

**GUIDELINES FOR ASSESSMENT OF IMPACTS ON
TERRESTRIAL BIODIVERSITY**

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1 Introduction

The Northern Territory has been subject to a relatively high rate of extinction of biodiversity. Nineteen species are extinct in the wild and 181 are viewed as threatened with extinction. Different groups of organisms have experienced differing levels of threat. The percentage of species either extinct or threatened ranges from a high of 28% of native mammals (total of 150 species) to a low of 1.9% of plants (total of 4,702 species). The decline in our biodiversity is continuing with an additional 482 species listed as 'near threatened' during the recent (2012) revision of the threatened species classification.

The worsening conservation status of our biodiversity places a premium on insuring that development proceeds without significant impacts on the Territory's vegetation types, habitats and species. This is especially so for our species and ecological communities threatened or near threatened with extinction.

1.1 Guideline Objectives

These guidelines are provided so that proponents of development:

- have a clear understanding of what is required when they undertake an assessment of a project's impacts on biodiversity as required for a Public Environmental Report or an Environmental Impact Statement
- are able to focus their biodiversity assessments on significant impacts potentially caused by their projects, rather than an unfocused broad scale biodiversity survey of an area
- develop information sufficient to allow planning for mitigation of potential impacts and future rehabilitation of the development site.

2 Legislative Requirements

EIA may involve assessments and approvals in relation to matters regulated under a range of Northern Territory and Commonwealth legislation. Relevant legislation includes that listed below. The list is indicative of matters that may require assessment. It is not exhaustive.

Proponents and assessors should carefully review projects to determine legislated requirements relevant to particular projects.

The legislation listed has been used in developing these Guidelines.

- *Planning Act*
- *Water Act*
- *Biological Control Act 2011*
- *Territory Parks and Wildlife Conservation Act*
- *Marine Pollution Act*
- *Waste Management and Pollution Control Act*
- *Weeds Management Act*

2.1.1 Commonwealth Legislation

Some proposals may need consideration under Commonwealth legislation. Those Acts include the *Aboriginal Land Rights (Northern Territory) Act*, *Native Title Act*, *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Airports Act*.

2.1.1.1 Environment Protection and Biodiversity Conservation Act

The Commonwealth's EPBC Act provides protection for matters of national environmental significance (NES). The Commonwealth agency determines whether an action could potentially affect a NES matter and whether it requires assessment and approval under the EPBC Act. The NES matters are:

- World Heritage properties;
- National Heritage Places;
- Ramsar wetlands of international importance;
- Nationally threatened animal and plant species and ecological communities;
- Internationally protected migratory species;
- A water resource, in relation to coal seam gas development and large coal mining development
- Commonwealth marine areas;
- Great Barrier Reef Marine Park; and
- Nuclear actions (including uranium mines).

There is overlap between the species listed as threatened under the EA Act and EPBC Act. Only the EPBC Act specifies listed migratory species. An EIS that involves NT biodiversity is likely to require assessment under the EA Act and the EPBC Act. For convenience it is anticipated that field investigations and assessments would need to be designed to meet the NT and Commonwealth needs. Proponents are referred to the Commonwealth's website for comprehensive information on EPBC Act requirements. (<http://www.environment.gov.au/epbc>)

Specific information on matters of national environmental significance can be found at: <http://www.environment.gov.au/epbc/protect/index.html>.

3 Limitations

This Guidance is:

- not an instrument for predicting outcomes of deliberations by the NT EPA;
- designed to promote a more certain and consistent approach to assessments; and is
- intended to apply to proposals prior to the proponent submitting the proposal to NT EPA for environmental assessment.

The Northern Territory Environment Protection Authority (NT EPA) has prepared this document in good faith, exercising all due care and attention, but no representation or warranty, express or implied, is made as to the relevance, completeness or fitness for purpose of this document in respect of any particular user's circumstances. Users of this document should satisfy themselves concerning its application to their situation and, where necessary, seek expert advice.

4 Sources of Information

The Department of Land Resource Management (DLRM) maintains spatial databases on the Territory's bioregions, parks and reserves, soils, land units and systems,

vegetation types, flora, fauna, weeds and threatened species. Information can be accessed via the DLRM website (<http://www.lrm.nt.gov.au/>), including through the NR Maps NT mapping function. Detailed data for particular areas can be accessed by contacting datarequests.dlr@nt.gov.au. Biodiversity information for selected areas may also be extracted through the NT Infonet site (<http://www.ntinfonet.org.au/reports/>).

The Northern Territory Herbarium, Department of Land Resource Management, provides support on plant taxonomy, and the Northern Territory Museum provides a similar service for animal taxonomy.

