Project Plan SP 2018-009

Dirk Hartog Island vegetation monitoring

Remote Sensing and Spatial Analysis

Project Core Team

Supervising Scientist	Ricky Van Dongen
Data Custodian	Ricky Van Dongen
Site Custodian	

Project status as of June 15, 2020, 4:52 p.m.

Update requested

Document endorsements and approvals as of June 15, 2020, 4:52 p.m.

Project Team	granted
Program Leader	granted
Directorate	granted
Biometrician	granted
Herbarium Curator	not required
Animal Ethics Committee	not required

Dirk Hartog Island vegetation monitoring

Biodiversity and Conservation Science Program

Remote Sensing and Spatial Analysis

Departmental Service

Service 6: Conserving Habitats, Species and Communities

Project Staff

Role	Person	Time allocation (FTE)
Research Scientist	Bart Huntley	0.05
Supervising Scientist	Ricky Van Dongen	0.1

Related Science Projects

Proposed period of the project

June 6, 2018 – June 30, 2030

Relevance and Outcomes

Background

Dirk Hartog Island is the largest island of the West Australian coast. Since the 1860s the Island was managed as a pastoral lease. In 2009 the Island was gazetted as a National Park and the process to remove introduced animals and enable a suite of 12 native mammal species to be reintroduced began. With the removal of large numbers goats and sheep came questions about the ability of the Islands native vegetation to recover and concerns regarding the proliferation of weed species (which would no longer be grazed). A monitoring program was developed which integrates detailed floristic surveys, repeated site photography and Landsat time series data to provide a comprehensive picture of how the Islands ecology has changed since destocking.

The integration of the ecological and satellite data has allowed present day observations to be put into context with the historical Landsat imagery. Statistical analysis of Landsat time series imagery at monitoring points identifies those at which vegetation cover has increased as a result of destocking. Field observations were then used to identify the species responsible for increases in cover. These data sources, when analysed together, allow management to have great confidence that, following destocking, the native vegetation cover is increasing at a rapid rate. Also that while introduced species, such as buffel grass, have increased in density, there is no evidence that it has increased in extent. Rather it appears that with the reduction in grazing native species are out competing buffel grass. This result provides management with confidence that vegetation condition in the Island is improving, that active revegetation programs are not required and that future mammal reintroduction programs have the best chance of success.

Aims

The data sets to be acquired and analysed will provide baseline measures of vegetation cover. These will be used to identify areas of degraded vegetation and, in the following years, will be used to monitor changes in vegetation cover including restoration of native species and spread of invasive species.

Expected outcome

Monitoring using a combination of satellite imagery and field data will provide spatial and measurable changes in the vegetation cover that will be used to report against feral animal eradication and provide information to support the restoration of native species.

Knowledge transfer

Dirk Hartog Island: Return to 1616 team.

Staff from Geomedia also attended the May 2017 field work to capture film of the monitoring work.

Tasks and Milestones

Objectives for 2017/18:

- Analyse vegetation cover changes over DHI from Landsat imagery (1990 to 2018).
- Provide a report with summary statistics of vegetation change from analysis of Landsat imagery.
- Report on vegetation change related to destocking and goat removal.
- Update measurements of sand dune extent.
- Submit a paper for publication in a scientific journal on the analysis of vegetation change on DHI.

References

Van Dongen, R., and Zdunic, K. (2012). Dirk Hartog Island Aerial Cull and Vegetation Trend Analysis – 2012 (Department of Environment and Conservation).

Garkaklis, M., and Behn, G. (2009). Assessment of Eucalyptus Wandoo (Wandoo) and other tree canopy decline using Landsat Trend Analysis (Perth: Department of Environment and Conservation).

Gove, A.D., Sadler, R., Matsuki, M., Archibald, R., Pearse, S., and Garkaklis, M. (2013). Control charts for improved decisions in environmental management: a case study of catchment water supply in south-west Western Australia. Ecological Management & Restoration 14, 127–134.

Röder, A., Udelhoven, T., Hill, J., Del Barrio, G., and Tsiourlis, G. (2008). Trend analysis of Landsat-TM and -ETM+ imagery to monitor grazing impact in a rangeland ecosystem in Northern Greece. Remote Sensing of Environment *112*, 2863–2875.

Wallace, J., and Thomas, P. (1998). Rangeland Monitoring in Northern Western Australia using Sequences of Landsat Imagery: Summary Product Report on the Image Processing Component (CSIRO Mathematical and Information Sciences).

Wu, X., and Danaher, T. (2001). Radiometric Calibration Methods and Software for Landsat MSS and TM Imagery.

