
RCM Project

# Threatened and Priority Ecological Communities Report Form -

# Field Manual

Prepared by:

Gillian Stack, Senior Project Officer, Department of Environment and Conservation, Species and Communities Branch, Locked Bag 104 Bentley Delivery Centre WA 6983
Monica Hunter, Ecologist, Department of Environment and Conservation, Species and Communities Branch, Locked Bag 104 Bentley Delivery Centre WA 6983
Mia Podesta, Ecologist, Department of Environment and Conservation, Species and Communities Branch, Locked Bag 104 Bentley Delivery Centre WA 6983

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# *Table of Contents*

# 1 Overview

Monitoring is the repeated measurement of a factor or range of factors over time to determine change. The Threatened and Priority Ecological Community Occurrence Report Form (ORF) has been used as an ecological community monitoring tool in Western Australia since 1994 in a number of various formats. It collects data from occasional and repeated observations of occurrences of threatened and priority ecological communities. The form has been used predominantly by Department of Environment and Conservation (DEC) staff, but can be used by anybody visiting threatened and priority ecological community occurrences, including NRM professionals, environmental consultants, nature enthusiasts and other members of the public.

The data that have been collected over the years can be used to draw some conclusions about the effectiveness of management, but these conclusions are constrained by wide variability in interpretation of fields and terms and uncertainty about the rigour of observation. After extensive consultation with stakeholders, the *Resource Condition Monitoring (RCM) Significant Native Species and Ecological Communities* reviewed and revised the ORF and monitoring processes. These changes have tightened definitions of fields and terms, and give a more detailed indication of effort applied during observation.

The revised form is the Threatened and Priority Ecological Communities Occurrence Report Form (ORF). The information collected is used to:

- highlight those occurrences in need of urgent management action;
- monitor the effectiveness of management actions; and
- provide data to support any recommended changes to conservation status.

The review identified that it is also desirable to capture more detailed information for each occurrence to address important knowledge gaps. For example, increasing the level of confidence about the occurrence's condition, or identifying the causes of decline and effective recovery techniques. This can be achieved through careful design of detailed monitoring protocols. These identify the monitoring question, the methodology by which it will be addressed, and the analysis that will be performed on data obtained to influence management decisions. For more information on developing or accessing existing monitoring protocols see http://www.dec.wa.gov.au/management-and-protection/monitoring/monitoring-protocols.html. These monitoring protocols, carefully designed to answer specific questions, are particularly important for critically endangered communities, which most urgently need rigorous data to guide management. While desirable for all threatened and priority ecological communities, it is not realistic to hope to achieve this detailed level of monitoring for all threatened and priority ecological community occurrences known in Western Australia.

The department encourages the regular gathering of good quality basic information about all threatened and priority ecological community occurrences and submission of this data on the ORF. This field manual provides information to support best-practice completion of the ORF. Completing the ORF in a standard way, to a high degree of accuracy, ensures that the data collected is consistent, comparable and reliable. This data can then be used to support and evaluate management decisions, which in turn contributes to the long-term conservation of Western Australia's unique rare ecological communities.

# 2 Introduction

There are several different methods for submitting ORFs. Individual ORFs can be printed and submitted as a paper form, or completed on a field computer using custom-built software and submitted electronically. A hard copy of all ORFs (and attachments) received must be filed for audit purposes. Please ensure attachments are physically attached to the relevant ORF to prevent information from being misdirected.

This field manual provides explanations for the terms used on the form, to ensure consistent understanding across all users. This is necessary because of the variety of ecological communities in Western Australia, and the wide variety of techniques used to observe their biological characteristics. It also sets out how to collect, record and submit information via any of these methods.

This manual can and should be used by anyone submitting ORFs to DEC.

# 3 Completing the ORF

## 3.1 General principles

### 3.1.1 Complete as much as possible

All fields on the revised ORF represent valuable information about the occurrence. However, the most important fields have been indicated with a border. If you have to prioritise effort to meet time constraints, please put the effort into these fields and leave the others blank. The fields on the reverse side of the form contain detailed habitat information, which does not usually vary over time. This does not need to be completed on every occasion, but effort should be made to complete it well once, for each occurrence, especially when it is a newly identified occurrence.

Many fields of the ORF provide a list of specific terms from which one can be chosen. This enables the data to be searched more easily in the database. If more than one term could apply, check more than one box or choose the most applicable or most common one, and provide more detail in the 'Comments' field.

### 3.1.2 Extra details

There is often extra information that is valuable and may be specific to the ecological community under observation, but which cannot be captured by choosing from specific terms. For this reason the form has several 'Comments' fields – 'Other comments' and 'Specify other'. 'Other comments' can capture information about management actions required or completed, other data captured and how to locate that data, and any other comments about the observation.

### 3.1.3 If you don't know, leave it blank

Try to complete as much of the report form as you can. However ,please do not complete a field if you do not know the answer with reasonable confidence.

### 3.1.4 Occurrences

In biological terms, an occurrence is a discrete example of an ecological community.

To be considered a separate occurrence it must be entirely separated by:

- a distance of 20 metres from an example of the same community
- an occurrence of a different ecological community
- an artificial surface such as a sealed road or building
- a water body, where the community is terrestrial
- a terrestrial body where the community is aquatic

Examples of the same community separated by an unsealed road are considered to be part of the same occurrence unless the road is wider than 20m.

An occurrence must be in at least a degraded condition (Bush Forever scales) or better to be considered an extant occurrence of a community. New occurrences will be considered on a case-by-case basis to determine whether they are in good enough condition to be considered an extant occurrence of a threatened or priority ecological community. This may depend upon the community type and location of the occurrence.

There is no minimum size of an occurrence of a threatened or priority ecological community.

### 3.1.5 Choosing a time to assess threatened and priority ecological communities

The ORF provides a reporting mechanism for observations from both surveys and regular monitoring efforts. A survey is not usually repeated, and is conducted to determine the presence or absence of an ecological community. Monitoring is the repeated measurement of a factor or range of factors over time to determine change.

The ORF can be completed by anyone, so can capture observations made opportunistically, or as part of a planned survey or monitoring program. A monitoring program will ideally be guided by a

Monitoring Protocol, which will establish the timing and parameters of observations (see 'Monitoring protocols - Threatened Ecological Communities (TECs)' on DEC's Monitoring website).

Where there is no monitoring protocol, or the occurrence has not previously been surveyed, the following advice is provided. Surveys that are intended to gather information towards assessing whether an ecological community is present or absent. For floristically defined ecological communities, these surveys are best done over several seasons (See attached example at Appendix 1).

EPA Guidance Statement Number 51 should be utilised for more information specific to survey for environmental impact assessment in Western Australia.

#### 3.1.6 Gaining permission to access threatened and priority ecological communities

Prior to survey you must identify the land manager of the area you wish to survey. It is necessary for all people assessing threatened and priority ecological community occurrences to gain permission for access to land. Local Government Authority offices may be able to assist with land manager contact details, such as an address for correspondence.

Access to rail reserves is controlled by WestNet Rail's District Superintendents, who need to know why people are on the reserve, and give permission or protection depending on how close to the running line persons or machinery are likely to go. Drivers of trains scheduled to be operating in the area will be alerted to the possible presence of people on the reserve. Reflective vests are recommended while operating on the rail reserve. Road reserves are accessible without permission, but it is wise to wear a reflective vest and turn on beacon lights if available to maximise visibility, and ensure you have pulled safely off the road.

### 3.2 Community and observer identity

**Community:** The name of the threatened or priority ecological community that the ORF relates to. Official or TEC/PEC database name is preferred. The current lists for threatened and priority ecological communities can be viewed on DEC's website at http://www.dec.wa.gov.au/content/view/849/2017/.

**Observation date:** The date the observation was made in the field.

**New occurrence:** Tick this box if this record is for a new occurrence. If unknown leave blank.

**Site ID:** A unique code, usually a combination of letters and numbers that the TEC/PEC database attributes to an occurrence of a TEC/PEC at this location. If it is a new occurrence, a suggested Site ID that indicates the location of the site can be used.

**Conservation status:** The conservation status of the TEC in Western Australia, if known. This may be Critically Endangered (CR), Endangered (EN), Vulnerable (VU), or Priority 1 to 5 (P1, P2, P3, P4 and P5). If desired, the conservation status of WA ecological communities can be sought on DEC's website at http://www.dec.wa.gov.au/content/view/849/2017/.

**Observer/s:** The name of the person/people who made the observations.

**Phone:** A contact phone number for one observer who could clarify details submitted if required for entry or verification of data into the TEC/PEC database. This phone number will not be retained in the database.

**Role:** The role of the observer (e.g. conservation officer, volunteer, consultant etc). A list of available terms is available at Appendix 2. If your role does not fit within the available terms, please specify your role.

**Organisation:** Any organisation or body the observer is employed by or affiliated with in connection with this observation (e.g. DEC, a catchment council, Wildflower Society, consultancy etc). A list of available terms is available at Appendix 2. If your organisation type does not appear within the available terms, please specify your organisation.

### 3.3 Location details

**Description of location:** Even if a GPS coordinate has also been recorded, it is very important to

capture this information well at every visit. This improves confidence that the details recorded in this ORF can be compared to others from the same place (GPS coordinates can be inaccurate). Provide at least the nearest town/named locality, and the distance and direction to that place. A closer description is also highly desirable, using named reference points as much as possible. For example, '30km NE of Wubin; 2.4km north east of Goodlands Rd along Great Northern Highway, and then 50m west into bushland'. Estimates should be as accurate as possible, and where possible refer to local markers to assist relocation (e.g. near the corner fence post, or adjacent to rock outcrop). A supplementary map is desirable for descriptions without named reference points (e.g. tracks within a nature reserve) or where named reference points can be flexible (e.g. tracks on stations).

Occurrence location information needs to be detailed enough to allow them to be relocated, and also to permit the determination of land ownership or vesting. This is essential for management purposes, as the land manager must be informed of the presence of the threatened ecological community if it is to be managed appropriately.

**Reserve No.:** Indicate the number of the Crown Reserve that this occurrence occurs on if applicable.

**DEC District:** The DEC District that this occurrence falls within. A map of the DEC District boundaries is provided in Appendix 3.

**LGA:** The Local Government Authority that this occurrence falls within – e.g. Shire of Cue, City of Geraldton, Town of Cambridge.