5 Vegetation Assessment

5.1 Objectives

Vegetation assessment is to provide documentation of:

- the vegetation of proposed development sites and the immediately adjacent area
- the presence and distribution of critical habitats (*Territory Parks and Wildlife Conservation Act* (TPWCA) or listed ecological communities (*Environment Protection and Biodiversity Conservation Act* (EPBC Act)) that conform to a vegetation type or group of vegetation types
- the local and regional conservation status of vegetation types present in development sites
- the potential impacts of projects on vegetation in, adjacent to, and downstream from development sites
- the conservation significance of a development's impacts on vegetation at local and regional levels
- compliance with Northern Territory Land Clearing Guidelines (Department of Natural Resources, Environment, the Arts and Sport. 2010. *Land Clearing Guidelines*. Technical Report 20/2009D, NT Government, Darwin).

5.2 Information Requirements

5.2.1 Desktop Assessment

The DLRM maintains spatial data on Territory-wide mapping of vegetation. Mapping is available at a scale of 1:1,000,000 for the entire Territory. Additional mapping is available by higher levels of resolution for some areas. The lower resolution data are suitable for preliminary assessment of vegetation. Available spatial data on soils, land units and land systems may assist in preliminary assessments.

5.2.2 Mapping a Site's Vegetation

Vegetation types on and immediately adjacent to a development site are to be mapped at a scale appropriate to the size of a development, usually at least 1:50,000, unless the project site is exceptionally large or exceptionally elongated over hundreds of kilometres. Mapping, classification of vegetation types, ground truthing of vegetation types and boundaries and vegetation descriptions (structural and species composition) should follow: Brocklehurst, P., D. Lewis, D. Napier and D. Lynch. 2007. *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping*. Technical Report No. 02/2007D, NT Government, Darwin.

Mapping should be as described for unmapped sites and involve full characterisation of multiple samples per vegetation type. Vegetation classification should involve use of the NVIS methodology allowing interpretation at more than one scale. The intensity of

sampling should be determined according to the level of variation present within individual vegetation types. The adequacy of the applied sampling intensity should be demonstrated. Sampling should occur at a time/times of year when floristic material allowing plant identification is most likely to be available for most species.

Data on the floristic and structural attributes of the existing vegetation types provide a sound basis for planning rehabilitation of disturbed sites.

Background information on frequencies and extent of fire at various times of year can be obtained from the North Australia Fire Information service website: www.firenorth.org.au

5.3 Assessment of Conservation Significance

An assessment of conservation significance of a site's vegetation types can be made with reference to:

- the Northern Territory Land Clearing guidelines for vegetation regarded as “sensitive” to disturbance
- vegetation types included in designated buffer zones precluded from clearing under the Clearing Guidelines
- the *Supplement to the NT Parks and Wildlife Conservation Masterplan* for bioregional conservation significance (The Masterplan provides information on the area of each major vegetation type in each bioregion, together with the reservation status of vegetation types)
- critical habitats listed under the TPWCA or ecological communities listed under the EPBC Act
- previous area specific assessments by government or information to be found in the scientific literature.

Bioregions can cover extremely large areas of land. Assessments of conservation status at sub-regional levels can be more informative than those completed at the broader bioregional level. Both levels of assessment are encouraged.

5.4 Assessment of Impacts on Vegetation

Sources of impacts on the conservation significance of vegetation types inevitably include loss of vegetation from clearing. All other forms of impact should be addressed e.g. such as those caused by dust deposition, sedimentation, erosion, wildfire or weeds.

Impact assessment should include each form of impact on each vegetation type or group of vegetation types. Impacts or impact levels specific to particular vegetation types should be assessed on a vegetation type by type basis. Impacts can be assessed for groups of vegetation types when impacts from particular sources are determined as uniform across types. The significance of a development's impacts is to be determined for each source of impact and each identified consequence to each vegetation type/group of types. Significance of the impacts is to be determined at local and regional levels. Standard risk assessment procedures are to be applied (see section 8). Assessment should consider whether impacts on vegetation are permanent, or the vegetation is likely to recover over what particular time periods.

6 Flora Assessment

6.1 Objectives

Flora assessment is to provide documentation of:

- the threatened flora species (as listed under the TPWCA and/or EPBC Act) of proposed development sites and immediately adjacent areas
- the local and regional conservation status of threatened flora present in development sites
- the potential impacts of projects on threatened flora in, adjacent to, and downstream from development sites
- the conservation significance of a development's impacts on threatened flora at local and regional levels.

6.2 Information Requirements

6.2.1 Desktop Assessment

The DLRM maintains a database on all plant specimens held by the Northern Territory Herbarium. The data include spatial location of collection sites, dates of collection and species and conservation status. Additional plant location records are collated by DLRM in a Vegetation Survey Database. Information can be accessed via the DLRM website (<http://www.lrm.nt.gov.au/>), including through the NR Maps NT mapping function. Detailed data for particular areas can be accessed by contacting datarequests.dlrm@nt.gov.au.

These data are useful in establishing the likely level of knowledge on the flora of a site, and in making a preliminary assessment of an area's likely species of threatened flora.

