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# Terrestrial vertebrate fauna surveys for the preparation of environmental impact assessments; how can we do it better? A Western Australian example

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**Abstract**

The Western Australian Environmental Protection Authority (EPA) in 2002 released *Position Statement, No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection* outlining how terrestrial fauna survey data are to be used and interpreted in the preparation of environmental impact assessments (EIA). In 2004, the EPA released its *Guidance for the Assessment of Environmental Factors, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56*. This paper briefly assesses the adequacy of recent terrestrial fauna surveys undertaken to support publicly released EIAs and indicates that the EPA is not always adhering to its own position and guidance statements. This paper argues that the current fauna survey guidelines are in need of improvement. The approach and requirements of some other Australian states are briefly assessed to identify similarities and where improvements can be made to the Western Australian (WA) guidelines. This paper concludes with suggestions on how the process and the guidelines in WA can be revised to more adequately assess the impact of developments on terrestrial vertebrate biodiversity and ecosystem function. These suggestions may have relevance for other areas where fauna surveys are undertaken to support EIAs.


*Keywords:* Terrestrial vertebrate fauna; Surveys; Environmental impact assessment; EIA; Environmental protection authority; Western Australia



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## 1. Introduction

In 2000, the EPA (Environmental Protection Authority, 2000) released *Preliminary Position Statement No. 3*, General Requirements for Terrestrial Biological Surveys for Environmental Impact Assessment in Western Australia seeking public comment on the statement before releasing its formal position on terrestrial fauna surveys. In this document the EPA indicated the difficulty it had in assessing impacts on biodiversity values because of poor quality terrestrial vertebrate fauna surveys. The EPA suggested that the lack of appropriate baseline data did not allow for a proper assessment, data were not being interpreted for biodiversity value and there was a lack of survey standards. The EPA went on to indicate that it had accepted substandard work and had received inconsistent and changing advice from the Department of Environment and Conservation (DEC) and other government agencies (pp. 6–7).

Having considered the public comments on the Preliminary Position Statement, the EPA issued *Position Statement No. 3, Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002). In its overarching principles, the EPA indicated that it expected proponents to ensure that terrestrial biological surveys provided sufficient information to address both biodiversity conservation and ecological function values (pp. 5). Terrestrial fauna surveys were expected to meet standards and requirements as published by the EPA. The EPA explained that it used a two level assessment system (Levels 1 and 2) based on Western Australia's (WA) 26 bioregions as defined in the Interim Biogeographic Regionalisation of Australia (IBRA), and the potential scale and nature of the impact to determine the extent of investigation and fauna survey work to be undertaken. A Level 1 assessment includes a desktop study (i.e. literature review) and a reconnaissance visit to the site to verify the desktop study. A Level 2 survey includes a desktop study and a comprehensive fauna survey. The EPA indicated that it would subsequently publish guidelines on how terrestrial fauna surveys should be undertaken. The Position Statement indicated that the EPA required that fauna survey data should be used to assess the impact of a development on biodiversity at the genetic, species and ecosystem level, and the functional value at the ecosystem level.

Fraser et al. (2003) reported on the extent and quality of 15 terrestrial fauna surveys that were contained in Consultative Environmental Review level assessments that had been approved for a disturbance in areas not previously mined or where mining had been minimal in the Coolgardie IBRA. As part of this project, an expert panel was established to determine 'best practice' against which the adequacy of the terrestrial fauna surveys could be assessed, as there were no published standards for terrestrial fauna surveys at that time. It was evident from the examination by Fraser et al. (2003) that many of these reports were deficient and that the terrestrial fauna trapping effort undertaken by many of the consultants fell short of the minimum standards of best practice as described by the expert panel. This information confirmed the EPA view that it had been accepting substandard terrestrial fauna surveys and the reporting of this information.

In February 2003, the EPA (Environmental Protection Authority, 2003) released *Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56* Draft for public comment. After reviewing submissions, in June 2004 the EPA released *Guidance for the Assessment of Environmental Factors, Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia, No. 56*. The EPA claimed this document provided guidance, among other things, on approaches and standards, when surveys should be undertaken, the extent and level of survey effort, survey sampling design and intensity, and reporting requirements. *Guidance Statement No. 56* added to the Level 2 assessment the need for either a 'detailed' or 'comprehensive' survey (pp. 32) but did not explain the difference. Detailed information was

provided on whether a Level 1 or 2 assessment was required based on factors such as the size and scale of the impacted area, whether the area or surrounds were likely to support native fauna, rarity of vegetation or fauna, whether the area served as an ecological refuge for fauna species (e.g. remnant populations, disjunct populations, restricted distributions), whether the area contained protected fauna, whether the area had ecological significance and whether the area was a complex habitat with a diverse faunal assemblage.