**Land manager present:** Tick box if the land manager was present for part or all of the observation period.

**Datum:** Record the datum associated with the geocode coordinates. The datum used by a GPS can often be found in its Setup screen, or by following the manual. This can also be set to a preferred option – generally GDA94. The datum used by a map will be recorded near the title and legend.

GDA (Geocentric Datum of Australia): This replaced the earlier Australian Geodetic Datum, and is the preferred option for coordinates collected.
Geographic coordinates (latitude/longitude): Geocentric Datum of Australia 1994 (**GDA94**)
Grid coordinates (UTMs - easting/northing): Map Grid of Australia 1994 (**MGA94**)

AGD (Australian Geodetic Datum): This system predates the current Geocentric Datum of Australia – the first version was established in 1966, and revised in 1984.
Geographic coordinates (latitude/longitude): Australian Geodetic Datum 1984 (**AGD84**)
Grid coordinates (UTMs - easting/northing): Australian Map Grid 1984 (**AGM84**)

WGS84 (World Geodetic System 1984): This system is global rather than Australia-specific, and is considered to be roughly equivalent to GDA94. A slight difference between the two systems is caused by Australia's tectonic drift north-easterly. This was 77cm at 2005, and increasing at ca 7cm per year (ICSM 2006). For coordinates expected to be accurate at a distance of 2m or greater, this difference is not particularly problematic.

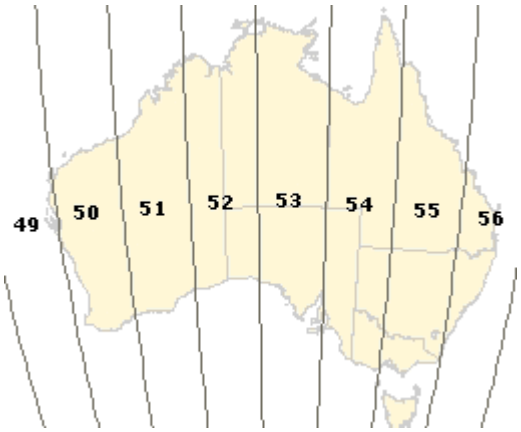
**Coordinates:** Nominate whether the coordinates are recorded in:
Decimal degrees (e.g. 31.99373˚S; 115.88268˚E);
Degrees/Minutes/Seconds (e.g. 31˚ 59' 37.4"S; 115˚ 52' 57.7"E); or
Universal Transverse Mercator units (UTMs – e.g. 0394453mE; 6459714mN; Zone 50).
Geographic coordinates (latitude/longitude) record a position on the Earth's curved surface, while the grid coordinates record a position projected onto a flat surface.

Note regarding coordinates: The coordinate recorded here is regarded as a single point within the occurrence for the purposes of locating the occurrence in a GIS layer. Ideally, this point would be recorded from well within the occurrence boundary rather than at the edge. Where occurrence boundaries (see boundary polygon captured) have been detailed, these can be attached to the report form – refer to the 'Attached' field of the form. For more information on how to name and store other spatial information files (e.g. survey locations or boundary polygon information) see the 'Standard Operating Procedure 1.4 File Management: Naming convention, directory structure, storage and creation of metadata for spatial and aspatial data' on DEC's website.

**Lat/Northing:** Record the geocode's southern reading – either Latitude or Northing (e.g. 31.99373˚S; or 31˚ 59' 37.4"S; or 6459714mN).

**Long/Easting:** Record the geocode's eastern reading – either Longitude or Easting (e.g. 115.88268˚E; or 115˚ 52' 57.7"E; or 0394453mE).

**Zone:** This is essential to interpret grid coordinates (eastings/northings) provided as UTMs. The world is divided into 60 zones to correct for distortion when transferring rounded global surfaces to flattened map surfaces. Western Australia falls within Zones 49, 50, 51 and 52, moving west to east. GPS units or maps displaying UTM coordinates will also provide the zone.




[Image sourced from Geoscience Australia (2007)]

**Method used:** Record the method used to obtain the coordinates (GPS, differential GPS or map).

**No. satellites:** If GPS or differential GPS was used, please indicate the number of satellites the GPS was reading from at the time. This is usually prominently displayed on the GPS. (Note: it is recognised that this value is only a partial indicator of signal quality, but it was deemed the most readily accessible value on a range of different makes of GPS, and a better articulation of signal quality would require completion of too many fields. A set of these is captured automatically using the field computer-delivered ORF.)

**Boundary polygon captured:** Indicate whether an occurrence boundary polygon was captured on this occasion using a GPS. An occurrence boundary may be mapped with a GPS to produce a polygon that may be viewed with other spatial data using GIS software. For more information on how to name and store these and other spatial information files (e.g. individual plant locations) see Standard Operating Procedure 1.4 File Management: Naming convention, directory structure, storage and creation of metadata for spatial and aspatial data on DEC's website. In the 'Other comments' section, the name of the file and where the data are stored should be recorded so that others may be able to locate the data in future. Copies of occurrence boundaries should be sent to the TEC Database Administrator at the Species and Communities Branch for backup storage.

**Map used:** If a map was used to derive coordinates, please indicate the name of the map and map series if relevant.

**Map scale:** Indicate the scale of the map used (e.g. 1:25,000).

**Land tenure:** Nominate the land tenure this occurrence occurs on.

**SLK:** Straight Line Kilometres is a system of marking used by Main Roads WA (MRWA). All main roads have SLK markers (small white posts with numbers and yellow caps) placed every two kilometres on the left side of the road from its starting point. For threatened ecological community occurrences on main road verges, referring to this system of marking makes it easy for MRWA operators to avoid these occurrences during maintenance operations.

**Pole:** Pole numbers are a similar system of marking used by WestNet Rail. The poles used by the old telegraph lines that ran along rail lines are marked by a numbering system. The lines have been removed, but the poles are often still present and the numbers used as the basis for identifying points along the line for maintenance. These poles are usually about 80m apart, with between 12 and 14 poles per kilometre. The numbering is stencilled on the pole (e.g. 322/04 tp or 328/12 tp). As these old telegraph poles deteriorate, they are being replaced by markers placed every 250m. The marker posts are white with the distance marked in black (e.g. 322.250 or 322.750).

## 3.4 Observation details

**Area assessment:** Indicate whether this was an edge survey, partial survey or full survey.

Edge survey: A quick visit to the site of the occurrence, sufficient to confirm ongoing presence of the community and macro-change – e.g. rubbish dumping at an occurrence, or whether affected by recent fire. The purpose of this survey might be to collect minimal details while also checking the condition of an occurrence.

Partial survey: A survey where only part of the occurrence was observed. It may be that part of the occurrence was observed in detail, but time constraints halted the survey before the full extent of the occurrence could be determined.

Full survey: Sufficient time and effort were spent determining the limits of the occurrence, and details recorded on this ORF apply to the whole extent of the occurrence.

**Area observed ($m^2$):** Indicate the approximate area observed in metres squared – e.g. an area roughly 200m long x 50m wide would be 10,000$m^2$). Note that the area observed may be very different to the extent of the occurrence.

**Effort:**

**Time spent surveying (minutes):** Indicate the length of time spent on survey on this occasion. E.g. if two people surveyed the occurrence for 45 mins, record 90 mins. Do not include time spent completing other tasks on site – e.g. weed control. Note that this field will be used to derive Number of minutes spent per 100$m^2$, which is intended as a measure of effort, or thoroughness, of inspection.

**No. of minutes spent/100$m^2$:** Divide the total area surveyed (note that this is not the area occupied by the occurrence) by 100 to give the 100 $m^2$ value. The time spent surveying divided by that number will give the number of minutes spent/100$m^2$.

## 3.5 Threats

**Threat type and information:** Nominate the most important threats. A list of threat and cause/agent terms available in the database is provided at Appendix 4.

For each threat, notes can be made to record detail useful for management (e.g. location, area affected, samples taken etc). Rate each threat's area affected as a per cent, current impact on the occurrence, its potential impact and the timeframe in which you might expect that potential impact to occur. Capturing the potential level of impact is most useful for threats which may have changing impact over time if left unmanaged, such as weeds or disease. This includes threats which may not be impacting the occurrence already (rating of L) but which are considered likely to impact in the future (e.g. dieback known to be present uphill of this occurrence). It is not necessary to rate the potential impact of stochastic events such as flood events, which may have an unpredictable level of impact or time to onset.

It is acknowledged that these ratings are subjective without quantitative data about impact of a threat on mortality or reproductive capacity of an ecological community, rates of spread at this site etc, but they are intended to give a sense of priority to management actions.

**Cause/agent:** This may not be applicable for all threat types. For example, for threats such as weed invasion, please list major weed types, or for recreational disturbance, please list the cause such as motorcycle or horse riding.

**Area affected:** Estimate the total proportion of the area of the occurrence surveyed currently affected by the threat.

**Threat current and potential impact:** N=Nil, L=Low, M=Medium, H=High, E=Extreme

- **Low:** Threat easily ameliorated with some management
- **Medium:** Threat could be ameliorated with moderate level of management
- **High:** Threat could only be ameliorated with intensive management
- **Extreme:** Unlikely that threat can be managed even with intensive management

**Potential threat onset:** S=Short (<12mths), M=Medium (<5yrs), L=Long (5yrs+)

### 3.6 Condition of occurrence

**Condition of occurrence:** Use the one or more options given to record the condition of the area of the occurrence surveyed. Estimate the percentage of the total area of the occurrence in each condition scale to add up to 100 per cent. It is acknowledged that choice between the condition types provided is subjective with or without reference to benchmark descriptions of each condition type. The terms given here for habitat condition were drawn from the Bush Forever Condition Scale see Appendix 5. The descriptions used by the Bush Forever Condition Scale were designed for the Swan Coastal Plain and do not apply equally across other regions of the state. The same terms are utilised here to convey a general sense of condition.

### 3.7 Recommended management actions and actions implemented

List management actions that are required, management actions that have been completed (include date of completion and if possible who was the coordinator of the management actions, any liaison with stakeholders, and/or details of other data that have been captured and how an interested party could access it. A suggested list of management action and action implemented terms available in the threatened and priority ecological community database are provided in Appendix 6.

### 3.8 Habitat information

It is anticipated that habitat information could be captured well once and then only revised if habitat characteristics change. This section of the ORF is therefore of less importance than the preceding sections, and may be omitted if time is limited or existing information is adequate.