A less reliable understanding of threatened flora possibly occurring in an area can be obtained using the Commonwealth's search engine for protected matters.

6.2.2 The Native Flora and its Threatened Species of Plant

The flora of the area and each vegetation type will be documented during the characterisation of vegetation types. These data, DLRM threatened species fact sheets (<https://nt.gov.au/environment/animals/classification-of-wildlife>), herbarium records and the Commonwealth's protected matters search engine can be used to establish a list of threatened species potentially present in the proposed development area. Habitats for each possible threatened species are to be searched at appropriate times of year to determine the presence of the species and obtain estimates of population abundance where the species occur. Search areas, full descriptions of methods, search/sampling time/effort and results are to be reported for each possible threatened species, demonstrating the adequacy of the applied level of sampling effort. Greater reliance on historic records or habitat distributions may be needed for more arid environments. Searches for rare plants should be undertaken by people who have appropriate expertise with some species identities needing to be confirmed (e.g. by suitable specimens examined at the NT Herbarium). Searches of habitat away from the proposed development site may be appropriate to provide context for the status of poorly known species located in the development area.

6.2.3 Weeds

Species of introduced weed listed under the *Weeds Management Act 2001*, as a Weed of National Significance (WoNS) or as a Key Threatening Process (KTP) should be identified from DLRM digital weed records Datarequests.DLRM@nt.gov.au and by ground survey. Weed data should be collected using the format provided in the '*Guidelines for Weed Data Collection in the Northern Territory*'. Where these weed species are identified measures required to meet statutory obligations for their management under the *Weeds Management Act 2001* should be documented.

6.3 Assessment of Conservation Significance

Assessment of conservation significance for flora should be on the basis of observed levels of species richness of the flora, the number of threatened present and the sizes of populations of threatened species. These data can only be interpreted in relation to known species richness or threatened species distributions/abundances in the locality or region. In many cases there will be little such information other than that collected from the site. Therefore interpretation must also use existing information from off the site. It may be appropriate to sample similar habitats outside the development area in order to develop a suitable comparative basis for the assessment of conservation significance. The precautionary principle will need to be used in interpreting the conservation significance of findings.

6.4 Assessment of Impacts on Flora

Sources of impacts on the conservation significance of the flora and threatened plant species will inevitably include loss of vegetation from clearing. All other forms of impact should be assessed e.g. such as those caused by dust deposition, sedimentation, erosion, wildfire or weeds.

Impact assessment should include each source of impact on the flora, and each threatened species. Significance of a development's impacts from each source and for each identified consequence and flora/species is to be determined at local and regional levels. Standard risk assessment procedures are to be applied (see section 8).

7 Fauna Assessment

7.1 Objectives

Fauna assessment is to provide documentation of:

- the threatened fauna (as listed under the TPWCA and/or EPBC Act) of proposed development sites and immediately adjacent areas
- congregations, large populations or important sites for listed migratory fauna (EPBC Act) found on the proposed development site
- important fauna sites (e.g. major breeding areas, fauna congregations, isolated permanent water sources, geological features such as caves, large boulder piles or escarpments) in the proposed development area
- the local and regional conservation status of threatened fauna, listed migratory fauna, or important fauna congregations or sites present in development sites
- the potential impacts of projects on threatened fauna, listed migratory fauna, or important fauna congregations or sites in, adjacent to, and downstream from development sites

- the conservation significance of a development's impacts on threatened fauna, listed migratory fauna, important fauna congregations or sites at local and regional levels.

7.2 Information Requirements

7.2.1 Desktop Assessment

The DLRM maintains a database on fauna records from across the Northern Territory. The data include spatial locations of record sites, dates of records and species and conservation status. Information can be accessed via the DLRM website (<http://www.lrm.nt.gov.au/>), including through the NR Maps NT mapping function. Detailed data for particular areas can be accessed by contacting datarequests.dlr@nt.gov.au. Biodiversity information for selected areas may also be extracted through the NT Infonet site (<http://www.lrm.nt.gov.au/>).

These data are useful in establishing the likely level of knowledge of the fauna of a site, and in making a preliminary assessment of an area's likely species of threatened and/or migratory fauna.

A less reliable understanding of threatened and/or migratory fauna possibly occurring in an area can be obtained using the Commonwealth's search engine for protected matters.

7.2.2 Threatened and Migratory Fauna

Species of threatened and/or listed migratory fauna likely to be found on the proposed development site can be determined from the DLRM fauna database and threatened species fact sheets (lrm.nt.gov.au/biodiversity-conservation/animals/home), the scientific literature and the Commonwealth's protected matters search engine. Habitats for each of the possible species can be sampled according to methods provided by the Commonwealth's guidelines for survey of threatened, migratory and other species (<http://www.environment.gov.au/epbc/guidelines-policies.html#threatened>), using the standard DLRM fauna survey methods (Appendix A) or other methods as appropriate. Alternative methods may be required for assessment of species abundances. Sampling is to occur at suitable times of year and appropriate intensity to determine the presence of the species and obtain estimates of population abundance where the species occur. Search areas, sampling methods, search time/effort, capture effort as appropriate and results are to be reported for each possible threatened or migratory species. The adequacy of sampling needs to be demonstrated.

