Department of Environment and Conservation

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DEC Nature Conservation Service

Biodiversity

Monitoring Protocol

Monitoring the impacts of fire and Phytophthora within the shallow soil plant communities of the Mt Lindesay Threatened Ecological Community, Denmark WA

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Prepared for:

Significant Native Species and Ecological Communities – Resource Condition Monitoring Project

Version 1.0 (June 2009)

Monitoring the impacts of fire and Phytophthora within the shallow soil plant communities of the Mt Lindesay Threatened Ecological Community, Denmark WA.

Revision History Log			
Version #	**Revision Date**	**Author**	**Changes**

Acknowledgments

Advice when commencing this project was provided by DEC staff from the Warren Region. Advice when developing the protocol, and assistance with field work logistics was provided by Karlene Bain. Jason Fletcher, Carol Ebbett and Mavis Sowry participated in the establishment of monitoring. Thanks also to Janine Liddelow for reviewing the protocol.

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1 Introduction

This monitoring protocol provides information and procedures for monitoring the effects of fire and *Phytophthora* on the shallow soil plant communities of the Mt Lindesay threatened ecological community in Denmark, Western Australia (**Figure 1**).

Figure 1: **Mt Lindesay, located within the Mt Lindesay National Park, north of Denmark WA.**

2 Protocol Constituents

This protocol consists of this Protocol Narrative and the following Standard Operating Procedures (SOP):

SOP 6.2 Establishing vegetation transects

3 Background and Objectives

3.1 Background and history

Mt Lindesay and Little Lindesay are located within Mt Lindesay National Park, 15km due north of the town of Denmark, 400km or 5 hours drive south of Perth. The Mt Lindesay threatened ecological community (TEC) is currently ranked as endangered (endorsed by the Minister in 2001) and the TEC boundary is based on mapping by Beard (1979) (**Figure 2**). The TEC is defined by the following

description (Beard 1979):

"E. marginata shrub-mallee and heath predominates on the upper slopes and summit area with mixed E. marginata – E. calophylla – E. megacarpa low woodland in gullies. Soils are shallow or skeletal. In these areas, typical (occurring in more than 60% of quadrats) shrub species include Banksia grandis, Hakea varia and Beaufortia decussata, and typical sedges are Mesomelaena gracilipes and Tetraria capillaris. Priority taxa on the upper slopes and summit area include: Sphenotoma parviflorum, Gastrolobium brownii and Sollya drummondii. Andersonia sp. Mt Lindesay, which occurs on the lower slopes, and Andersonia aff. setifolia are endemic to Mt Lindesay and Little Lindesay. Relatively bare granite rock slabs dominate the middle slopes and support a unique community of scrub and open herbs, which includes a number of species endemic to Mt Lindesay and Little Lindesay. These include: Borya longiscapa, Grevillea fuscolutea, Lasiopetalum aff. cordifolium, Cryptandra congesta and an undescribed species of Laxmannia."