To facilitate standardisation of what is meant by different terms, existing published definitions have been adopted. Many of these have been sourced from the Australian Soil and Land Survey Field Handbook (McDonald, Isbell, Speight, Walker and Hopkins 1998), with additional geomorphic wetlands sourced from Hill, Semeniuk, Semeniuk and Del Marco (1996). National Vegetation Inventory System (NVIS) was recognised as a generally accepted standard for description of Australian vegetation.

The number of habitat terms listed on the ORF was kept brief and general so that the form could be printed on a single page if desired. Details of more specific terms available are detailed in the appendices of this field manual and can be noted on the ORF if desired. Therefore, information with different levels of precision can be accommodated on the ORF and in the database.

**Landform:** Nominate the landform(s) the occurrence occurs on. There are both general and more specific options available. A list of these is provided at Appendix 7. If a more specific term is chosen, enter in the Specific Landform Element field.

**Rock type:** Nominate the rock type(s) present, if known. If identified rock type(s) is not present in options available, specify. A longer list than is available on the form is provided at Appendix 8. If a term not listed on the form is chosen, enter in the Specify other field.

**Loose rock:** Indicate the approximate quantity of rock fragments present on soil surface. This includes any type of loose rock, such as gravel, quartz fields etc.

**Soil type:** Nominate soil type(s), as determined by instructions in Appendix 9, sourced from the Australian Soil and Land Survey Field Handbook (McDonald *et al*. 1998). There are both general and more specific options available. A list of these is also provided at Appendix 9. If a more specific term is chosen, enter in the Specify other field.

**Soil colour:** Nominate soil colour(s). There are both general and more specific options available. A list of these is provided at Appendix 10. If a more specific term is chosen, enter in the Specify other field.

**Drainage:** Nominate drainage characteristics of the site. This is not necessarily evident on the particular observation date, but may be known from previous experience or records.
Well drained includes areas that are not inundated at any time of year.
Seasonally inundated includes areas that are covered by water at some times of the year, but not for

the rest of the year. For example, winter-wet areas, seasonal lagoons or intermittent lakes that may only fill occasionally.
Permanently inundated includes permanent lakes or rivers.
Tidal includes those areas where inundation is dictated by lunar cycles rather than seasonal cycles.

**Condition of soil:** Record general moisture level of soil. Unlike some previous fields, this is directly observable on the observation date.

**Vegetation structure:** National Vegetation Information System (NVIS) Structural Formation terms have been adopted for vegetation descriptions. It is important to choose the four layers which are the most representative of that community. A table detailing NVIS structural formations (e.g. closed forest, woodland, open shrubland, isolated clumps of sedges etc) is provided at Appendix 11, sourced from ESCAVI (2003). A comparison of Muir's classification and NVIS system equivalents is available on the DEC website.

### 3.9 Additional information

**Fire history:** If the season/month and year of the most recent fire is known or can be interpreted with some confidence, note it here. Please see Appendix 12 for table on estimating time since last fire.

**Fire intensity:** As above.

**No evidence of fire:** Check this option if there is little or no visible evidence of fire at the site (e.g. no charring, dead sticks and leaves still present on vegetation, heavy leaf litter presence, etc). Please see Appendix 12 for table on estimating time since last fire.

**Actual occurrence land use:** Note the observed land use(s) occurring on the TEC or PEC occurrence in practice at the time of survey.

**Adjacent land use:** Note the observed land use(s) occurring adjacent to the TEC or PEC occurrence in practice at the time of survey. It is helpful to note which direction (N, S, E, W etc) these land uses are occurring in relation to the occurrence.

**Associated flora and fauna species:** Note any species occurring within the community. If you are not sure of the flora species either collect it (if you have a valid flora taking license) and identify it at a later date, or you may record the species name with a question mark (?) after it.

**Other comments:** Record any other information that you would like to capture. This space may also be used as an overflow area where another section has not been large enough to include all your comments. This may include (but is not limited to) liaison with stakeholders, quadrat locations/details, and/or details of other data that have been captured and how an interested party could access it.

If GIS shapefiles were captured, record their name, contents and where they are stored in the other comments section so that others may be able to locate the data in future. For more information on how to name and store information files see Standard Operating Procedure 1.4 *File Management: Naming convention, directory structure, storage and creation of metadata for spatial and aspatial data* on DEC's website. Electronic copies of these data should be sent to Ecologist TEC Database, Species and Communities Branch for back-up storage.

**Attached:** Please provide details of any additional information attached to the ORF (e.g. topographic map, GIS-based map, GIS datapoints, field notes etc). Please physically attach them to the ORF so that there is no confusion as to which ORF they belong. If GIS data are attached please specify what the data are (e.g. occurrence boundaries, quadrat locations) in the 'Other comments' section.

**Copy sent to:** Note anybody who has received a copy of this ORF apart from the TEC Database Administrative Officer, Species and Communities Branch (e.g. DEC regional offices, a research facility, a Wildflower Society branch or NRM region office).

**Submitter of record:** Record the name of person who completed the ORF. Note: this is not always the observer, but may be someone the details were passed on to.

**Role:** The role of the person who completed the ORF (e.g. volunteer, botanist). A list of available

terms is available at Appendix 2. If your role does not fit within the available terms, please specify your role.

**Date:** Date the ORF was completed. (Not necessarily the same as the date the observations took place.)

## 4 Data management

The effort spent gathering data will return best value if the information obtained can be located again when needed. Long-established practice sees paper-based records filed. Electronically submitted ORFs are printed and filed in the same way, as hard-copy records are needed for audit purposes.

However, some information (e.g. GIS files, translocation measurement data) is much more useful in digital form so that it can be manipulated through GIS, statistics or other software packages. File naming conventions and a standardised directory (folder) structure would contribute greatly to making this information accessible to other users across space and time.

A Standard Operating Procedure has been drafted to support improved data management and accessibility –SOP 1.4 File Management: Naming convention, directory structure, storage and creation of metadata for spatial and aspatial data on DEC's website. This could effectively be used to store all threatened and priority ecological community data, including ORFs, field notes, reports, translocation measurement data and photos as well as GIS data. It is well worth taking the time to establish good data management practices and then continue to follow them. Copies of files should be sent to the TEC Database Administrative Officer at Species and Communities for backup storage.

## 5 List of acronyms

| | |
|---|---|
| DEC | Department of Environment and Conservation |
| IUCN | International Union for the Conservation of Nature |
| NRM | Natural Resource Management |
| NVIS | National Vegetation Inventory System (Executive Steering Committee for Australian Vegetation Information 2003) |
| PEC | Priority ecological community |
| SOP | Standard operating procedure |
| TEC | Threatened ecological community |
| ORF | Threatened and Priority Ecological Community Report Form |

## 6 References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McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J. and Hopkins, M.S. (1998). Australian Soil and Land Survey – Field Handbook, Second Edition, CSIRO, Australia, Canberra.

# 7 Appendix 1 – Vegetation survey methods and analysis to determine floristic community type/s for a new site on the southern Swan Coastal Plain.

**1. Quadrats**

*The best way to determine the floristic community types (FCTs) present at a new survey site on the southern Swan Coastal Plain is to repeat methods as described in the Gibson* et al*. (1994) report. That is, to establish 10 by 10m quadrats in vegetation in best condition (and not in ecotones), and score them (i.e. record all the flora species present) at least twice at appropriate times. A form that provides standard format for recording quadrat-based data occurs in Keighery (1994). Permanent markers such as fence droppers or cut down star pickets should be used to mark corners, and corner locations preferably recorded with a Differential GPS. Take a photo of the quadrat from a specified corner (typically the north east corner) using a standard lens.*

The scoring of quadrats should be planned around the flowering times of the majority of the species present. This will vary depending on whether the site is a wetland, and will also depend on the latitude, and specific characteristics of the season (late or early rains etc). Spring and late spring are usually best (September, and late October/early November). It should be noted that a third or even fourth scoring was sometimes undertaken for quadrats established for Gibson *et al*. (1994), especially in wetlands. In addition, some quadrats were scored over a series of years for Gibson *et al.* (1994), due to poor seasonal rains. It is therefore possible that climate will influence results for quadrats established, and scorings across a series of additional seasons or even years may be indicated.

A good (flowering) voucher specimen of every taxon encountered should be collected, and lodged with the WA Herbarium. The cost of vouchering needs to be considered. Any new taxa recorded at each scoring should also be vouchered.

The species data from quadrats established should then be compared and analysed against data held in Gibson *et al*. (1994) using appropriate statistical techniques and parameters (e.g. PATN, Primer or PC-ORD). The reporting should note the closest matches for FCTs present at the new site.

It should be noted that unless the new data are of similar quality, (that is, where similar numbers of native plant taxa are recorded when compared to average species richness in quadrats established for the Gibson *et al*. (1994) report) then results could be unreliable and potentially misleading. Determining appropriate locations for quadrats may be quite crucial in this regard, in that they should be placed in areas in best condition.

The importance of the application of this quadrat-based method is highlighted where few taxa are recorded. Relevee data are generally not comparable with the quadrats for Gibson *et al.* (1994). In addition, it is generally not possible to exactly relocate relevees, so they can't easily be rescored.

Analyses should be carried out against the quadrat data from Gibson *et al.* (1994) so that conclusions are logical and valid (i.e. partial species lists held in the tables in the hard copy Gibson report should not be used, full species lists for all quadrats available through DEC should be utilised for these comparisons). Gibson *et al*. (1994) utilised the quadrat-based data collected during that survey and PATN was used to sort the quadrat data into a series of floristic community types using specified parameters. To validly compare new data collected for new sites on the southern Swan Coastal Plain, these methods should be repeated.

There are quite a number of ways this statistical analysis can be done. The proponents could insert their quadrat data and rerun the classification and examine with cluster (some minor typological changes might be expected) or ordination techniques, they could examine nearest neighbour distances of their plots to the Gibson *et al*. (1994) data, or they could use some form of multivariate discriminate analysis (such as CAP – canonical analysis of principal coordinates, in the Primer package). Whatever methods are used, the most reliable comparison would be comparison of adequately sampled quadrat data.

**2. Use of other methods**

Species lists for vegetation units can be collected and analysed using other methods where native

species richness is inadequate to provide good quality data for statistical analysis, e.g. where vegetation is not in suitable condition.