To support an argument for improvements, the adequacy of some recently published terrestrial fauna surveys (but not stygofauna) used to support recently released EIA reports approved by the EPA are assessed. This is followed by a comment on the adequacy of Guidance Statement No. 56. A brief assessment of the fauna survey guidelines issued by various other government conservation agencies is then provided as a context for suggested improvements to the WA approach. This is followed by a discussion of the general issues and recommendations on how WA can improve terrestrial fauna surveys and their reporting. These recommendations may be relevant for other areas where fauna surveys are undertaken.

## 2. Adequacy of level 2 terrestrial fauna surveys

Only projects approved by the EPA for release in 2004 and 2005 for public comment and that required a Level 2 assessment according to the criteria contained in Table 3 of Guidance Statement No. 56 are evaluated. The adequacy of these fauna surveys and reporting of these data are based on criteria contained in Position Statement No. 3 and Guidance Statement No. 56. For each of the criterion, each report has been assessed using a five point rating system. Appendix A describes each criterion, indicates its rationale and the basis for the subjective judgements that allocated a rating of 1 to 5 for each report for each of these criterion.

Table 1 provides a summary of the assessment of seven reports. It is appreciated that because the rating system is subjective, different reviewers might score the reports slightly higher or lower; however, an effort has been made to consistently apply the criteria to all reports. The areas in which most reports failed to meet the required standard include the survey effort, characterisation of the faunal assemblages and ecosystems for each habitat type and a discussion of ecosystem functional values. Other areas not well addressed included not accounting for seasonal and temporal variations and not utilising a range of trap-types. Overall, all surveys fell short of the requirements outlined in the EPA Position Statement No. 3 and Guidance Statement No. 56, and there was considerable scope for improvement.

## 3. Guidance Statement No. 56

Guidance Statement No. 56 was prepared to provide the necessary guidance to proponents of a development and their environmental consultants undertaking fauna surveys and preparing EIAs so that they complied with the intent of Position Statement No. 3. Although the introduction to the *Guidance Statement* claimed that it provided direction and information on general standards and protocols for terrestrial fauna surveys to environmental consultants and proponents engaged in EIA activities (p. 1), 'it does not provide prescriptive guidelines for survey methodology' (p. 6) which is a deficiency. Readers could reasonably expect to find in a guidance statement, advice on how to undertake terrestrial fauna surveys, and specific information on the standards and protocols recommended (or required) by the EPA.

Guidance Statement No. 56 lists a number of factors (p. 12–13) that might influence survey sampling design and intensity, but fails to explain how the design and intensity of surveys should

be adjusted to account for these factors. Guidance Statement No. 56 cites a number of references that readers might consult when designing and planning a fauna survey. Two of these references are for publications in 1984, and a considerable amount has been written on this topic since then. The two more recent references are to Burbidge et al. (2000a,b), who reported on the research protocols employed for the Carnarvon Basin fauna survey. The fauna survey protocol used in the Carnarvon Basin terrestrial fauna survey is not appropriate for site surveys (i.e. inadequate trapping effort in each habitat and failure to employ a wide range of traps) and should not be used as a model when undertaking terrestrial fauna surveys for the purposes of preparing an EIA for a disturbed site. Furthermore, no adequate explanation of trapping effort or intensity is provided nor is there an indication of when surveys should be repeated to account for temporal variations.

Trap type is an important component of any terrestrial fauna survey; however, Guidance Statement No. 56 provides little advice on this issue. Funnel traps, PVC 20 L buckets, PVC storm water piping as pit-traps, Elliott traps, wire cage traps, cover boards, hand-foraging, night spotlighting, hair traps and scat analysis all sample the small vertebrate assemblage differently (Bauer and Sadler, 1992; Bury and Corn, 1987; Catling et al., 1997; Enge, 1997a; Fitch, 1992a,b; Greenberg et al., 1994; Jacob et al., 2002; Lobert et al., 2001; Thompson et al., 2005a,b). Detailed information should have been provided on the bias associated with each trap type and search strategy; and guidance provided on the appropriate mix of traps and search strategies to be employed in terrestrial fauna surveys.