7.2.3 Important Congregations of or Sites for Fauna

Important congregations of fauna or sites for fauna include locations with:

- seasonal feeding/roosting congregations of migrant species
- colonies of roosting species
- breeding colonies
- caves
- breeding areas for species with known highly specific breeding area requirements e.g. Gouldian finches
- isolated and possibly spatially rare habitat resources important to fauna or of importance to fauna at a particular time of year or the life cycle e.g. isolated sources of permanent water, large boulder piles, escarpments.

The occurrence of areas with these attributes in the proposed development area are to be mapped and investigated to determine the nature of the resources provided to fauna, and the fauna using those resources (seasonal or otherwise).

7.3 Assessment of Conservation Significance

Assessment of conservation significance of fauna should be on the basis of the observed number of threatened / migratory species present, the regional significance of these records, and the size of the population of threatened species or congregation of wildlife. These data can only be interpreted in relation to known threatened/migratory species distributions/abundances in the locality or region. In many cases there will be little such information other than that collected from the site. Interpretation must use existing information from off the site. It may be appropriate to sample similar habitats outside the development area in order to develop a suitable comparative basis for the assessment of conservation significance. The precautionary principle will need to be used in interpreting the conservation significance of findings.

The conservation significance of congregations of or sites for fauna can only be assessed on the basis of:

- the biology of each fauna species involved (to be accessed from the scientific literature)
- the pattern of occurrence, abundance and importance to the species of those habitat features and congregations in the landscape.

7.4 Assessment of Impacts on Fauna

Sources of impacts on the conservation significance of the threatened/migratory species or congregations/important sites will inevitably include loss of vegetation from clearing. All other forms of impact should be assessed e.g. such as those caused by dust, noise, deposition, sedimentation, erosion, wildfire or weeds.

Impact assessment should include each form of impact on each threatened/migratory species or congregation/site. Significance of a development's impacts from each source of impact and for each identified consequence and species/congregation/site category is to be determined at local and regional levels. Standard risk assessment procedures are to be applied (see section 8).

8 Assessment of the Significance of Impacts

The significance of impacts is to be determined using standard risk assessment procedures (e.g. AS/NZS ISO 31000:2009). Risk assessment is undertaken assuming that standard impact avoidance and mitigation measures have been undertaken.

Thorough identification of sources of impact (e.g. land clearing, dust and others) and consequences is critical to successful risk analysis. Each source of impact can and often will have more than one consequence for a particular component of biodiversity. Analysis of the potential significance of impacts on any one component of biodiversity (e.g. a threatened species) must inevitably be made up of assessments of:

- each potential consequence from each source of impact, and
- a subsequent assessment of each consequence from the cumulative impacts of all sources

This is well recognised in the Commonwealth's guidelines for the assessment of the significance of impacts on matters of national environmental significance (<http://www.environment.gov.au/epbc/guidelines-policies.html>).

The Commonwealth significant impact guidelines provide a discussion about impacts to heritage places listed for their natural values. These guidelines are appropriate for assessing the risks to vegetation, entire floras and entire faunas of particular areas. The Commonwealth also provides useful consequences for assessing the significance of impacts to threatened or migratory species, and ecological communities. Consequences for assessment of the significance of congregations of fauna or sites of importance to fauna can be developed using either, or combinations of the natural heritage and threatened/migratory species consequences.

The particular consequences mentioned need not necessarily be used. What is important is recognition of and assessment according to the existence of multiple consequences stemming from each particular source of impact. Assessment without due consideration of all potential sources of significant impact and the multiple potential consequences to individual components of biodiversity can fail to identify potentially significant impacts, and the potential for significant consequences from interaction among sources of impact.

Clarity and adequate justification in identification of the sources of impacts and associated consequences, likelihoods of consequences and severity of consequences are essential in the appropriate design for mitigation should standard mitigation fail to result in a low level of risk.

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Appendix A

Standard terrestrial vertebrate survey methods used by the Department of Land Resource Management

Pre-survey requirements

Permits and Animals Ethics

All fauna survey works require a permit under the *Territory Parks and Wildlife Conservation Act*, and animal ethics approval. A permit to conduct a fauna survey can be obtained from the Department of Land Resource Management (DLRM) Permits section, contactable on (08) 8999 4814. Results of all surveys are to be provided to DLRM as quickly as possible.

Contact your approved Animal Ethics Committee for ethic approval.

Working with landowners

Specific permission must be obtained from the relevant landowner before entering the property and undertaking the survey (also a condition of Scientific Research Permit)

For aboriginal lands, permission to undertake the survey should be sought from traditional owners through the relevant Land Council, but also directly via the local indigenous ranger group or community council. It is desirable for the local ranger group or local community to be involved in the survey whenever possible.