The flora and vegetation can be surveyed along a series of transects across the site, with species recorded for different vegetation units being compiled in separate lists. Detailed notes should be recorded about the species present, vegetation condition on Bush Forever scales, and soils and landform. Plant species that may be particularly significant in differentiating the floristic community types should also be noted.

The species lists for each identified vegetation unit should be compared to full species lists compiled from all quadrats established for the Gibson *et al.* (1994) report, for floristic community types considered most likely to occur at the site on the basis of soil and landform characteristics and general species composition. These quadrat data from Gibson *et al.* (1994) are available free of charge from DEC.

Results should be provided in the form of raw data (species lists) and tables that indicate the alignment (proportional overlap) of species present in each different vegetation unit, with species lists compiled for all quadrats in likely FCTs from Gibson *et al.* (1994).

Combinations of plant species that are indicative of particular FCTs should be evaluated from species present in each identified vegetation unit. Lists of taxa that are 'typical' or 'common' to particular FCTs are listed in Gibson *et al*. (1994). In addition, taxa that are indicative of the eastern side of the Swan Coastal Plain (Keighery and Trudgen 1992 – Table 4) may be particularly helpful in determining the floristic community types present. The eastern side of the plain is characterised by the presence of a suite of threatened ecological communities including three marri communities on heavy soils (floristic community types 3a, 3b and 3c, and three closely allied woodlands and shrublands – type 20a, 20b and 20c – 'the 20 group of floristic community types' as described in Gibson *et al*. (1994)). There are a suite of taxa listed in Keighery and Trudgen (1992) that are associated with the highly cleared heavier soils on this side of the plain, and that are associated with either or both of these two groups of TECs. These taxa are particularly helpful in distinguishing the presence of these threatened ecological communities.

In addition, information about reference sites that provide good examples of specific FCTs in Bush Forever sites is on the Western Australian Local Government Association website at: http://www.walga.asn.au/about/policy/pbp/prpbp/prpbp_bf_ref_sites.

The location in question should be compared to these reference sites in terms of composition and structure of the vegetation, habitat, and soil and landform.

The logic used to determine the likely FCTs present at the new site should be evident in reporting, (e.g. soil and landform, patterns of species composition). Table 14 in the Gibson *et al*. (1994) report provides a list of the most frequent landforms on which the FCTs occur, but this is not a definitive list of landforms on which the FCTs were found. Conclusions that certain priority ecological communities (PECs) and TECs could not occur because the soil and landform units from which they have been recorded do not occur at the proposed development site are not conclusive and additional data would need to be presented.

If taxa indicate that vegetation is generally transitional between specific FCTs, then this should be noted and the FCTs to which the vegetation aligns most closely should be identified. The status of each possible FCT should be noted (e.g. TEC or PEC, and rank).

Note: when there is no dispute about the identification of a site as an FCT that is a threatened ecological community and soil, landform, habitat and species composition are consistent with conclusions, some data and analysis requirements can be omitted.

**3. Mapping**

The boundaries between vegetation condition classes using Bush Forever scales should be mapped and digitised.

The boundary of the vegetation units (FCTs) identified should also be mapped and digitised.

**References**

Clarke, K.R., Gorley, R.N. (2006). PRIMER v6: User Manual/Tutorial. PRIMER-E, Plymouth.

Gibson, N., Keighery, B., Keighery, G., Burbidge, A. and Lyons, M. (1994). *A floristic survey of the Southern Swan Coastal Plain*. Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).

Keighery, B. (1994). *Bushland plant survey: a guide to plant community survey for the community.* Wildflower Society of WA (Inc.), Nedlands, WA.

Keighery, B. and Trudgen, M. (1992). *Remnant vegetation on the alluvial soils of the eastern side of the Swan Coastal Plain.* Report prepared for the Department of Conservation and Land Management. Perth, Western Australia.

Government of Western Australia (2000) *Bush Forever*. Western Australian Planning Commission, Perth.

# 8 Appendix 2 – Observer role and organisation

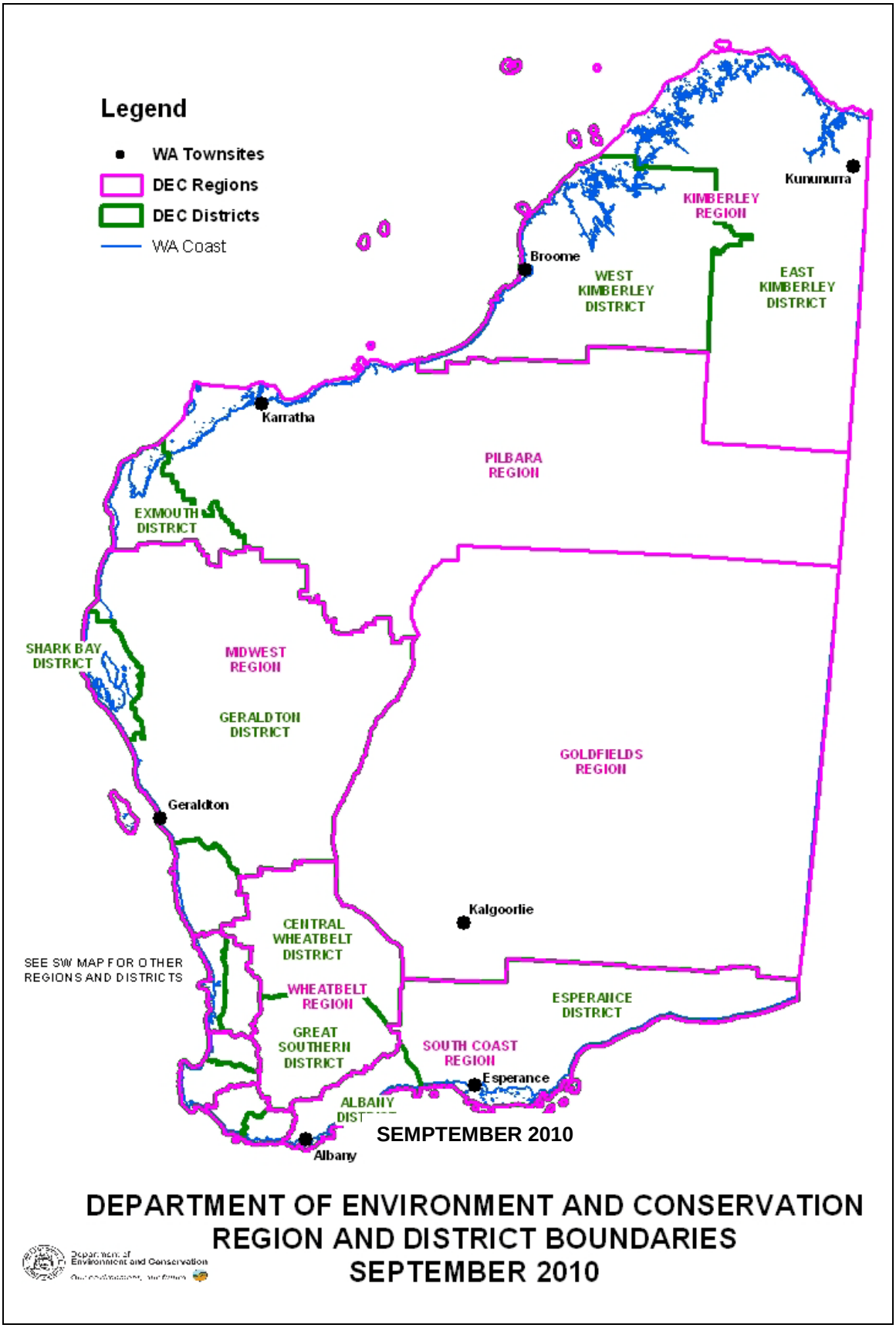
If you wish to record an observer's role, please choose one of these terms. If the role clearly does not fit within any of these terms, please specify.

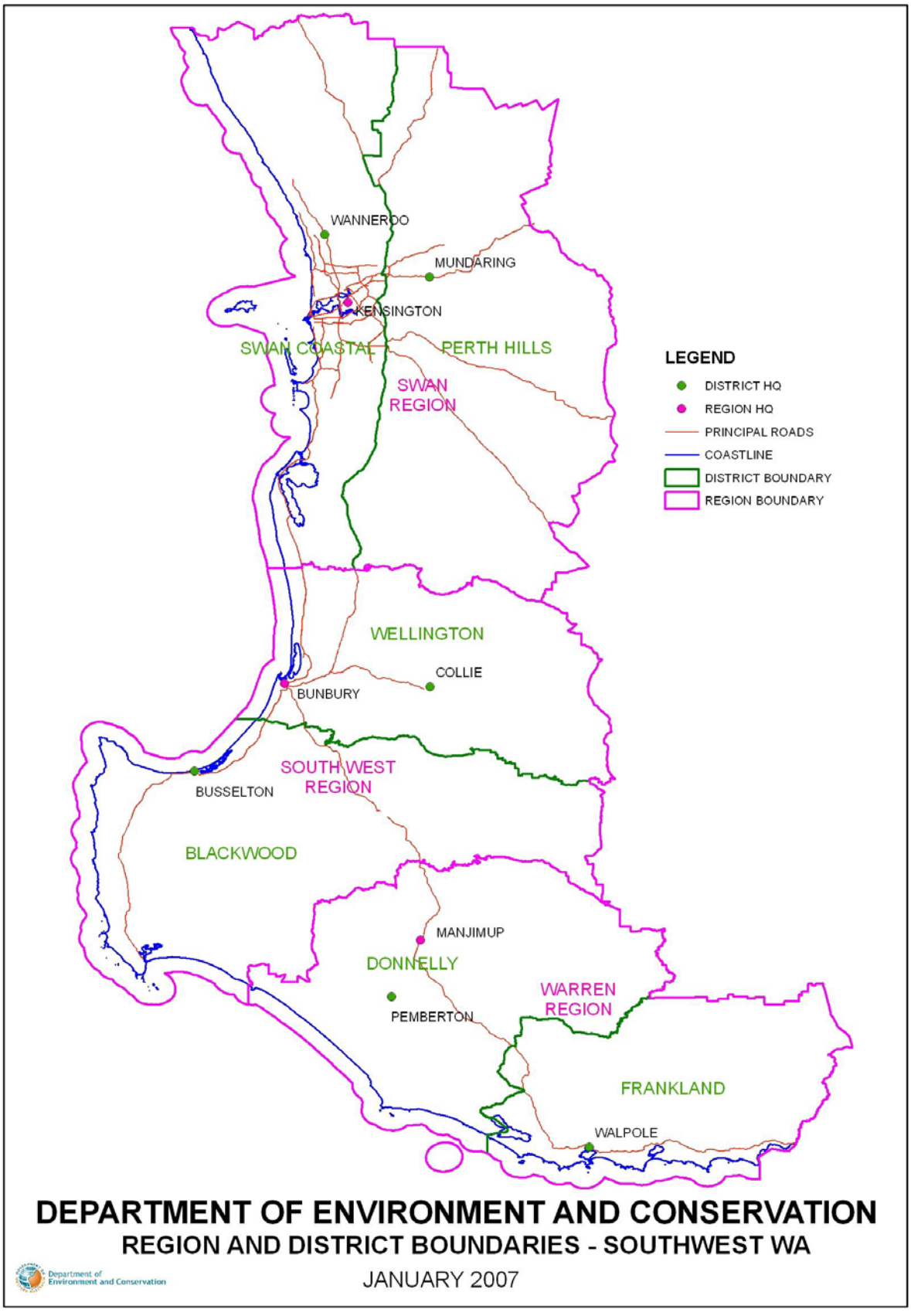
**Observer role:**
Botanist
Conservation Employee
Conservation Officer
Ecologist
Nature Conservation Coordinator
Program Leader – Nature Conservation
Project Officer
Regional Ecologist
Research Scientist
Student
Technical Officer
TPFL Administrators
Volunteer