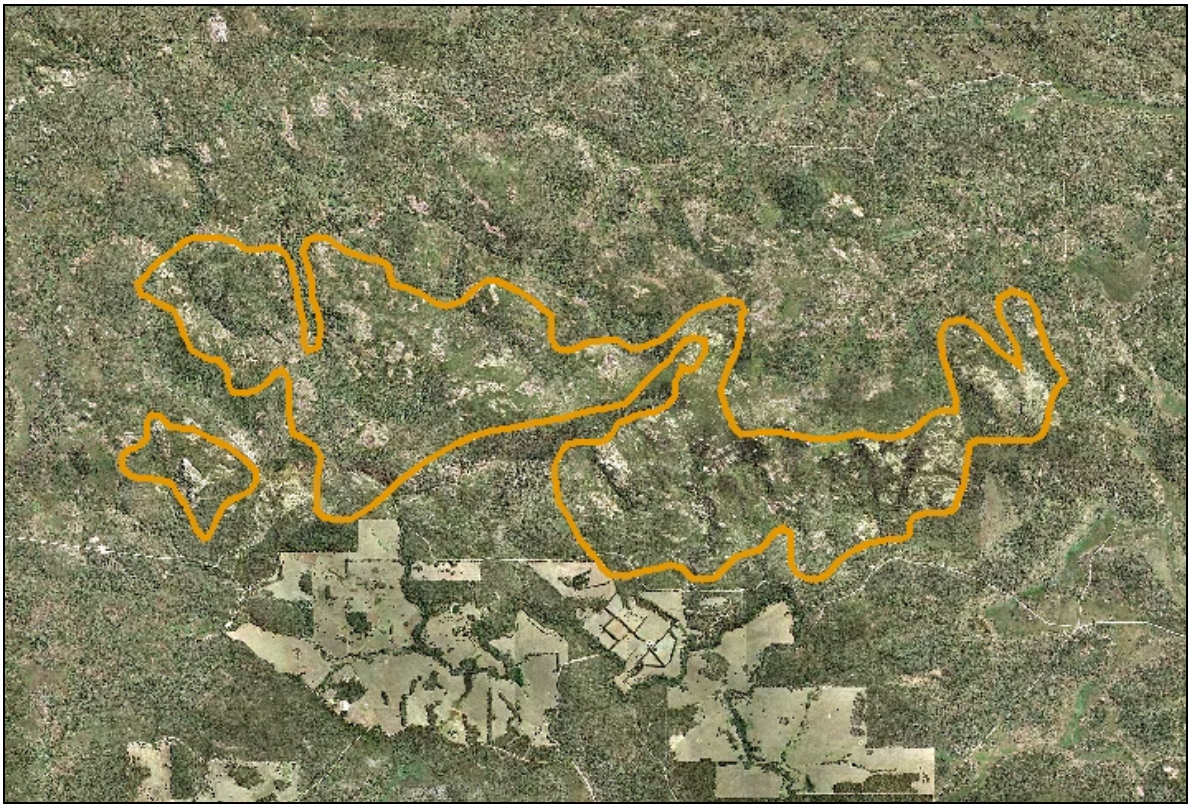

Figure 2 **The Mt Lindesay threatened ecological community boundary (based on Beard (1972) mapping).**

Threats listed for this TEC include *Phytophthora* spp., inappropriate fire regimes, and high intensity fires. *Phytophthora cinnamomi* infestation on Mt Lindesay has been recently surveyed by DEC staff and the TEC area has been mapped largely as infested with only a few areas, generally in the uplands, of uninfested or protectable areas (**Figure 3**).

Mt Lindesay National Park was proposed for a prescription burn in late spring 2008 by Frankland District. Due to late, heavy rains during September through to November, the prescription burn was postponed until either Autumn or late Spring 2009 (K. Bain pers. comm.)

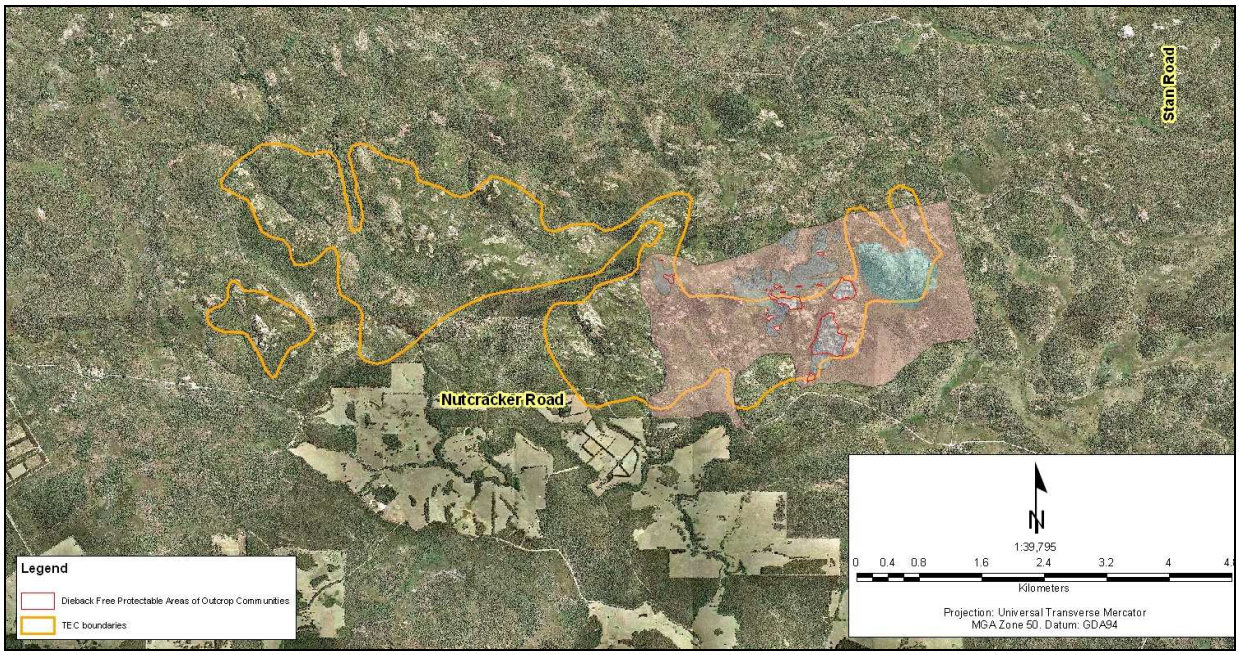

Figure 3 *Phytophthora* survey mapping of Mt Lindesay (shaded area is the survey area and red bounded areas are the only Dieback free protectable areas).