Working on aboriginal land entails certain obligations and responsibilities. A number of protocols and guidelines exist and researchers should be aware of these – a good example is at

<http://www.nailsma.org.au/hub/resources/publication/nailsma-research-guidelines-and-protocols-2007.html>

There should be prompt feedback about survey progress and results in a format accessible to the relevant land owners and/or managers.

Species lists

Lists of species known or likely to occur in the survey area may be useful. The NT Fauna atlases may be interrogated for any specified area through the *Infonet* web interface:

<http://www.ntinonet.org.au/reports/>).

Checklists of NT species are available at:

<https://nt.gov.au/environment/native-plants/native-plants-and-nt-herbarium> (plants)

<https://nt.gov.au/environment/animals/classification-of-wildlife> (vertebrates)

<https://nt.gov.au/environment/animals/threatened-animals> and <https://nt.gov.au/environment/native-plants/threatened-plants> (threatened species)

Survey methods

Fauna survey methods and habitat description are based on defined and precisely located quadrats. Some incidental observations are made outside these quadrats, and some special methodologies may be adopted in targeted surveys.

Quadrats

In the Top End, the quadrats used for trapping are 50 x 50 m. In the arid zone, a 100 x 100 m quadrat or 200 x 50 m transect may be used.

Rectangular quadrats, with an equivalent area, may be used to sample narrow patches e.g. riparian strips.

Birds are sampled in a 100 x 100 m quadrat centred on the core 50 x 50 m quadrat. In the arid zone a larger quadrat (250 x 250 m) or belt transect (100 x 500 m) may be used, although this should not straddle several vegetation types.

Quadrats are located within substantial areas of relatively homogeneous vegetation and landform, and not near boundaries, e.g. fences or roads. The exception is when a deliberate decision is made to sample a small patch, edge or ecotone.

Quadrats should be well separated (i.e. 500 m + apart) except where sampling adjacent contrasting land types in a paired-sample design.

The location of each quadrat should be determined as precisely as possible, preferably using an averaged GPS reading.

Traps

Each quadrat is sampled using:

- Four cage traps – one in each corner;
- Twenty Elliott traps around the perimeter – five on each side, c. 8 m apart (for a 50 x 50 m quadrat);
- Four pit traps scattered within the quadrat. Each pit trap comprises a 20 litre plastic bucket dug into the ground with 10m of drift-fence set across it to channel small ground-dwelling fauna into the bucket. Pits are located in different microhabitats in the quadrat e.g. in open ground; in dense grass; close to trees; in rocky areas;
- Four funnel traps - placed in pairs midway along two 10m drift fences;

All traps are marked clearly with flagging tape so they can be easily located.

Elliott and cage traps are baited with a mixture of oats, peanut butter & honey. Vanilla essence, cat biscuits and tuna can be added. Cage traps may also be baited with fruit or meat scraps.

Traps are opened for a minimum of three nights. Sampling time may be extended depending on the requirements of the survey

Traps are checked early each morning and rechecked at midday. Elliott and cage traps are rebaited each afternoon.

Trapped animals are identified and released near the capture point, or retained for as short a time as possible for identification or for taking measurements.

Bird counts

Eight daylight bird counts are carried out in each quadrat. In addition, birds are recorded during two nocturnal visits – see below.

The majority of bird counts should be done in the early morning, with the remainder spread through the day if necessary.

Each bird count is theoretically an instantaneous count of all the birds within the quadrat. In practice this involves briefly walking through the quadrat but it is not a count over an extended period of time.

The number of individuals of each species is recorded for each count.

Only birds that are using the quadrat are recorded (i.e. birds merely flying across overhead are not included). Raptors, wood-swallows, etc are included if they are observed hunting overhead.

Active searches

Each quadrat is actively searched five times for reptiles, amphibians, mammals, scats and signs.

Three searches are carried out during the day (morning, midday, late afternoon) and two searches at night using spotlights.

Each search takes about 15 minutes and involves turning rocks and logs, raking through leaf litter, looking under bark or in rock crevices.

The number of individuals of each species seen is recorded. Scats, bones and other signs are recorded where these can confidently be attributed to species.

Carnivore scats can be collected for hair analysis.

Incidental records

Species that are seen in the vicinity of the quadrat and in the same environment are recorded as incidental records for that site, with an abundance of zero to indicate they were not within the quadrat

Other species seen in the general area are recorded on a separate list for incidental records. Where possible, the exact location and brief habitat details for the species are noted. This is most important for species that have some significance (e.g. rare or vulnerable species or species for which the record may be a range extension)

Bat Sampling

Systematic methods for censusing bats include timed recordings using Anabat equipment (with a digital Anabat recorder it is usually practical to record calls for one or more complete nights per site)

Bat calls are identified by comparison with a reference library (Milne 2002).