If you wish to record an observer's organisation, please choose one of these terms where possible, with specific reference to your group/organisation. If your organisation does not fit within any of these terms, please specify.

**Observer organisation:**
Department of Environment and Conservation (DEC) – Nature Conservation Division
DEC – Science Division
DEC – Regional Services Division
Botanic Gardens and Parks Authority
Other state government department – please specify
University – please specify
Wildflower Society
Consulting company – please specify
Local Government Authority – please specify
Non-government organisation – please specify
Community group – please specify

## 9 Appendix 3 – Map of DEC Districts and Regions




WANNEROO
MUNDARING
KENSINGTON
SWAN COASTAL
PERTH HILLS
SWAN REGION
WELLINGTON
COLLIE
BUNBURY
SOUTH WEST REGION
BUSSELTON
BLACKWOOD
MANJIMUP
DONNELLY
PEMBERTON
WARREN REGION
FRANKLAND
WALPOLE
LEGEND
DISTRICT HQ
REGION HQ
PRINCIPAL ROADS
COASTLINE
DISTRICT BOUNDARY
REGION BOUNDARY
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
REGION AND DISTRICT BOUNDARIES - SOUTHWEST WA
Department of Environment and Conservation
JANUARY 2007

## 10 Appendix 4 – Threats and threat agents

The following terms are available in the threatened and priority ecological community database for use. These terms are provided to enhance search ability of data, so a new term should only be created if it does not fit at all within one of the existing terms. Highly specific threats that are distinct from listed threats (but are unlikely to be useful for queries) should be captured within these terms wherever possible, with the specific differences recorded in the threat details.

Consideration should also be given to how the information is most usefully interpreted. For example, the weed species listed under 'Threat agents' are not intended to be a comprehensive list of all weeds in WA, but rather a listing of those most likely to be specifically queried for control programming purposes. If it seems unlikely that a control program will be implemented as the weed is uncommon or has low impact, it could be captured as a weed (type), with the specific species and perhaps distribution notes recorded in the details rather than create a new term for that species in the database.

### Threats

| |
|---|
| Altered soil chemistry – acid sulfate soils |
| Altered surface drainage – accumulating |
| Altered surface drainage – draining |
| Clearing – complete vegetation clearing |
| Clearing – overstorey removal/ reduction |
| Clearing – understorey removal/ reduction |
| Climate change – drying climate |
| Climate change – increasing sea levels |
| Disease – invasion and spread |
| Erosion |
| Fence construction/maintenance |
| Fire – too frequent |
| Fire – too high intensity |
| Fire – too infrequent |
| Fire – too low intensity |
| Fragmentation – edge effect – large edge to area ratio |
| Fragmentation – landscape fragmentation |
| Grazing by native or introduced species |
| Groundwater decline |
| Groundwater rise |
| Hydrological changes – water quality and/or quantity |
| Intentional burns and fire management (prescribed burning) |
| Loss of topsoil |
| Mechanical/physical disturbance |
| Nutrient enrichment |
| Recreational activities |
| Resource extraction – impacts of dust |
| Resource extraction e.g. gravel, sand, wood, minerals |
| Road/rail/utility maintenance – clearing/slashing/herbicide |
| Road/rail/utility maintenance – impacts on drainage |
| Rubbish dumping |
| Salinisation |
| Sedimentation/siltation |
| Soil compaction |
| Track creation |
| Track/firebreak maintenance |
| Trampling |
| Water contamination |
| Weed invasion |

**Threat cause/agent**

| **Hydrology** | **Weed** |
|---|---|
| Cave diving | African lovegrass |
| Groundwater extraction | Annual veldt grass |
| Groundwater drainage | Aquatic/wetland weed |
| Decreased recharge | Arum lily |
| Increased recharge | Blackberry |
| **Water movement** | Bridal creeper |
| Inflows | Bulb/corm/tuber weed |
| Stormwater runoff | Bulrush/Typha |
| **Pathogen** | Capeweed |
| Fungus/canker | Couch |
| *Phytophthora* spp. | Date palm |
| *Armillaria luteobubalina* | Freesia |
| Aerial canker | Geraldton carnation weed |
| **Human movement** | Grass weed |
| On-road traffic | Herb weed |
| Off-road vehicle (car) | Kikuyu |
| Off-road motorbike | Onion weed |
| Pedestrian, mountain bike | Perennial veldt grass |
| Boat | Pine |
| Maintenance equipment | Ruby dock |
| Dumped garden refuse | Sparaxis |
| Dumped rubbish | Tagasaste |
| Fire protection measures | Victorian teatree |
| **Natural force** | Water hyacinth |
| Water | Watsonia |
| Wind | Wild oats |
| **Fauna (vertebrate & invertebrate)** | Woody weed |
| Native fauna | **Land managers** |
| Introduced fauna | Road manager |
| Bird | Main Roads WA |
| Camel | Shire/LGA |
| Cane toad | Rail manager |
| Cattle | Water utility |
| Deer | Gas utility |
| Fish | Power utility |
| Goat | Phone utility |
| Horse | DEC |
| Invertebrate | FPC |
| Kangaroo | Private land manager (non-commercial) |
| Pig | Agricultural enterprise |
| Rabbit | Development enterprise |
| Sheep | Mining enterprise |
| Stock | |

## 11 Appendix 5 – Bush Forever Condition Scales

### Vegetation Condition Scale

| | | |
|---|---|---|
| **Pristine** | **1** | Pristine or nearly so, no obvious signs of disturbance. |
| **Excellent** | **2** | Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. |
| **Very Good** | **3** | Vegetation structure altered, obvious signs of disturbance.<br><br>For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing. |
| **Good** | **4** | Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it.<br><br>For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing. |
| **Degraded** | **5** | Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.<br><br>For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing. |
| **Completely Degraded** | **6** | The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.<br><br>These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs. |

Source: Government of WA (2000) *Bush Forever: Keeping the bush in the city. Volume 2, Directory of Bush Forever Sites*. Government of WA. Perth, Western Australia. p48.

## 12 Appendix 6 – Recommended management actions and actions implemented

The following terms are available in the threatened and priority ecological community database for use.

### Recommended management actions

| |
|---|
| Access management e.g close access tracks |
| Acquisition of the occurrence or portion of the occurrence |
| Conduct further survey on community or occurrences |
| DEC to liaise with any interested parties |
| Disease control strategy to be developed and/or implemented |
| Erect environmental markers/signage |
| Establish a Recovery Team |
| Evaluate threats to the community or occurrence |
| Fence occurrence |
| Feral or native animal control strategy to be developed and/or implemented |
| Fire management strategy to be developed and/or implemented |
| Hydrological maintenance strategy to be developed and/or implemented |
| Implement Management Plan/Recovery Plan/Interim MP/Interim RP |
| Improve security of tenure |
| Inform vesting authority/owner of presence of community. |
| Install quadrat |
| Investigate possible illegal clearing |
| Involve local community groups in management |
| Management Plan/Interim Management Guidelines to be developed for land parcel |
| Map boundary and/or condition of occurrence |
| Monitoring program to be developed and/or implemented |
| Negotiate for landholder to enter off-reserve conservation strategy e.g Land for Wildlife, Conservation Covenant |
| Negotiate to change purpose to protect conservation values |
| Promote awareness of community |
| Reassess threat category of community |
| Recovery Plan/Interim Recovery Plan to be developed for community |
| Reduce impacts of mechanical disturbance, including grading activity |
| Rehabilitation/revegetation strategy to be developed and/or implemented |
| Research on community or occurrences |
| Rubbish control or removal strategy to be developed and/or implemented |
| Weed control strategy to be developed and/or implemented |

## Actions implemented

| |
|---|
| Access management e.g. close access tracks |
| Acquisition of whole or portion of the occurrence |
| Boundary of occurrence mapped |
| Conducted further survey of community or occurrence |
| DEC liaison with interested parties |
| Disease control strategy developed and/or implemented |
| Erect environmental markers/signage |
| Fenced whole or portion of occurrence |
| Feral or native animal control strategy developed |
| Fire management strategy developed and/or implemented |
| Hydrology maintenance strategy designed and/or implemented |
| Impacts of grading activity reduced |
| Informed vesting authority/owner of presence of community |
| Landholder entered into off-reserve conservation s strategy e.g Land for Wildlife, Conservation Covenant |
| Local community groups involved in management |
| Management Plan implemented |
| Management Plan/Interim Management Guidelines developed |
| Monitoring program developed or implemented |
| Negotiate to change purpose to protect conservation values |
| Possible illegal clearing investigated |
| Promotion of community awareness |
| Quadrat installed |
| Recovery Plan/Interim Recovery Plan developed |
| Recovery team established |
| Rehabilitation/revegetation strategy developed and/or implemented |
| Research underway/completed on community or occurrence |
| Rubbish control or removal strategy to be developed |
| Security of tenure improved |
| Threat category of community reassessed |
| Threats to community or occurrence determined |
| Weed control strategy developed and/or implemented |

# 13 Appendix 7 – Landform

The following terms are available in the threatened and priority ecological communities database for use. They are also being used by the Threatened and Priority Fauna and Flora databases.