During floristic surveys of montane communities on the south coast of WA, Barrett (1996) noted that both inappropriate fire regimes and *Phytophthora* were altering not only species composition but also plant community structure, as resistant species, especially herbaceous perennials and in particular sedges, became more prevalent. Additionally, "a high level of disease impact was observed in more frequently burnt sites." The vegetation restricted to the shallow soils around granite outcrops has been noted to be more severely affected by inappropriate fire regimes and *Phytophthora* (Barrett 1996).

3.2 Rationale for selecting this resource to monitor

The Mt Lindesay TEC was prioritised for monitoring due to its current ranking as endangered and due to the opportunity to work with district and regional staff to monitor this community pre and post fire. Additionally, Mt Lindesay has recently been surveyed for *Phytophthora* and the results have been mapped.

The effects of fire and *Phytophthora* on the plant community structure and composition are proposed as the subjects of this monitoring proposal.

The monitoring method proposed will facilitate a range of statistical analyses to be performed, which over time, should indicate if plant species dominance and composition is changing in response to the identified threats. Over time and with decreased resources it may be possible to collect a reduced level of information to continue monitoring and analysis. For example, the expected increase in sedge/rush cover (due to *Phytophthora* or too frequent/hot fires) could be used as a surrogate to indicate a decrease in overall native plant species diversity. A large increase in sedge cover may be indicative of changes to plant community structure. Additionally, Proteaceous and Epacrid groups could be analysed separately to examine trends associated with *Phytophthora* infestation.

The plant communities of the shallow soils will be targeted as these are thought to be more adversely affected by inappropriate fire regimes and *Phytophthora.* The monitoring proposed for the Mt Lindesay TEC seeks to answer the following questions:

- is *Phytophthora cinnamomi* altering plant community composition and structure?
- is the current fire management for the Mt Lindesay National Park altering plant community composition and structure? and

- are the cumulative effects of *Phytophthora cinnamomi* and fire altering plant community composition and structure to an even greater degree?

The Mt Lindesay TEC has been selected for monitoring as part of the Resource Condition Monitoring (RCM) project. The RCM project provides an opportunity to document and establish monitoring programs that may not have been achievable without additional external resources and funding.

3.3 Measurable objectives

The main objective of this monitoring proposal is to determine the effect of fire and *Phytophthora* spp. on plant community structure and composition in the TEC. The monitoring will be undertaken in such a way that the following minor objectives will also be able to be achieved:

- to determine if sedges/rushes (Restionaceae, Cyperaceae, Dasypogonaceae) are increasing in cover in transects in areas more frequently burnt and/or *Phytophthora* infested;
- to determine if the cover of taxa from the Proteaceae and Epacridaceae families are decreasing in transects in *Phytophthora* infested areas; and
- to determine if plant community composition (determined by frequency of transect intercepts) are changing in areas subject to both fire and *Phytophthora.*

4 Sampling Design

4.1 Rationale for selecting this sampling design over others

Point intercept transects have been selected as the appropriate method for answering the monitoring questions relating to plant diversity and dominance responses to perceived threats. A short transect length was selected to facilitate the establishment of transects that would fit within the restricted pockets of granitic vegetation on shallow soil areas of Mt Lindesay, the focus area of this monitoring.

For each transect, every plant taxon intercepted will be noted and will have a sample collected for the WA Herbarium to allow verification of field identifications. Not all specimens will be retained by the herbarium but will be limited to range extensions, new collections for the area, and taxa of interest.

The TEC was mapped with aerial photography, the TEC boundary, contour heights, fire scar information and recent *Phytophthora* mapping. Monitoring sites were then randomly placed within shallow soil habitats of the TEC and stratified to encompass the following variables:

- burnt and unburnt areas;
- *Phytophthora* infested and uninfested areas; and
- burnt and unburnt *Phytophthora* infested and uninfested areas.

Warren Region staff involved in the prescription burn for the Mt Lindesay National Park are proposing to manage the prescribed burn to allow sufficient areas to remain unburnt/burnt for monitoring purposes. Should the need for additional replicate sites be required, additional monitoring plots will be added post-burn.

4.2 Site Selection

4.2.1 Criteria for selection

The Mt Lindesay TEC boundary has been mapped according to the vegetation described and mapped by Beard (1979) and therefore all sites selected are within the mapped boundary.

