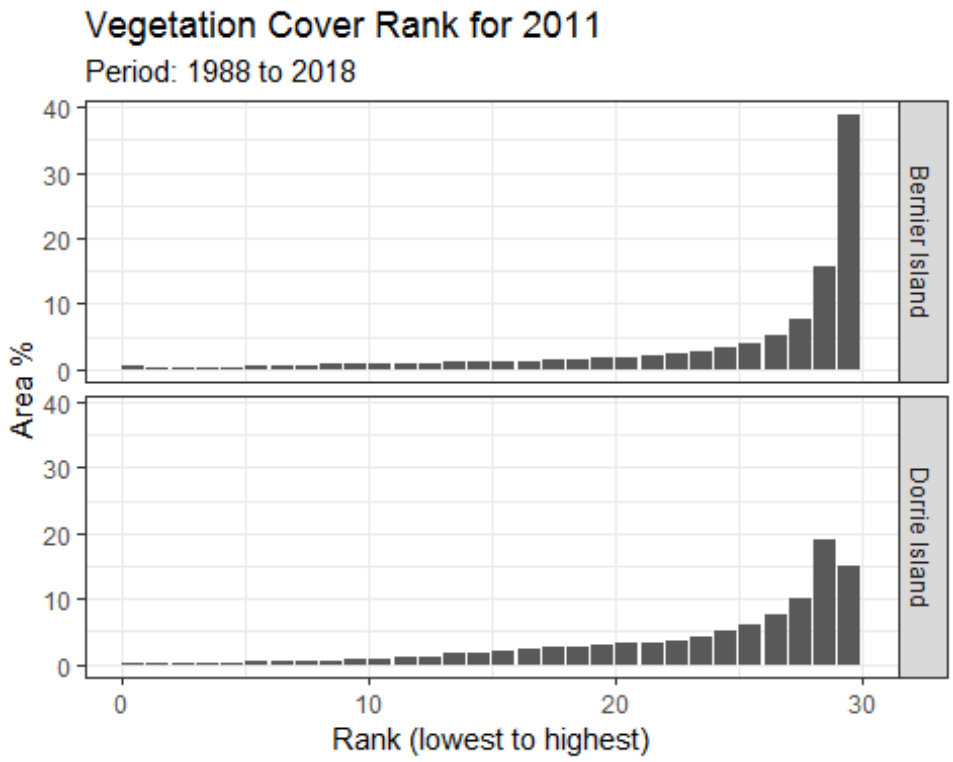

Figure 17: A histogram of vegetation cover rank values for 2011 for the 1988 to 2018 period.