Bats may also be sampled opportunistically using harp traps and mist nets, by sightings or captures in caves, and identification of audible calls for a few species. For each record the location and brief habitat description are noted. When traps are used the trapping time is also recorded. It is usual procedure to take basic measurements of all bats trapped.

Invertebrate Sampling

Invertebrate taxa are not routinely sampled during DLRM biodiversity surveys (although systematic sampling of ants and some other groups effectively sampled using pit traps have sometimes been included – e.g. Andersen *et al.* 2002, 2004).

Appropriate methods for sampling various invertebrate groups should be discussed with staff from the NT Museum and/or CSIRO Sustainable Ecosystems in Darwin.

Data recording

Each species from the quadrat is recorded on a proforma (example attached) with an abundance score, as the survey progresses.

Each bird count, each day or night of survey and each trapping methods are recorded separately, in order to allow additional analyses (e.g. species accumulation curves).

Incidental records adjacent to the quadrat are given an abundance of zero.

Data are later transferred from proformas to electronic databases.

Specimens

Specimens should only be collected when absolutely necessary – when a species cannot be positively identified in the field (and such identification is important) or when the specimen represents a significant range extension. Live photographs can be of assistance in confirming identifications in other circumstances.

Equally, positive identification may be crucial and museum specimens form a very valuable resource, so collecting specimens when appropriate should not be avoided.

Specimens can only be collected where this is specified on the animal ethics approval, and must be lodged with the NT Museum.

Guidelines for collecting voucher specimens and recommended euthanasia techniques are at: <http://www.cdu.edu.au/research/ori/animal-ethics>.

Specimens are usually fixed in 10% formalin and stored in 70% alcohol, although formalin fixing is not essential.

Genetic Samples

Genetic samples may be a viable non-destructive alternative to voucher specimens in some cases.

Genetic samples are routinely collected from all mammal species captured during DLRM surveys, for taxonomic, conservation genetics and other potential future research projects.

Small amounts of tissue (e.g. tail tip, ear clip) are collected using sterile techniques and stored in 70% alcohol.

Habitat Description

A standard proforma (attached) is used in DLRM biodiversity surveys to record ecologically meaningful information about the sample sites. Fields are described in the box following the attachment.

Digital photographs should be taken of each site.

Post-survey

All data should be promptly entered onto electronic databases, and data-sheets archived in an ordered fashion in an accessible location.

Purpose-built Access and Excel databases are available from the DLRM Biodiversity Conservation group.

Photographs should be stored digitally with a filename or number linked to the site description.

Specimens should be lodged with the NT Museum, with location, collector, date and brief habitat details as soon as possible.

All data should be sent to the Permits Branch, Parks and Wildlife Conservation Northern Territory in an approved format as soon as possible.

Useful references and field guides

Andersen A, Hoffmann BD, Muller WJ & Griffiths AD (2002) Using ants as bioindicators in land management: simplifying assessment of ant community responses. *Journal of Applied Ecology* 39:8-17.

Andersen AN (2000) *The ants of northern Australia: a guide to the monsoonal fauna*. CSIRO Publishing.

Andersen AN, Woinarski JCZ, Hoffmann BD (2004) Biogeography of the ant fauna of the Tiwi Islands, in northern Australia's monsoonal tropics. *Australian Journal of Zoology* 52, 1-14.

Braby MF (2004) *The complete field guide to the butterflies of Australia*. CSIRO Publishing, Melbourne.

Brock J (2001) *Native plants of northern Australia*. Reed New Holland, Sydney.

Brocklehurst P, Lewis D., Napier D, Lynch D. (2007) *Northern Territory guidelines and field methodology for vegetation survey and mapping*. Technical Report No. 02/2007D, Department of Natural Resources, Environment and the Arts, Palmerston, Northern Territory.

Churchill S (2008) *Australian bats. Second edition*. Jacana Books, Crows Nest, Australia.

Cogger HG (2000) *Reptiles & amphibians of Australia*. 6th edition. Reed New Holland, Sydney.

Cole J & Woinarski J (2002) *Field guide to the rodents and dasyurids of the Northern Territory*. Surrey Beatty & Sons, Chipping Norton.

Cowie ID, Short PS & Madsen MO (2000) *Floodplain flora: a flora of the coastal floodplains of the Northern Territory, Australia*. Flora of Australia Supplementary Series Number 10. ABRS, Canberra & PWCNT Darwin.

Dunlop CR, Leach GJ & Cowie ID (1995) *Flora of the Darwin region volume 2*. Northern Territory Botanical Bulletin No. 20, Conservation Commission of the Northern Territory, Darwin.

Horner P (1991) *Skinks of the Northern Territory*. Handbook Series Number 2, Northern Territory Museum of Arts and Sciences, Darwin.

Jessop J (1981) *Flora of central Australia*. Reed Books, Sydney.