The sampling is to occur within the midslope to upper contours of the TEC to enable the shallow soil, fire and *Phytophthora* sensitive vegetation to be sampled and to represent all the site variables (burnt/unburnt/Pc infested/uninfested). These shallow soil areas are potentially more affected by fire and *Phytophthora* and are habitat for a range of declared rare, priority and endemic flora.

4.2.2 Procedures for selecting sampling locations

The procedure for selecting sampling locations was based on the need to establish adequate replicates of the treatment types to ensure powerful statistical analysis. Although sites have been stratified within the upper to midslope contour band of 120 meters to 400 meters all sites were randomly selected within this contour zone. Spatially, the sites were placed randomly within an area of the range which allowed the combination of treatments to be sampled. A suite of aspects were selected to ensure adequate sampling across the variability in the shallow soil granitic habitats.

4.3 Sampling frequency and replication

Sampling replication was limited to the site variables (Pc infested, Pc free, burnt, unburnt) being sampled within this project and the maximum number of sites able to be installed during the pre-burn field sampling time. Due to the somewhat unpredictable nature of fire some post-fire plots may need to be installed to ensure enough replication across the treatment types.

The transects are 5 metres in length and are sampled at 10 centimetre intervals starting at ten centimetres and up to and including 500 cm.

The frequency of monitoring should be: sampling in the spring immediately prior to the prescription burn; and then two, five and ten years post fire. When a subsequent prescription burn is proposed for Mt Lindesay, or in the event of wildfire the same sampling frequency is recommended.

If any other significant management action is undertaken (eg phosphite spraying) pre and post monitoring should be undertaken for transects subject to management at the same frequency.

4.4 Recommended number and location of sampling sites

The location of the transects was recorded with a differential GPS and marked by short metal pegs (tent pegs) to assist in relocating the transects post-burn and to minimise visual impacts. Initially 10 replicates within each treatment were proposed. Following the data analysis and discussion with a biometrician of the trial transect establishment (13 transects were established in May 2009) it was revealed that more transects in dieback free areas were required.

In spring (September 2008) 40 transects were monitored (including re-monitoring the 13 initial transects). A total of forty transects were established as it was felt that this number may adequately sample the range of shallow soil habitats; it would provide enough dieback free transects to give power in data analysis; having greater than 40 transects to re-monitor would be an impractical time/resource demand on district staff who already have significant field work loads.

4.5 Recommended frequency and timing of sampling

The recommended frequency and timing of sampling is one sampling occasion (in spring) pre-burn and then post-fire monitoring after two years, five and ten years post-burn (or wildfire). Monitoring should also occur before and after any major management action is initiated (such as phosphite spraying).

4.6 Level of change that can be detected for the amount/type of sampling being instituted

Due to the lack of comprehensive baseline information on shallow soil granitic plant communities, it is not possible to state the level of change that will be able to be detected over time with continued sampling. Monitoring will have to occur over a significant period of time and at numerous sites before an understanding of the natural variations and fluctuations can be inferred.

Over the longer monitoring term (+ ten years post fire) and with a number of transects re-sampled, a number of trends related to the identified threats may become apparent.

5 Field Methods

5.1 Field season preparations and equipment setup

Field work will be scheduled and organised prior to the start of each field season. Contact will be made with NRM and DEC Regional and District staff to schedule field trip dates and access arrangements. Prior to working in the field, staff must complete a field advice form and review the RCM safety protocol and this protocol.

Desktop study

The following equipment will be required to undertake the desktop study prior to field reconnaissance:

- Digital data including aerial photography, contour information, TEC boundary, cadastre, *Phytophthora* interpretation mapping, fire scar (history) mapping;
- Burn prescription documentation; and
- Site selection based on stratified (within selected contour bands) random (sites selected at random points within contour band) basis.

Field reconnaissance

A field reconnaissance will be undertaken to set up some preliminary transects so that an indication of the field time required in spring can be determined. Additionally the data from the preliminary transects will be analysed to indicate how many transects will need to be installed to achieve power in the statistical analyses.

The following equipment will be required to undertake the field component of the monitoring:

- plant collection permits (including Permit to Take Declared Rare Flora (DRF));
- secateurs;
- plant tags;
- newspaper;
- plants presses (6);
- pens, pencils, permanent thick black marker pens;
- recording sheets (or PDA for direct data entry);
- digital camera, memory card, batteries;
- DGPS and GPS;
- metal tent pegs;
- hammer;
- flagging (survey) tape;
- 50 m measuring tape (2);
- point intercept device (for example extendable car aerial);
- plant specimen books;
- hygiene kit (*Phytophthora*); and
- soil depth gauge.