The terms listed below in **bold** text represent 'umbrella' terms that can be used to encompass the terms listed below it. These terms generally follow the morphological types as listed in McDonald *et al*. (1998, p13). The 'umbrella' terms are the only ones listed individually on the Threatened and Priority Ecological community Report Form (ORF) due to space considerations. However, a line exists on the ORF for the more accurate terms to be specified if the user is familiar with them. The more accurate terms do convey more information about the landform, and so are preferred when time and expertise allow. The terms are listed in this document in the same order as they appear on the ORF.

Two references were the main source for the standard definitions of these landform terms, and these are cited where relevant. These were the Australian Soil and Land Survey Field Handbook (McDonald *et al.* 1998) and Wetlands of the Swan Coastal Plain – Wetland Mapping, Classification and Evaluation - Vol 2a (Hill *et al.* 1996). Both were endorsed as the source of landform terms by this project's Reference Group. A few terms left undefined by those texts have been retained for use by request (e.g. claypan), and definitions for these have been sought elsewhere.

Some example landform profiles are given below in Figure 1. As stated in that figure, note that the boundary between crest and slope elements is at the end of the curvature of the crest. Each slope element is treated as if it were straight. A simple slope has a relatively even gradient from top to bottom. If the slope gradient changes significantly, it is divided into upper, mid and lower slope as appropriate.

Please note that wetlands have been listed under the landform type that they occur in, as detailed in Table 1. Each landform term can only be listed under one umbrella term. Their landform type was chosen as the umbrella in order to accommodate varying water longevity. That is, the landscape will be the same whether or not it is wet at the time of observation.

**Table 1** indicates the wetland types described by Hill *et al.* on the basis of water permanence and landform. (Adapted from Hill *et al.* 1996, p37)

| | LANDFORM | | | | |
|---|---|---|---|---|---|
| WATER LONGEVITY | BASIN (Closed Depression) | CHANNEL (Open Depression) | FLAT | SLOPE | HIGHLAND (Hill) |
| Permanent inundation | lake | river | - | - | - |
| Seasonal inundation | sumpland | creek | floodplain | - | - |
| Intermittent inundation | playa | wadi | barlkarra | - | - |
| Seasonal waterlogging | dampland | trough | palusplain | paluslope | palusmont |

## Landform terms

**Crest: "landform element that stands above all, or almost all points in the adjacent terrain."** (McDonald *et al*. 1998, p13)

Hill crest: "very gently inclined to steep crest, smoothly convex, eroded mainly by creep and sheet wash. A typical element of mountains, hills, low hills and rises." (McDonald *et al*. 1998, p31)

Dune crest: "crest built up or eroded by the wind (see also *Dune*)." (McDonald *et al.* 1998, p30) Note: *Dune* is listed under **Ridge**.

Summit surface: "very wide level to gently inclined crest with abrupt margins, commonly eroded by water-aided mass movement or sheet wash." (McDonald *et al.* 1998, p33) Note: a 'plateau' would fall within this type of landform.

Mesa: "(Spanish: "table"), flat-topped tableland with one or more steep sides, … formed by erosion; during denudation, or downcutting and stripping, areas of harder rock in a plateau act as flat protective caps for portions of underlying land situated between such places as stream valleys, where erosion is especially active. This results in a table mountain (mesa) or

fortress hill (butte)." (Britannica Online Encyclopaedia, accessed March 2009. http://www.britannica.com/EBchecked/topic/376530/mesa )

**Hill: "compound landform element comprising a narrow crest and short adjoining slopes, the crest length being less than the width of the landform element."** (McDonald *et al.* 1998, p18)

Note: if plants are limited to the crest of the landform element, a term from the 'Crest' list should be chosen. If the plants extend also onto the short adjoining slopes, a term from the 'Ridge' or 'Hill' lists (as appropriate) should be chosen.

Tor: "steep to precipitous hillock, typically convex, with a surface mainly of bare rock, either coherent or comprising subangular to rounded large boulders (exhumed core-stones, also themselves called tors) separated by open fissures; eroded by sheet wash or water-aided mass movement." (McDonald *et al.* 1998, p34)

Palusmont: "seasonally waterlogged highlands and hills. (After Latin *palus* = marshy, and *montanus* = mountain; hence the term refers to hills and highlands that are seasonal wetlands)." (Hill *et al.* 1996)

**Ridge: "compound landform element comprising a narrow crest and short adjoining slopes, the crest length being greater than the width of the landform element."** (McDonald *et al.* 1998, p19)

Note: if plants are limited to the crest of the landform element, a term from the 'Crest' list should be chosen. If the plants extend also onto the short adjoining slopes, a term from the 'Ridge' or 'Hill' lists (as appropriate) should be chosen.

Breakaway: "steep maximal mid-slope or upper slope, generally comprising both a very short scarp (free face) that is often bare rockland, and a stony scarp-foot slope (debris slope); often standing above a pediment." (McDonald *et a*l. 1998, p25)

Dune: "moderately inclined to very steep ridge or hillock built up by the wind. This element may comprise *Dunecrest* and *Duneslope*." (McDonald *et al.* 1998, p30) Note: *Dune crest* is listed under **Crest**. See *Swale* for the depression between dunes.

Embankment: "ridge or slope built up by human activity." (McDonald *et al.* 1998, p30)

Saddle: "point between two areas of higher elevation", named for the way "the surface resembles a saddle that curves up in one direction, and curves down in a different direction". (Wikipedia, accessed March 2009. http://en.wikipedia.org/wiki/Mountain_pass – 'saddle' listed as alternative name).

**Outcrop: "refers to any exposed area of rock that is inferred to be continuous with underlying bedrock."** (McDonald *et al.* 1998, p101)

Outcrop – on Crest: exposed area of rock inferred to be continuous with underlying bedrock, occurring on a *Crest*.

Outcrop – on Slope: exposed area of rock inferred to be continuous with underlying bedrock, occurring on a *Slope*.

Outcrop – on Ridge: exposed area of rock inferred to be continuous with underlying bedrock, occurring on a *Ridge*.

Outcrop – on Flat: exposed area of rock inferred to be continuous with underlying bedrock, occurring on a *Flat*.

Gnamma hole: "small holes of varying shape, diameter and depth, found in hard granite outcrops and in the decomposed granite of a breakaway, which can and usually does hold water." (Geoscience Australia, accessed March 2009. http://www.ga.gov.au/mapspecs/topographic/v5/appendixA_files/Waterbodies.jsp#Waterbodies%20Gnamma%20Hole%20Point )

**Slope: "planar landform element that is neither a crest nor a depression and has an inclination greater than about 1%."** (McDonald *et al.* 1998, p15)

Note: the following five definitions (in *italicised text*) and the note on class of slope combine to indicate which one of the available slope terms (listed below the definitions in normal text) applies

best. Please see Figure 1 for example profiles illustrating each of these slope elements. Remember that each slope element is treated as if it were straight. A simple slope has a relatively even gradient from top to bottom. If the slope gradient changes significantly, it is divided into upper, mid and lower slope as appropriate.

*Hillslope: "gently inclined to precipitous slope, commonly simple and maximal, eroded by sheet wash, creep, or water-aided mass movement. A typical element of mountains, hills, low hills and rises." (McDonald* et al. *1998, p31)*

*Simple slope: "slope element adjacent below a crest or flat and adjacent above a flat or depression." (McDonald* et al*. 1998, p15)*

*Upper slope: "slope element adjacent below a crest or flat but not adjacent above a flat or depression." (McDonald et al. 1998, p15)*

*Mid-slope: "slope element not adjacent below a crest or flat and not adjacent above a flat or depression." (McDonald et al. 1998, p15)*

*Lower slope: "slope element not adjacent below a crest or flat but adjacent above a flat or depression." (McDonald et al. 1998, p15)*

*Gentle/Steep:* (Note: measuring the exact degree of a slope will not significantly assist management of ecological community and it not expected that people reporting on threatened and priority ecological community will do so. However, this figure represents an approximate guide for those that would like one for background knowledge). McDonald *et al.* (1998, p12) suggest 40% tangent or 23˚ as an average figure for 'steep' slopes, applied over an observation span of no less than 20m. We could consider a slope of less than that grade as 'gentle', and more than that, 'steep'.

Upper slope gentle
Upper slope steep
Mid-slope gentle
Mid-slope steep
Lower slope gentle
Lower slope steep

Cliff: "very wide cliffed (greater than 72˚) maximal slope usually eroded by gravitational fall as a result of erosion of the base by various agencies; sometimes built up by marine organisms (cf. *Scarp)*". (McDonald *et al.* 1998, p25) Note: *Scarp* is defined in Glossary.

Paluslope: "seasonally waterlogged slope. (After Latin *palus* meaning marshy; the term refers to slopes which are similar in wetness to dampland basins, ie wetland slopes)." (Hill *et al.* 1996)

**Flat: "planar landform element that is neither a crest nor a depression and is level or very gently inclined (less than 3% tangent approximately)."** (McDonald *et al.* 1998, p18)

Plain: "large very gently inclined or level element, of unspecified geomorphological agent or mode of activity." (McDonald *et al.* 1998, p32)

Valley flat: "small, gently inclined to level flat, aggraded or sometimes eroded by channelled or over-bank stream flow, typically enclosed by hillslopes" (McDonald *et al.* 1998, p34)

Scald: "flat, bare of vegetation, from which soil has been eroded or excavated by surface wash or wind." (McDonald *et al.* 1998, p32)

Claypan: "a dense, compact, slowly permeable layer in the subsoil having a much higher clay content than the overlying material, from which it is separated by a sharply defined boundary. Claypans are usually hard when dry, and plastic and sticky when wet. They limit or slow the downward movement of water through the soil. (Wikipedia, accessed March 2009. http://en.wikipedia.org/wiki/Claypan )

Floodplain: "seasonally inundated flat." (Hill *et al.* 1996)

Barlkarra: "intermittently flooded flat. (North-west Australian aboriginal word referring to grassy flats/plains that are flooded from time to time)." (Hill *et al.* 1996)

Palusplain (Winter-wet flat): "seasonally waterlogged flat. (After Latin *palus* meaning marshy; the term refers to flats which are similar in wetness to dampland basins)." (Hill *et al.* 1996)

**Depression – open (valley): "Depression – landform element that stands below all, or almost all points in the adjacent terrain. An open depression extends at the same elevation, or lower, beyond the locality where it is observed"** (McDonald *et al*. 1998, p15)

Gorge: "deep and narrow, steep-sided, usually rocky river valley." (Geoscience Australia, accessed March 2009. http://www.ga.gov.au/mapspecs/250k100k/appendixA_files/Framework.jsp#Framework%20Gorge%20Point ).