Zhu, Z., Woodcock, C.E., and Olofsson, P. (2012). Continuous monitoring of forest disturbance using all available Landsat imagery. Remote Sensing of Environment.

Zdunic, K., Behn, G., Setiawan, H., van Dongen, R., (2011). Landsat vegetation trends and land management - geographically identifying the effects of Livestock numbers on vegetation in Dirk Hartog Island, in: Proceedings of the 7th International Symposium on Digital Earth (ISDE7). Presented at the 7th International Symposium on Digital Earth, International Journal of Digital Earth, Perth, Australia.

Study design

Methodology

A monitoring program was devised to investigate and monitor changes in vegetation cover following destocking. The program was essential to determine the effect of destocking on the spread of weed species and to ensure that conditions on the Island are favorable for the reintroduced native fauna. The monitoring program utilises detailed floristic site descriptions, site and nadir photography which provide validation and attribution to temporal changes observed in the Landsat satellite data. The monitoring program has change imagery and time series analysis from Landsat imagery at its core. Field validation was designed with the “Landsat scale” in mind and also had to fit in with time and budgetary restrictions. The validation data also had to adequately convince manages that change observed in the Landsat imagery reflected actual change on the ground and to also indicate which species may be responsible for change. The data also had to provide an indication as to whether these changes were the result of management actions or part of a longer term cycle of vegetation change and succession.

Landsat imagery is central to the analysis. The Landsat satellite series began in 1972 and captures reflectance data at moderate spatial (30 m) and temporal (16 day) resolution. Following a new distribution policy agreed to by National Aeronautics and Space Administration (NASA) and the United States Geological Survey (USGS), the entire Landsat archive was made available for download free of charge. This has led to a dramatic rise in the use of Landsat data across an increasing range of end users (Zhu 2017). One such use is to provide a record of how land cover and ecosystems have changed over the past 40 years (Wulder et al. 2012).

The analysis and interpretation of Landsat time series data is a constantly evolving field. Examples of the evolution of analysis techniques include Thomas et al., (2011) who utilized temporal stacks of Landsat data, captured bi-annually between 1985 and 2005, to estimate rates of forest disturbance. Kennedy et al., (2010) developed the TimeSync segmentation process which simplifies and classifies temporal signatures from Landsat temporal stacks. Temporal stacks of Landsat data can also be used to predict forest structure. This was done for a mixed conifer forest by Pflugmacher et al., (2012) using the disturbance history of a site as described by the Landsat time series. Accuracies achieved were comparable to structure measures obtained from LiDAR data ($r^2 = 0.80$). The study demonstrates how the history of a site is important in determining its current structure.

The analysis of annual and bi-annual temporal stacks was developed further by Zhu et al. (2012) who developed a change detection algorithm that uses all available Landsat data to continually monitor forest condition. The algorithm developed by Zhu et al. (2012) was designed to detect significant disturbance events, such as forest clearing. However, standard time series analysis techniques (e.g. break point analysis and cumulative sum control charts) could also be used to interrogate more subtle changes in the Landsat time series.

While break point analysis can be used to identify points of change within a time series, control charts can be used to identify undesirable trends early and provide criteria for defining when management actions should take place (Gove et al. 2013). Control limits within control charts delineate thresholds within which points should fall if processes are progressing as expected (in control). Points moving beyond these thresholds suggest that there are abnormalities in the system (that it is out of control), and that investigation and corrective action is required (Montgomery 1997). Corbett and Pan (2002) recommended the use of cumulative sum (CUSUM) control charts to monitor emissions data as they detect abnormal changes in a timely manner.

For satellite observations of vegetation cover change to be useful for management they required validation, to confirm a change has taken place, and attribution, to determine what is causing the change. Large events, such as fire, cyclonic activity and land clearing can be validated and attributed using sources such as the extensive online record of satellite imagery on Google earth (Pasquarella et al. 2016) However, small scale changes which require attribution to the species level, as is the case in this project, require field checking.

The aim of this study is to monitor changes in the Dirk Hartog Island ecology following destocking of introduced herbivores. This was done by developing a monitoring program utilizing Landsat satellite imagery in combination with detailed, yet efficient, field checking techniques.

Biometrician's Endorsement

granted

Data management

No. specimens

Herbarium Curator's Endorsement

not required

Animal Ethics Committee's Endorsement

not required

Data management

Budget

Consolidated Funds

Source	Year 1	Year 2	Year 3
FTE Scientist FTE Technical Equipment Vehicle Travel Other Total			

External Funds

Source	Year 1	Year 2	Year 3
Salaries, Wages, Overtime Overheads Equipment Vehicle Travel Other Total			