Preliminary preparations

Plant collection licences (including Permit to Take Declared Rare Flora (DRF)) should be organised at least one month prior to field reconnaissance. Accommodation in close proximity to Mt Lindesay will be booked as soon as field dates are determined and a full list of groceries and meal planning will be prepared prior to field reconnaissance. Shared vehicles and equipment should be booked in advance on the relevant field equipment booking sheets.

5.2 Sequence of events during field season

During field season the following actions are to be undertaken:

- the vehicle will be checked and packed with the relevant equipment;
- sufficient travel time will be allowed to reach accommodation destination and to unpack;
- purchase of groceries for field trip;
- field work component and plant pressing; and
- re-check and pack vehicle for return trip to Perth.

5.3 Details of taking measurements, with example field forms

It was initially envisaged that ten five metre long transects would be established within each treatment type (Pc infested, Pc free, burnt, unburnt) to enable enough of the natural variation within the shallow soil habitats to be sampled without too great a bias within a particular site (Appendix A). Due to accessibility issues during the field work sixteen transects were established in dieback infested areas; 22 in dieback free areas; and two transects in areas that were considered uninterpretable (Appendix B).

Transects were established using SOP 6.2 "Establishing vegetation transects" and were placed randomly within the areas pre-selected for sampling based on the treatment types. They were permanently marked with a small metal tent peg at the start and finish, and their location recorded using a differential GPS. The vegetation was sampled at 10 cm intervals along the transect length, beginning at 10 cm and continuing to and including 500 cm.

At each sampling point along the transect a point intercept device (such as an extendable car aerial) was placed vertically along the measuring tape and each plant that came into contact with the pointer was recorded for that distance along the transect. A collection of each plant was made adjacent to the transect line and pressed into a permanent collecting book. Larger collections of these specimens were collected for identification purposes and for lodgement with the WA Herbarium (where required).

A photograph was taken at the start of each transect with the tape run out to indicate the location (Appendix C).

Habitat information including aspect, *Phytophthora* status (free, infested, uninterpretable), depth to rock and landform characteristics will be noted. Species, community and environmental relationships will be revealed by ordination and classification.

Appendix D is an example collecting form for environmental and species data for transects, and Appendix E provides an example of the environmental data collected for each transect. A TEC Occurrence Report Form may also be filled out when undertaking monitoring (contact Department of Environment and Conservation, Species and Communities Branch, TEC specialist group).

5.4 Post-collection processing of samples

The procedure for post-collection of plant specimens includes:

- newspaper to be changed every fortnight;
- plants are taken to WA Herbarium and processed accordingly (i.e. placed in freezer or microwaved);
- preliminary plant identifications to be undertaken using reference collection and keys;
- additional identification assistance to be sought from herbarium staff;
- RFRFs to be completed for DRF and priority taxa;
- Plant collection labels produced (through MAX) and sorted with specimens; and
- Plant specimens and photographs lodged with the herbarium.

5.5 End-of-season procedures

The following tasks are to be undertaken at the end of the field season:

- plant specimens processed, mounted, boxed and sent to the WA Herbarium;
- equipment has been cleaned, stored and is ready for the next season;
- data stored appropriately in a central corporate location;
- transect data collated and input into an ordination analysis program (eg. Primer); and
- report preparation.

6 Data Handling, Analysis and Reporting

The *Natural Resource Management - Regional Spatial Information Management Toolkit* (2008) (the NRM Toolkit) states that it is important that data are collected and managed according to agreed industry standards. The benefits of doing this include (modified from NLWRA 2003):

- improved data consistency;

- higher quality data;
- greater opportunity for data integration and aggregation;
- increased opportunities for sharing data;
- improved documentation and understanding of data and information resources;
- improved control over data updating; and
- improved data security.

6.1 Metadata procedures

Metadata is "data about data". That is, a statement about a dataset which describes the content, quality, currency and location and custodianship of the data.

The Australia New Zealand Land Information Council (ANZLIC) has developed guidelines for the collection of metadata (ANZLIC, 2001*)*. These guidelines include core metadata elements that are required as minimum information in metadata statements. It is also standard practice for metadata of key custodial datasets to be included on spatial data catalogues, such as *Interragator+* or the Australian Spatial Data Directory, in order to provide wider access (WALIS 2007). The data custodian should develop the original metadata record. Metadata records can be created in a Word document or text file and should be saved in the same directory as the dataset. See Appendix F for a metadata statement template.

Metadata for this project will be for the data collected from both the survey and monitoring components of this protocol.