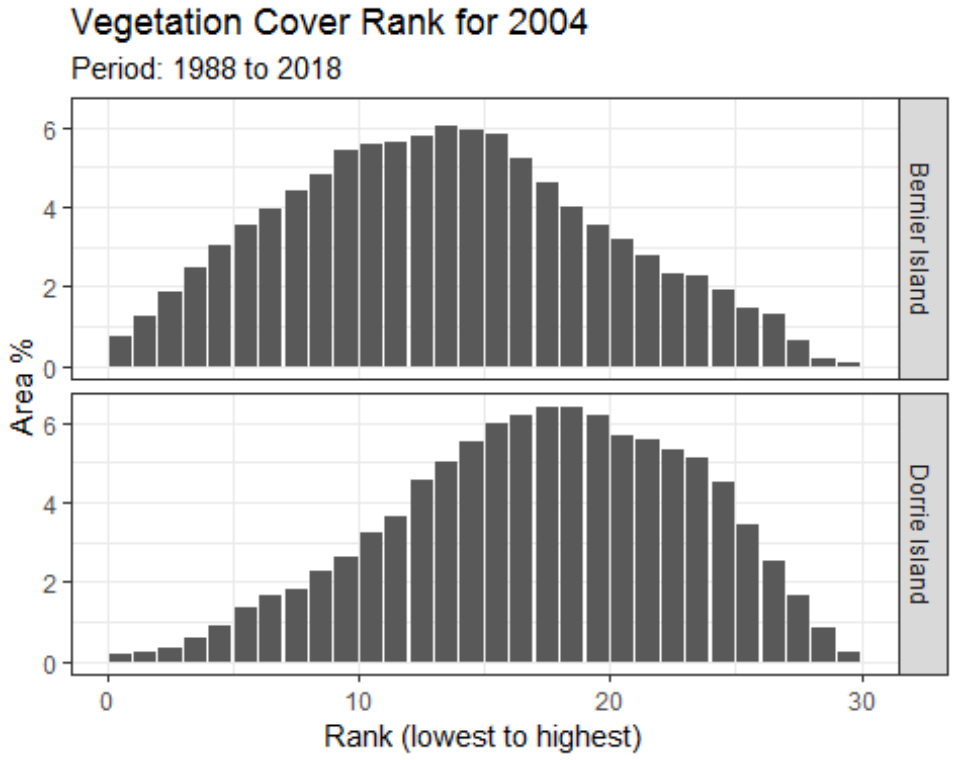

Figure 18: A histogram of vegetation cover rank values for 2004 for the 1988 to 2018 period.

Dune movement

The extent of sand dunes across the islands was assessed using Landsat imagery captured at five year intervals from 1973. To do this the imagery was firstly segmented, then a threshold was manually set to separate “dune” from “vegetated”. Beaches were removed as they vary in area with tidal changes.

The change in sand dune extent Bernier Island drops in a near linear manner from a maximum of 693 ha in 1973 to 488 ha in 2018 (Figure 19). However, it could be argued that the area has remained stable since 1993. Error in the measurements make this difficult to determine. On Dorre Island bare ground following the fire impact is included in the sand dune area (1973). Following the fire impact the area of sand dune on Dorre Island drops to 58 ha (1983), where it remains (also 58 ha in 2018).

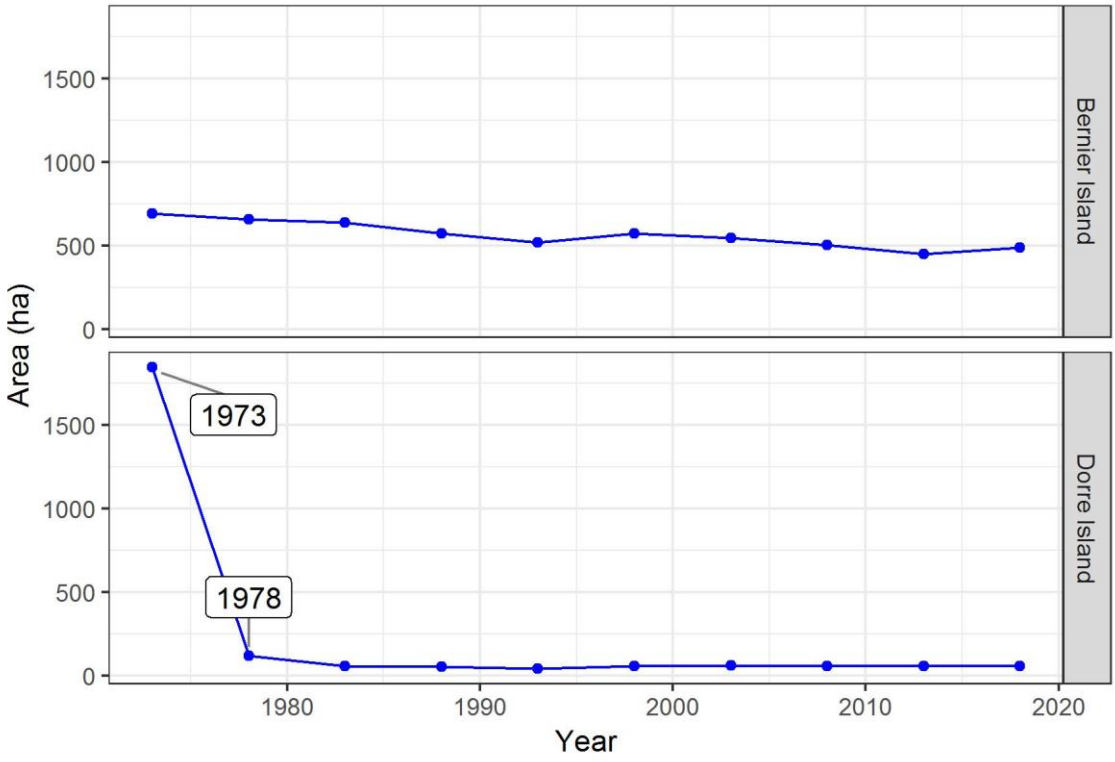

Figure 19: The area of sand dunes (bare ground) on Bernier and Dorre Islands from 1973 to 2018.