Gully: "open depression with short precipitous walls and moderately inclined to very gently inclined floor or small stream channel, eroded by channelled stream flow and consequent collapse and water-aided mass movement." (McDonald *et al.* 1998, p31)
"A gully is a channel more than 0.3m deep." (McDonald *et al.* 1998, p95) [A rill is a channel up to 0.3m deep].

Swale: "(i) linear, level-floored open depression excavated by wind, or left relict between ridges built up by wind or waves, or built up to a lesser height than them;
(ii) long, curved open or closed depression left relict between *scrolls* built up by channelled stream flow." (McDonald *et al.* 1998, p33) Note: *scrolls* defined in Glossary.

River: "permanently inundated channel of variable size and shape. (Established term, from Latin *rivus*, a stream." (Hill *et al.* 1996)

Riverbank (Bank, stream bank): "very short, very wide slope, moderately inclined to precipitous, forming the marginal upper parts of a *stream channel* and resulting from erosion or aggradation by channelled stream flow." (McDonald *et al.* 1998, p25)

Creek: "seasonally inundated channel of variable size and shape." (Hill *et al.* 1996)

Wadi: "intermittently flooded channel of variable size and shape. (Arabic term referring to drainage channels in desert environments that flash flood during the occasional storm)." (Hill *et al.* 1996)

Trough: "seasonally waterlogged channel of variable size and shape." (Hill *et al.* 1996)

Estuary: "*stream channel* close to its junction with a sea or lake, where the action of channelled stream flow is modified by tides and waves. The width typically increases downstream." (McDonald *et al.* 1998, p30)

Stream channel: "linear, generally sinuous open depression, in parts eroded, excavated, built up and aggraded by channelled stream flow. This element comprises *stream bed* and *banks*." (McDonald *et al.* 1998, p33) Note: *stream bed* defined in Glossary.

Swamp (open): "almost level closed, or almost closed depression with a seasonal or permanent water table at or above the surface, commonly aggraded by overbank stream flow and sometimes biological (peat) accumulation." (McDonald *et al.* 1998, p33)

**Drainageline: a subset of wetlands, generally associated with open depressions.**
Note: this is a general term, included for people who are unable to be more specific, but wish to record some habitat details.

**Depression – closed: "Depression – landform element that stands below all, or almost all points in the adjacent terrain. A closed depression stands below all such points"** (McDonald *et al*. 1998, p15)

Pit: "closed depression excavated by human activity." (McDonald *et al.* 1998, p32)

Lagoon: "closed depression filled with water that is typically salt or brackish, bounded at least in part by forms aggraded or built up by waves or reef-building organisms." (McDonald *et al.* 1998, p31)

Lake: 1) "permanently inundated basin of variable size and shape. (Established term, from *lacus*, a hollow)." (Hill *et al.* 1996)
2) "large water-filled closed depression." (McDonald *et al.* 1998, p31)

Lakebed: the substrate at the bottom or edges of a lake.

Sumpland (swamp): "seasonally inundated basin of variable size and shape. (After 'sump' meaning site of water retention, ponding or accumulation. The term is fortuitously similar to 'sumpf' the German term for swamp)." (Hill *et al.* 1996)

Playa: 1) "large, shallow, level-floored closed depression, intermittently water-filled, but mainly dry due to evaporation, bounded as a rule by flats aggraded by sheet flow and channelled stream flow." (McDonald *et al.* 1998, p32)
2) "intermittently flooded basin of variable size and shape. (Established term referring to intermittently flooded basin; usually in arid environments such basins are 'salt lakes')." (Hill *et al.* 1996)

Swamp (closed): "almost level closed, or almost closed depression with a seasonal or permanent water table at or above the surface, commonly aggraded by overbank stream flow and sometimes biological (peat) accumulation." (McDonald *et al.* 1998, p33)

Dampland: "seasonally waterlogged basin of variable size and shape. (After 'damp' meaning moist or wet. Thus it refers to a dampness or waterlogging of soils of some basin wetlands)." (Hill *et al.* 1996)

**Wetland: "areas of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh or saline, eg waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries."** (Wetlands Advisory Committee 1977; cited in Hill *et al.* 1996, Glossary).

Note: this is a general term, included for people who are unable to be more specific, but wish to record some habitat details.

**Cave: "A natural cavity in rock, large enough for a human to enter. The extent of a cave system which may have more than one entrance and consist of many chambers and passages. The term still applies if the cavity is totally filled with water. If the cavity is filled with sediment or ice, (making it impenetrable), then qualification of the term is required."** (G.K. Smith, accessed March 2009. http://wasg.iinet.net.au/glossary.html )

**Figure 1** illustrates example landform profiles. (Extracted from McDonald *et al.* 1998, p14).

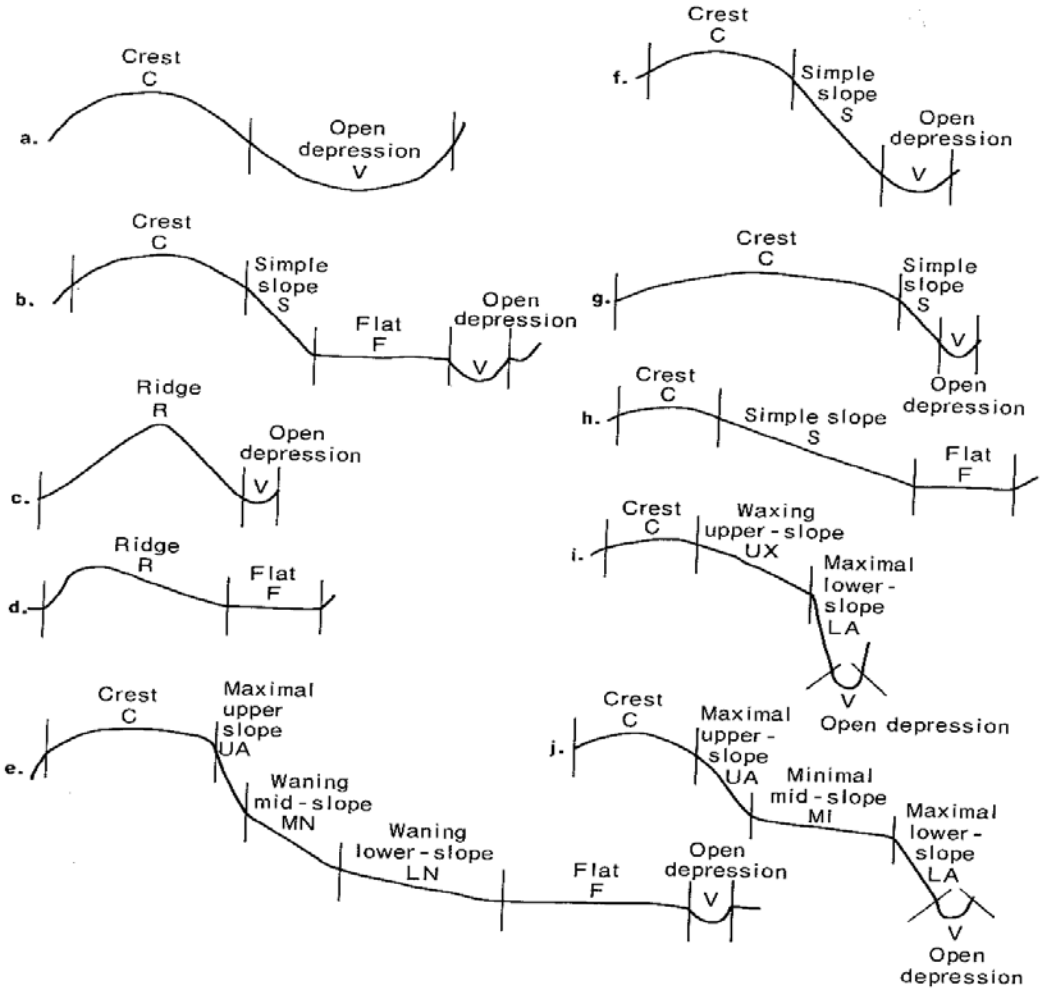



**Figure 1** Examples of profiles across terrain divided into morphological types of landform element. Note that the boundary between crest and slope elements is at the end of the curvature of the crest. Each slope element is treated as if it were straight.

## GLOSSARY

Aggradation: "the presence of material deposited on a pre-existing surface as a result of wind and/or water erosion." (McDonald *et al.* 1998, p96)

Bar (stream bar): "elongated, gently to moderately inclined low ridge built up by channelled stream flow; part of a *stream bed*." (McDonald *et al.* 1998, p25)

Erosion: 'removal of surface soil from an area by various agents, including wind, water (sheet wash, high stream flow, wave action) or mass movement.' (McDonald *et al.* 1998, pp92-96)

NB: concerned with recording accelerated erosion (follows the destruction or loss of protective cover often resulting from man's influence on the soil, vegetation or landform) rather than natural or geologic erosion (type and rate of movement of land surface material in its undisturbed natural environment). (McDonald *et al.* 1998, p92)

Inundation: "includes flooding from over-bank flow, inundation from local run-on and overland flow." (McDonald *et al.* 1998, p96)

Scarp: "very wide steep to precipitous maximal slope eroded by gravity, water-aided mass movement or sheet flow (*cf. Cliff).*" (McDonald *et al.* 1998, p32)

Scroll: "long, curved very low ridge built up by channelled stream flow and left relict by channel migration." (McDonald *et al.* 1998, p33)

Stream bed: "linear, generally sinuous open depression forming the bottom of a *stream channel* eroded and locally excavated, aggraded or built up by channelled stream flow. Parts that are built up include *bars*." (McDonald *et al.* 1998, p33)

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## 14 Appendix 8 – Rock type

The following is a suggested list of rock types. If you wish to record a rock type not present in this list, please specify.