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Attachments (following pages):

- Proforma for recording vertebrate species recorded at each site
- Habitat description proforma for biodiversity survey sites
- Description of variables in habitat proforma

BIODIVERSITY CONSERVATION – VERTEBRATE FAUNA SURVEY

SITE:	SURVEY:	start date:	obs:
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BIRDS	inc	Q								spot	
		1	2	3	4	5	6	7	8	1	2
DATE											
TIME											
OBSERVER											

BIODIVERSITY CONSERVATION – VERTEBRATE FAUNA SURVEY

E = Elliott; C = Cage; P = Pit; F = Funnel; S = Search/Spot; X = scat/sign							
	D0	N1	D1	N2	D2	N3	D3
DATE							
REPTILES							
FROGS							
MAMMALS							

DLRM Biodiversity Unit – Systematic Biodiversity Surveys

QUAD*:	survey:	date:	observer:
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* must be letters followed by numbers, maximum eight characters

bird q: 50x50 100x100 ?:	trap q: 50x50 100x100 ?:	nights: 1 2 3 4 ?:	
Elliotts: 20 ?:	cages / LEs: 4 ?:	pits: 2 4 8 ?:	funnels: 2 4 8 ?:

region / station:	resample: Y N	photo ref:	
location details:			
Lat DD:	Long DD:	x:	y:
zone: 52 53	datum: GDA94 (preferred) WGS84 AGD66	acc: av.GPS GPS other (m):	

landscape position:			
land unit:	run: on off plain	patch size (ha): <1 1-5 5-50 50-500 500+	
slope (°):	aspect: none N NE E SE S SW W NW		
perm water: 0 <50m 50-500m 0.5-5km >5km	curr water: 0 <50m 50-500m 0.5-5km >5km		

disturbance 0=no visible impact -> 5= major impact affecting all of quadrat			
fire impact: 0 1 2 3 4 5	last fire: this year* last year 2+ years ago long unburnt (*after Wet)		
pig damage: 0 1 2 3 4 5	cow/horse/donkey: 0 1 2 3 4 5	weeds: 0 1 2 3 4 5	
other: 0 1 2 3 4 5 describe:			

rock cover (%)	rock type
pebbles (<0.6cm): 0 <2 2-10 10-20 20-50 50-90 >90	sandstone
small stones (0.6-2cm): 0 <2 2-10 10-20 20-50 50-90 >90	laterite
stones (2-6cm): 0 <2 2-10 10-20 20-50 50-90 >90	limestone
small rocks (6-20cm): 0 <2 2-10 10-20 20-50 50-90 >90	basalt
rocks (20-60cm): 0 <2 2-10 10-20 20-50 50-90 >90	quartz
big rocks (60cm-2m) 0 <2 2-10 10-20 20-50 50-90 >90	<u>other:</u>
boulders (>2m): 0 <2 2-10 10-20 20-50 50-90 >90	
outcrop: 0 <2 2-10 10-20 20-50 50-90 >90	

soil texture: sand sandy-loam sandy-clay loam clay-loam clay cracking clay peat rock		
soil depth (cm): 0 <10 10-40 >40	soil colour:	
termite mounds - no:	max ht (m):	profile: tower dome magnetic

ground cover (measured along 100m point-intercept tape) – must add to 100%	total
bare ground	
rock	
litter	
hummock grass	
perennial grass	
annual grass	
sedge	
other forbs	

logs >5cm (intersecting 200m perimeter)	
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QUAD:	canopy ht (m):	canopy cover (%):
veg. profile (% cover in height classes) >10m: 0 <5 5-10 10-25 25-50 50-75 >75 5-10m: 0 <5 5-10 10-25 25-50 50-75 >75 3-5m: 0 <5 5-10 10-25 25-50 50-75 >75 1-3m: 0 <5 5-10 10-25 25-50 50-75 >75 0.5-1m: 0 <5 5-10 10-25 25-50 50-75 >75 0-0.5: 0 <5 5-10 10-25 25-50 50-75 >75		structural formation (upper storey) <i>cover</i> <i>crown separation</i> CF 70-100% overlapping OF 30-70% 0 - 0.25 W 10-30% 0.25 - 1 • <u>OW</u> <u><10%</u> <u>>1</u> ST scattered isolated trees none ground layer only

Full floristic data collected: Y N		herb. plot no.:				
Bitterlich sweeps		number: 1 2 3 4		multiplier: 0.25 0.5 0.75 1.0		
species	coll?	FL- FR (0->5)*	<5cm	5-20cm	20-50cm	>50cm
dead tree						

Dominant species (>5% cover only)		
upper	mid	ground

* nectarivorous flowers and fleshy fruits: 0=no plants in flower (FL); 1=isolated plants with few flowers; 2=isolated plants with moderate no. of flowers or most plants with few flowers; 3=many plants with moderate no. flowers; 4=most plants with many flowers; 5=all plants with many flowers. Comparable score for fruit (FR).