Archived aerial photography from 1959, 1969 and 1973 of the Islands are held by the department. They consist of around 16 hard copy prints per year. Two of the prints were scanned and georeferenced for the example in figure 20. From the example prints it seems that the dunes expanded considerably between 1959 and 1973. The

analysis of sand dune changes back to 1959 is possible but would require additional work.

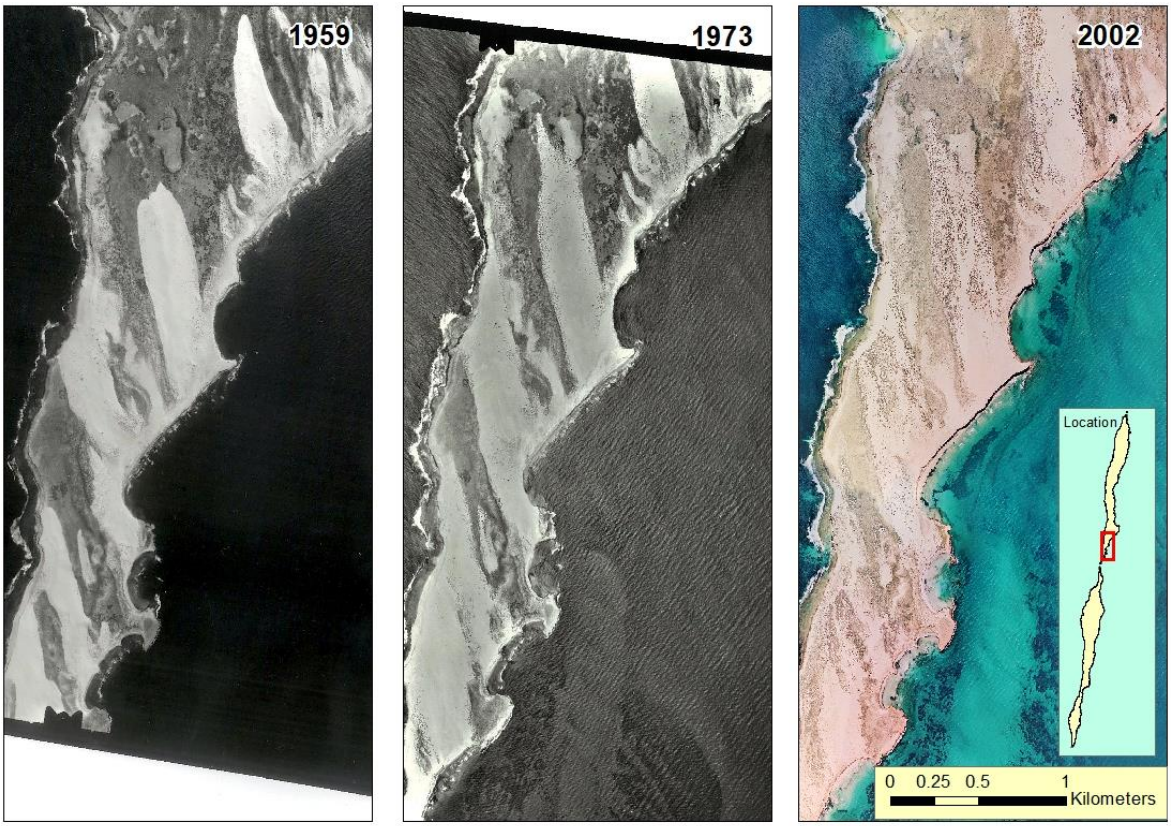

Figure 20: Sand dune extent on the southern tip of Bernier Island 1959, 1973 and 2002.

4 References

R Core Team. 2014. ‘R: A language and environment for statistical computing’. url: www.R-project.org/.

Wu, X., and T. Danaher. 2001. Radiometric Calibration Methods and Software for Landsat MSS and TM Imagery. CSIRO Mathematical and Information Sciences and Queensland Department of Natural Resources.