6.2 Overview of database design

The various databases, reports, GIS data, etc. used and generated by vegetation monitoring create a large number of files and folders to manage, with the organisation and linkages increasing in complexity as data accumulates through time. Foresight in database design is integral to ensuring data quality (DeBacker *et al*. 2004)

The DEC Threatened Ecological Communities Database (Microsoft Access) is the primary software environment for threatened ecological community data. ESRI ArcGIS 9 serves as a tool for validation of spatial data residing in this Microsoft Access database. The Microsoft Access database Site Species (T.Griffin) has been designed on "a vision that through using an organised and standardised system, data can be compiled across the botanical sector to benefit the sector and the community. It is designed to manage the capture of, manipulation of, and reporting on information related to collections of plants in a systematic manner." Monitoring data collected according to this monitoring protocol will therefore be stored in Site Species, with a copy of the data stored with the district.

6.3 Data entry, verification and editing

Data entry is the initial set of operations in which raw data from paper field forms or field notebooks are transcribed into a computerized form (i.e. within a database) (DeBacker *et al.* 2004). Data collected according to this monitoring protocol was entered as soon as possible after data collection into the TEC database and Site Species database by people familiar with the data. This helped to minimise errors as familiarity with the data allowed errors to be detected and easily corrected. Where edits to data were required, information was crossed out and replaced with the correct information on the hardcopy datasheets, in order to document decisions made about the data.

Data entry forms with quality assurance and quality control (QA/QC) features have been developed to minimize errors. Data entry forms reduce transcription errors through drop-down lists and value limits. Standardized identifiers (e.g. sample period or location) are selected from a list generated from a look-up table. Look-up tables contain project specific data and prohibit entry of data into a field if a corresponding value is not included in the look-up table. Consequently, only valid names or measures may be entered and spelling mistakes are eliminated. If a species name does not appear in the drop-down list, a series of quality control measures will prevent the entry of an erroneous species name into the database. Without a species name or habitat measure listed in the drop-down list, it cannot be typed in. Sequential procedures within the database structure determine if it is the result of a name change or a new species or habitat measure. Synonymous names (i.e. two or more different names referring to the same taxon), common for plant species, are searched for prior to entering a new species name, thereby preventing the duplicate entry of synonyms. To check the current

nomenclature for a taxon, a nomenclature update form is attached to the data entry form via a button. If the species or habitat measure name has changed, the form will indicate the current accepted name. If the species name is valid, but not currently in the database, a form is provided to update the species table with the new species name and attribute data (DeBacker *et al*. 2004).

GPS points for transect locations were entered into the TEC database and converted into a GIS layer for use in ArcMap9 using the available ArcGIS Desktop Help 9.2 linking tool for adding x,y coordinate data as a layer: http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?id=202&pid=200&topicname=Adding_x,y_coordinate_data_as_a_layer. Additional GPS data not suitable for the TEC database were transferred into ArcMap9. Location data were verified for accuracy in relation to survey area boundaries.

As noted in DeBacker *et al*. (2004), data verification should immediately follow data entry and involve checking the accuracy of computerised records against the original source (eg. paper field records). Once the computerised data have been verified as accurately reflecting the original field data, the paper forms can be archived and the electronic version used for all subsequent data activities.

6.4 Recommendations for routine data summaries and statistical analyses to detect change

A critical component of any long-term monitoring protocol is a consistent and systematic way of analysing and reporting on information (data) collected. Data summaries and statistical analyses need to describe the current condition, or status, of a plant community and be robust enough to detect community changes through time. The information provided in data summaries must be complete, descriptive and easily interpretable. (DeBacker *et al*. 2004)

Data summaries and statistical analyses for this project need to detail information about changes in plant community composition, dominance and community structure based on the indicators noted under section 3.3.

Any management interventions (for example phosphite spraying) that may influence these indicators need to be noted in the data summaries.

Data summaries will be undertaken at the end of each monitoring occasion. Given that after the initial year, monitoring is recommended after 2, 5 and 10 years, data summaries at this interval should not be too laborious. Statistical analyses will focus on changes in density of sedges and taxa from the Proteaceae and Epacridaceae families. As additional data are collected, trend analysis using time-series analysis or repeated measures may be used to detect temporal trends in vegetation community data (DeBacker *et al*. 2004).

6.5 Recommended reporting schedule

Reports will be prepared and distributed within the same year as data collection and include maps, graphs, figures and other visuals to facilitate comprehension of findings. More extensive summary reports, including trend analysis, should be completed every five to ten years depending on the rate of change in the vegetation community dynamics and the need for summary information to guide resource management. Summary reports may be used in place of annual reports for that year (DeBacker et al. 2004).