Banded ironstone
Basalt
Calcrete
Chert
Dolerite
Gneiss
Granite
Greenstone
Gypsum
Ironstone
Laterite
Limestone
None
Quartz
Quartzite
Sandstone
Schist
Shale
Siltstone
Slate
Spongelite
Unknown

## 15 Appendix 9 – Soil type

The following is a suggested list of soil types. The definitions provided are of the behaviour of the moist bolus as detailed in the Australian Soil and Land Survey Field Handbook (McDonald *et al.* 1998). Some additional terms are provided following Carlile *et al.* (2001 – CSIRO Technical Report), plus peat and gypsum from user request.

**Sand: "Coherence nil to very slight, cannot be moulded; sand grains of medium size; single sand grains adhere to fingers."** (McDonald *et al.* 1998, p118)
Loamy sand: "Slight coherence; sand grains of medium size; can be sheared between thumb and forefinger to give minimal ribbon of about 5mm." (McDonald *et al.* 1998, p118)
Clayey sand: "Slight coherence; sand grains of medium size; sticky when wet; many sand grains stick to fingers; will form minimal ribbon of 5-15mm; discolours fingers with clay stain." (McDonald *et al.* 1998, p118)
**Sandy loam: "Bolus coherent but very sandy to touch; will form ribbon of 15-25mm; dominant sand grains are of medium size and are readily visible."** (McDonald *et al.* 1998, p119)
Fine sandy loam: Bolus coherent and fine sand can be felt and often heard when manipulated; sand grains clearly evident under a x10 hand lens. (McDonald *et al.* 1998, p119-120)
**Loam: "Bolus coherent and rather spongy; smooth feel when manipulated but with no obvious sandiness or 'silkiness'; may be somewhat greasy to the touch if much organic matter present; will form ribbon of about 25mm."** (McDonald *et al.* 1998, p119)
Silty loam: "Coherent bolus; very smooth to often silky when manipulated; will form ribbon of about 25mm." (McDonald *et al.* 1998, p119)
Sandy clay loam: "Strongly coherent bolus, sandy to touch; medium size sand grains visible in finer matrix; will form ribbon of 25-40mm." (McDonald *et al.* 1998, p119)
**Clay loam: "Coherent plastic bolus, smooth to manipulate; will form ribbon of 40-50mm."** (McDonald *et al.* 1998, p119)
Fine sandy clay loam: "Coherent plastic bolus; medium size sand grains visible in finer matrix; will form ribbon of 40-50mm." (McDonald *et al.* 1998, p119)
Silty clay loam: "Coherent smooth bolus, plastic and often silky to the touch; will form ribbon of 40-50mm." (McDonald *et al.* 1998, p119)
**Light clay: "Plastic bolus; smooth to touch; slight resistance to shearing between thumb and forefinger; will form ribbon of 50-75mm."** (McDonald *et al.* 1998, p119)
Sandy clay: Plastic bolus; sandy to touch.
Silty clay: Plastic bolus; silky to touch.
**Clay: (Parent term incorporating the medium-heavy clays)**
Light medium clay: "Plastic bolus; smooth to touch; slight to moderate resistance to ribboning shear; will form ribbon of about 75mm." (McDonald *et al.* 1998, p119)
Medium clay: "Smooth plastic bolus; handles like plasticine and can be moulded into rods without fracture; has moderate resistance to ribboning shear; will form ribbon of 75mm or more." (McDonald *et al.* 1998, p120)
Medium heavy clay: "Smooth plastic bolus; handles like plasticine; can be moulded into rods without fracture; has moderate to firm resistance to ribboning shear; will form ribbon of 75mm or more." (McDonald *et al.* 1998, p120)
Heavy clay: "Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; has firm resistance to ribboning shear; will form ribbon of 75mm or more." (McDonald *et al.* 1998, p120)
**Peat: An accumulation of partially decayed organic matter, inhibited from decaying fully by acidic and anaerobic conditions. Forms in wetlands.**
Gypsum: Although gypsum is a mineral component of soil rather than a soil type like the others, it has such a distinctive effect on soil behaviour that it is also listed. It is flocculent and a key component of plaster of paris – when dry it is like fine powder, and when wet it is like goo. It is generally found as dunes or flats near the edges of salt lakes in lower rainfall areas, and the soil profile is generally clayey at depth. Gypsum locks up nutrient in the soil, inhibiting plant uptake. Good condition gypsum soils often have a blue-green algal layer on top that holds together the surface of the soil, and provides some nitrogen. Gypsum soils support a distinctive suite of ecological communities, as relatively few ecological communities have the ability to survive in those conditions (pers. comm. G. Keighery 2008)

## 16 Appendix 10 – Soil colour

The following terms are a suggested list of soil colours. If you wish to record a soil colour not present in this list, please specify.

**Red**
Pink
Red-orange
Red-brown
Orange
**Yellow**
Yellow-orange
Yellow-brown
**Brown**
Brown-black
**Black**
Red-black
**Grey**
Grey-black
Cream
**White**

## 17 Appendix 11 – Vegetation structure charts (NVIS)

Executive Steering Committee for Australian Vegetation Information (ESCAVI) (2003) Australian Vegetation Attribute Manual: National Vegetation Information System, Version 6.0. Department of Environment and Heritage, Canberra.

| | **Cover Characteristics** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Foliage cover * | 70-100 | 30-70 | 10-30 | <10 | ≈0 | 0-5 | unknown |
| | Crown cover ** | >80 | 50-80 | 20-50 | 0.25-20 | <0.25 | 0-5 | unknown |
| | % Cover *** | >80 | 50-80 | 20-50 | 0.25-20 | <0.25 | 0-5 | unknown |
| | Cover code | d | c | i | r | bi | bc | unknown |
| | | | | | | | | |
| **Growth Form** | **Height Ranges (m)** | **Structural Formation Classes** | | | | | | |
| tree, palm | <10,10-30, >30 | closed forest | open forest | woodland | open woodland | isolated trees | isolated clumps of trees | trees |
| tree mallee | <3, <10, 10-30 | closed mallee forest | open mallee forest | mallee woodland | open mallee woodland | isolated mallee trees | isolated clumps of mallee trees | mallee trees |
| shrub, cycad, grass-tree, tree-fern | <1,1-2,>2 | closed shrubland | shrubland | open shrubland | sparse shrubland | isolated shrubs | isolated clumps of shrubs | shrubs |
| mallee shrub | <3, <10, 10-30 | closed mallee shrubland | mallee shrubland | open mallee shrubland | sparse mallee shrubland | isolated mallee shrubs | isolated clumps of mallee shrubs | mallee shrubs |
| heath shrub | <1,1-2,>2 | closed heathland | heathland | open heathland | sparse heathland | isolated heath shrubs | isolated clumps of heath shrubs | heath shrubs |
| chenopod shrub | <1,1-2,>2 | closed chenopod shrubland | chenopod shrubland | open chenopod shrubland | sparse chenopod shrubland | isolated chenopod shrubs | isolated clumps of chenopod shrubs | chenopod shrubs |
| samphire shrub | <0.5,>0.5 | closed samphire shrubland | samphire shrubland | open samphire shrubland | sparse samphire shrubland | isolated samphire shrubs | isolated clumps of samphire shrubs | samphire shrubs |
| hummock grass | <2,>2 | closed hummock grassland | hummock grassland | open hummock grassland | sparse hummock grassland | isolated hummock grasses | isolated clumps of hummock grasses | hummock grasses |
| tussock grass | <0.5,>0.5 | closed tussock grassland | tussock grassland | open tussock grassland | sparse tussock grassland | isolated tussock grasses | isolated clumps of tussock grasses | tussock grasses |
| other grass | <0.5,>0.5 | closed grassland | grassland | open grassland | sparse grassland | isolated grasses | isolated clumps of grasses | other grasses |
| sedge | <0.5,>0.5 | closed sedgeland | sedgeland | open sedgeland | sparse sedgeland | isolated sedges | isolated clumps of sedges | sedges |
| rush | <0.5,>0.5 | closed rushland | rushland | open rushland | sparse rushland | isolated rushes | isolated clumps of rushes | rushes |
| forb | <0.5,>0.5 | closed forbland | forbland | open forbland | sparse forbland | isolated forbs | isolated clumps of forbs | forbs |
| fern | <1,1-2,>2 | closed fernland | fernland | open fernland | sparse fernland | isolated ferns | isolated clumps of ferns | ferns |
| bryophyte | <0.5 | closed bryophyteland | bryophyteland | open bryophyteland | sparse bryophyteland | isolated bryophytes | isolated clumps of bryophytes | bryophytes |
| lichen | <0.5 | closed lichenland | lichenland | open lichenland | sparse lichenland | isolated lichens | isolated clumps of lichens | lichens |
| vine | <10,10-30, >30 | closed vineland | vineland | open vineland | sparse vineland | isolated vines | isolated clumps of vines | vines |
| aquatic | 0-0.5,<1 | closed aquatic bed | aquatic bed | open aquatic bed | sparse aquatics | isolated aquatics | isolated clumps of aquatics | aquatics |
| seagrass | 0-0.5,<1 | closed seagrass bed | seagrassbed | open seagrassbed | sparse seagrassbed | isolated seagrasses | isolated clumps of seagrasses | seagrasses |

## 18 Appendix 12 – Estimates of time since last fire from vegetation attributes

| Time since last fire | Vegetation attributes |
|---|---|
| 0-2 years | Vegetation cover and natural leaf litter may be sparse. Many species may be in a juvenile stage of growth or regeneration; some trees and shrubs may have juvenile foliage or new shoots from a lignotuber or from epicormic buds; seedlings of species in all vegetation layers may be present. Species composition may be altered due to temporary dominance by native species (or their seedlings) that are favoured by fire (e.g. wattles, annual grasses, kangaroo paws) or by weed species. |
| 2-5 years | Vegetation structure may still be altered and/or regenerating (some species may be denser or less tall than previously). Some burn scars may be evident on the bark of the larger shrubs and the trees. Many species may not be mature (i.e. not at flowering or fruiting stage or at reduced height /cover). Species composition may resemble the original vegetation or may be altered due to temporary dominance by the native species favoured by fire (e.g. wattles, annual grasses, kangaroo paws) or by weed species. |
| >5 years | Most species will be mature; burn scars may be evident on trees. No evidence of damage on other layers. |
| No evidence of fire | No burn scars evident. Vegetation mature. |