Notes:

Description of habitat variables

<i>quad</i>	unique label for each quadrat e.g. TIPP01 (TIPP01_2 for a resample)
<i>survey</i>	unique survey name e.g., Daly Basin 2004
<i>bird q etc</i>	details of sampling intensity
<i>region/station</i>	usually park name, station name or sample region
<i>observer</i>	the person deciding what data values go onto the sheet (not necessarily the scribe)
<i>location</i>	explicit details about the site location – in relation to roads, tracks, creeks, landscape features etc – sufficient for someone else to relocate it
<i>lat/long</i>	precise location from GPS. Use averaged readings if possible. Datum is required
<i>x/y</i>	AMG easting and northings – alternative reading from GPS. Zone and datum is required
<i>acc</i>	If not from GPS, estimate spatial accuracy in metres
<i>landscape position</i>	brief description of landscape setting of site. Use the format of the "Yellow Book" (McDonald <i>et al.</i> 1998) e.g.: narrow valley in sandstone plateau; midslope on low hills
<i>landunit</i>	where available, from land unit mapping
<i>run on/off</i>	<u>run off</u> sites shed rainfall (e.g. hill crests, upper slopes); <u>run-on</u> sites receive run-off e.g. swamps, base of hills; plains are extensive flat areas
<i>patch size</i>	contiguous area of sampled habitat type. Most relevant for restricted habitats e.g.: rainforest, lancewood, rock outcrop.
<i>slope</i>	measured in degrees using a clinometer – estimate a mean slope for heterogeneous quadrats
<i>aspect</i>	the direction the slope faces – 'none' for zero slope
<i>altitude</i>	from topo map
<i>perm water</i>	estimated distance to nearest permanent water (including artificial sources)
<i>curr water</i>	distance to nearest water at time of survey
<i>disturbance</i>	various disturbance are scored on a scale of zero to 5, for major impact affecting all of quadrat. This will be somewhat subjective. 1 should mean that the disturbance is present but has had virtually no effect, 3 that there is a low level of disturbance throughout the quadrat, or a moderate effect concentrated in patches
<i>last fire</i>	estimate from fire scars and regeneration whether the site was burnt during the current year; the previous year; fire scars present but apparently old; or no sign of fire or its effects
<i>rock cover</i>	the total cover of rocks within the quadrat is estimated using cover classes for different size classes of rocks (see the "Yellow Book" for examples). Rock sizes refer to the longest dimension on the rock. Note this includes rock cover underneath vegetation or litter**
<i>rock type</i>	broad classifications of the principal rock types – add others if you can determine them
<i>lithology</i>	an optional field for the underlying lithology from a geological map
<i>soil texture</i>	broad texture classes relating to the amount of clay in the soil – see Yellow Book
<i>termite mounds</i>	estimate the total number in the quadrat, the maximum height and whether they are tall & thin, squat & wide or magnetic mounds
<i>ground cover</i>	These variables are best quantified by stretching out a 100m tape through the quadrat (use a V-shape). Walk along the tape, looking vertically down and at each 1m score which feature is directly below the mark. The measures should add to 100% (so a piece of grass above litter or rocks would be scored only as grass). Can also be done by pacing a boottip-intercept transect. <u>hummock grass</u> is <i>Triodia</i> spp; <u>annual grasses</u> can easily be pulled out and have very short root systems; <u>perennial grasses</u> are more firmly rooted in the ground and mostly form distinct tussocks; <u>other forbs</u> are herbs, ferns and small shrubs. Only score vegetation in the ground layer.
<i>canopy height</i>	mode height of canopy trees (not the tallest), using a clinometer

<i>canopy cover</i>	estimation of projective foliage cover of canopy. Best done objectively, using a device which we will try out shortly
<i>veg profile</i>	estimate the cover of vegetation (using cover classes) in different height zones. The same plant could contribute cover to more than one zone
<i>structural formation</i>	classification of the upper storey (in the quadrat and the surrounding vegetation it represents) as closed forest, open forest, woodland, open woodland, scattered trees or none. Canopy cover and crown separation are given as guides. A crown separation of 0.25 means the mean distance between the crowns of adjacent trees is one-quarter of the mean crown width
<i>Bitterlich sweeps.</i>	Basal area is estimated using sweeps with a Bitterlich measure. The number of sweeps is ideally four, from the 4 corners of the quadrat – fewer sweeps could be used in very open homogeneous vegetation. Unless the tree layer is very dense or trees are very large, use the smallest slot (multiplier = 0.25). Record the number of sweeps and the slot size (multiplier) used. For each individual tree scored, visually estimated the DBH class it falls into. All tree species registering a hit are scored separately. The total is the number of hits for each species over all the sweeps
<i>Dominant species</i>	Record the species with at least 5% cover in the three strata of the vegetation in decreasing order of cover. Only enter a max. of 5 species per strata. If there is a tall shrub layer and no tree layer, regard this as the mid layer. Except in monsoon forests, few species have >5% cover in a 50 m quadrat.