6.6 Recommended methods for long-term trend analysis

Data analyses that examine species diversity and abundance changes over time are recommended. Analyses offered through Primer are currently being considered.

6.7 Data archival procedures

Archived data are data that are copied and held and stored apart from the original dataset. The intention and purpose of archiving data is to ensure that data are available for other uses such as on-going monitoring, natural resource assessments or as agreed by the data custodian. Data should be archived unless this is prevented due to commercial, confidentiality, copyright, or previous contractual

arrangements. All archiving of data and other information must provide appropriate security; must ensure the continuing recoverability of archived data; and must include metadata and/or other relevant supporting documentation to enable use of that data and other information. See WALIS Data Management Guidelines:

(http://www.walis.wa.gov.au/policies/assets/WALIS%20Data%20Management%20Guidelines%20v01.00.pdf.

Archived data should be held in a dynamic database or secure repository. It should be time stamped and version controlled and should not be changed, amended or altered unless this is necessary to correct an error occurring during the archiving process. A data archive should be established for each project. This archive should be stored away from data accessed on a daily basis to satisfy normal project requirements. To minimise the risk of calamitous loss, the data should be stored at an external location and depending on the amount of data, on suitable digital media (CDROM, DVD or Tape), external removable hard disk drive or dedicated archival sever.

For ease of access and retrieval, the archived files should be stored using the same directory structure as the working project files. A program should be set in place to access the archived material at regular intervals to check that the data can still be read. Every attempt to access the data should be recorded in a log, noting the name of the person involved, the success or otherwise of the operation and include any relevant comments. Any access failures must be reported to the data custodian immediately and steps taken to rectify the loss.

Long-term archives of TEC data (both electronic and hardcopy materials) will be stored at the DEC Species and Communities Branch offices in Kensington. The data will be stored on the DEC server and the TEC/PEC database. Hard copy materials may also be stored at the DEC region/district headquarters. In this case, copies of all materials will be made and sent to the DEC Species and Communities Branch archive.

7 Personnel Requirements and Training

7.1 Roles and responsibilities

General roles of the project team leader include:

- liaison with managers and other stakeholders;
- co-ordination of field visits;
- determination of team logistics (delegation);
- preparation of survey reports;
- overseeing review of reports; and
- finalisation of protocols.

General requirements of a team botanist or ecologist include:

- the qualification to undertake floristic surveys as per Section 3.2.3 of the EPA's "Guidance for the Assessment of Environmental Factors Western Australia (in accordance with the Environmental Protection Act 1986) No. 51 (June 2004)".
- the ability to identify plant specimens;
- writing up statistical methodologies in liaison with a biometrician; and
- analysing and interpreting findings in liaison with a biometrician.

A biometrician is required to:

- assist in statistical design;
- run analyses; and
- assist in interpretation of findings.

A project/field officer is required to:

- use GIS applications such as ArcMap 9;
- enter data into the relevant database applications such as the TEC Database;
- organise field visits (accommodation, equipment etc);
- undertake field work with suitably qualified botanist/ecologist; and

- write up reports in liaison with botanist/ecologist and statistician.

7.2 Qualifications

The EPA's "*Guidance for the Assessment of Environmental Factors Western Australia* (2004)" recommends the following:

"Flora and vegetation surveys should be coordinated and led by botanists who have had training, mentoring and experience in flora and vegetation survey. It is expected that they will have specific training and/or experience in ecology and taxonomy of the Australian flora and would normally have had a wide exposure to WA's flora and vegetation, preferably with knowledge and experience in the region being surveyed."

7.3 Training procedures

Training is essential for developing competent observers. Refreshment of skills including species identification and clarification regarding point intercept methodology may be necessary for observers. Observers should be trained in the use of SOPs relevant to this protocol and discussions in the field regarding techniques are recommended.

8 Operational Requirements

8.1 Annual workload and field schedule

Given that the majority of flora and vegetation should be monitored or surveyed during spring to capture peak flowering, an annual field schedule was drafted pre-field season to ensure that sufficient preparation and field time could be accommodated.

8.2 Facility and equipment needs

Aside from general office facilities and equipment requirements, a range of computer hardware and software for data capture and storing are required. A differential GPS was deemed necessary to record the transect start and end points, as after Mt Lindesay is prescription burnt, relocating transects could be problematic if only physically marked with pegs.

8.3 Startup costs and budget considerations

Field equipment, accommodation and vehicle hire were the three major budgetary considerations for this project. Staff are all employed by DEC and the use of consultants was not required.

9 References

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10 Appendix

Appendix A Proposed monitoring areas for the Mt Lindesay TEC based on desktop analysis

Appendix B Map of the 40 monitoring transects established for Mt Lindesay

Appendix C Mount Lindesay monitoring transect photos

Appendix D **Example collection form for environmental and species data for transects**

Environmental data

TEC	Mt Lindesay, Denmark WA					**DGPS:**	✓		
Date:	__/__/200_	**Recorders:**	VTC	CH	MH	CN	**Coords:**	**UTM**	
Time:		**Photo #**						**UPS**	

Pc Status	**Soil Depth (cm)**	**Soil Type**	**Soil Colour**	**Position in relation to granite**	above	below	inbetween	adjacent

Species data

Transect #	**Distance (cm)**	**Coll. #**	**Field id**		**Confirmed id**

KEY TO ENVIRONMENTAL DATA: **Transect #: 1,2,3,etc** **Transect bearing: in degrees (use compass)** **Aspect: N,NNE, NE, ENE, E SE, S, SW,W, ETC (use compass)** **Aspect bearing: in degrees (use compass)** **Pc status: Inferred; Pc free; or infested** **Veg community: 4 dominant taxa** **Lats/longs/ UTM: use DGPS**		**Notes:**

Appendix E Example of the environmental data collected for a transect

Environmental data - Mt Lindesay		
Categories:	***Detail:***	***How to measure:***
Transect No	1,2,3,4, etc	Sequential numbering
Transect Bearing	in degrees	measured with compass
Aspect	N, NNE, NE, ENE, E, SE, S, SW, W, etc	16 points measured with compass
Aspect Bearing	in degrees, measured with compass	measured with compass
Pc status	PCF or PCI	Inferred Pc free or Infested
Elevation (m) from contours to 10m	No need to fill out detail	All recorded from DGPS
Altitude from DGPS		
Longitude		
Latitude		
Vegetation Community	4 dominant taxa	Genus & species of the four dominant taxa in each transect community

Appendix F Metadata statement template

Category	Element	Comments
Dataset	**Title**	The ordinary name of the dataset.
	Custodian	The organisation responsible for the dataset.
Description	**Abstract**	A short description of the contents of the dataset.
	Search Word(s)	Words likely to be used by a non expert to look for the dataset.
	Geographic Extent Name(s) **OR**	A list of geographic extents such as • map sheets; • local government areas; • catchments; • IBRA regions; and • latitude/longitude co-ordinates for the top left and bottom right corners of the area covered, that reasonably indicate the spatial coverage of the dataset.
	Geographic Extent Polygon(s)	An alternate way of describing geographic extent if no pre-defined area is satisfactory. Provide polygon title and location/directory address.
Date Currency	**Commencement date**	Commencement date (of field work/data collection)
	Completion date	Last date of information in the dataset.
Dataset Status	**Status**	What is the current status of the database? Ongoing/Completed/Under development/Planned.
	Maintenance and Update Frequency Daily Weekly Fortnightly Monthly Annually Irregular	Frequency of changes or additions made to the dataset

Access	**Stored Data Format**	The format or formats in which the dataset is stored by the custodian. Eg. Microsoft Access database, Microsoft Excel Spreadsheets, ESRI shapefiles etc.
	Location/Directory address	Where can the data be found
	Available Format Types	The formats in which the dataset is available, showing at least, whether the dataset is available in digital or non digital form.
	Reports/Publications	What reports and publications have been produced using the dataset?
	Access Constraint	Any restrictions or legal prerequisites applying to the use of the dataset, eg. Licence required. Access and reliability.
Data Quality	**Lineage**	A brief history of the source and processing steps used to produce the dataset.
	Positional Accuracy	A brief assessment of the closeness of the location of spatial objects in the dataset in relation to their true position on the Earth.
	Attribute Accuracy	How accurate are the values in the Attribute Table of this spatial data in respect to the real world values? Eg. 'complete' = all tables are correctly labelled in the dataset.
	Logical Consistency	A brief assessment of the logical relationships between attributes and spatial objects in the dataset. Eg. 'consistent' = attribute values have been checked and validated for consistency; logic checked in relation to attribute names; and all attributes that require values have values assigned.
	Completeness	A brief assessment of the completeness of coverage, classification and verification.
Contact Information	**Contact Organisation**	Ordinary name of the organisation from which the dataset may be obtained.
	Contact Position	The relevant position in the Contact Organisation.
	Postal Address	Postal address of the Contact Position.
	Telephone Number	Telephone of the Contact Position.
	Facsimile	Facsimile of the Contact Position.
	Electronic Mail Address	Electronic Mail Address of the Contact Position.