Guidance Statement No. 56 points out that 'in many cases the timing of the fauna and faunal assemblage survey will be critical …..' (p. 11) and goes on to indicate 'a survey in the season that follows the season of maximum rainfall is generally the most productive and important survey time' (p. 12). I know of only three Australian published datasets that have been systematically collected and allow comparison of fauna collected in the various seasons. How (1998) reported on a reptile and frog fauna survey in a remnant urban bushland (Bold Park) in the Perth metropolitan area on the coastal dunes. Pit-trapping was undertaken between December 1986 and June 1993 on multiple occasions each year between September and the following June (398 days and 2388 pit-trap days). Trapping rates were highest in November (4.35 individuals/10 pit-days) and December (5.03 individuals/10 pit-days). Peak periods of rainfall for Perth most often come in June and July (www.bom.gov.au/climate/averages/tables/text/cw_009034.csv), which would indicate that spring was the best survey period at Bold Park based on the EPA Guidelines. However, catch rates in September (1.36 individuals/10 pit-days) and October (1.32 individuals/10 pit-days) were only better than May and June which is mid-winter and were appreciably lower than November and December. Thompson and Thompson (2005) surveyed 10 habitat types in the eastern Goldfields of WA on 10 occasions over a two year period (twice in June, Sept. Dec. Jan. and April) using an identical survey protocol. Peak rainfall periods for the eastern Goldfields are February, and May–July (http://www.bom.gov.au/climate/averages/tables/text/cw_012038.csv). Summer rain comes from two sources; a) decaying cyclones that penetrate inland occasionally bring heavy late summer rain, and b) local thunderstorms which are more consistent. Summer rain is unpredictable but can occasionally be heavy (greater than 100 mm per event) which elevates the monthly average. Fig. 1 demonstrates this variability in heavy daily rainfall for Paddington mine site at Ora Banda. Almost all of the daily rainfall that is in excess of 30 mm occurred in summer. Winter rains are more predictable. Very heavy rainfall was experienced in February 2000 prior to the first 12 months of surveys but rainfall was more normal proceeding the second 12 months of surveys (Fig. 1). Thompson and Thompson's (2005) data indicated that January followed by December were the best periods to trap both the highest number of individual and species of reptiles for all sites in both years. For small mammals, catch rates were highly variable but

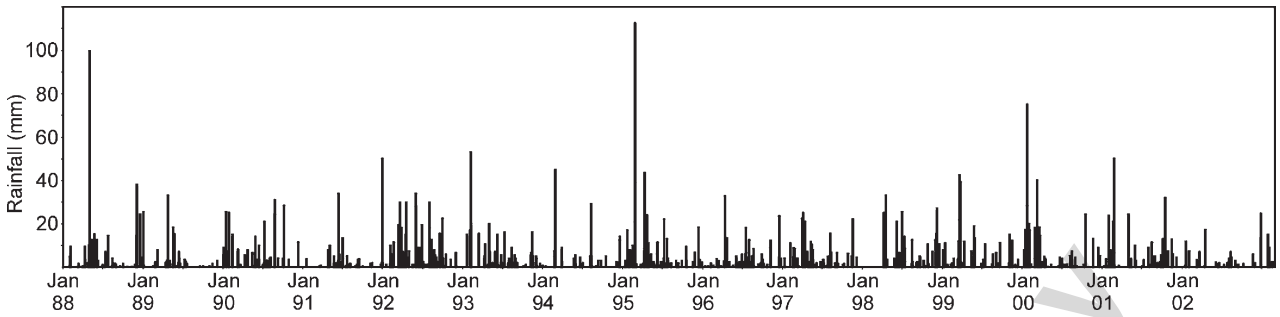


Fig. 1. Rainfall measured on a daily cycle at Paddington gold mine, near Ora Banda.

generally lower in the cooler months. Based on this rainfall pattern, autumn or possibly spring would be when the EPA suggest is the best time to undertake terrestrial fauna surveys in the Goldfields, which is clearly not the case.

Rainfall is highest in the Pilbara region of WA in summer (e.g. the heaviest rainfall for Marble Bar and Newman is in January, February and March; http://www.bom.gov.au/climate/averages/tables/ca_wa_names.shtml) and adherence to the EPA guidelines in this circumstance would require terrestrial fauna surveys be carried out in autumn. How and Cooper (2002) and How and Dell (2004) report on a small vertebrate fauna survey in the Pilbara conducted over nine sampling periods (March 1988 to November 1990) in eight different habitat types. Mammal capture rates were variable and showed no obvious seasonal pattern (How and Cooper, 2002). The highest number of reptiles were trapped in summer (How and Dell, 2004), indicating the guidelines for this region of WA are inappropriate. Rainfall data provided by How and Dell (2004) indicated that heavy rain fell in March of 1988 and again in February of 1989. The authors commented on this above average rainfall during the first two summers of survey and that this had followed a long drought. They suggested that many of the reptile species in the Pilbara reproduce opportunistically following improved environmental conditions after episodic rainfall events. These potential increases in reptile abundance are likely to manifest themselves many months later given the time it takes for the environment to respond and the reproductive processes to take their course. In contrast, fauna assemblages in the Pilbara respond negatively to fires, at least in the short term, although, in the longer term fires are probably a major contributor to habitat diversity and high species richness.

Rainfall in the wet–dry tropics (e.g. Kununurra) is heaviest in January and February (http://www.bom.gov.au/climate/averages/tables/cw_002038.shtml) and the EPA guidelines would suggest that the best time to survey is at the end of the wet season. Many reptiles, frogs and small mammals are most active at the beginning of the wet season, particularly those species that have been inactive during the 'dry' season, and are therefore best trapped during this period. These data suggest that the EPA guidelines for when terrestrial fauna surveys should be carried out in most areas of WA are inappropriate.

Activity patterns for some reptile species are influenced by rainfall events (e.g. pythons), however, the general pattern is that reptiles are most active and mostly easily trapped in the hotter parts of the year, whereas mammals are more variable and activity extends over a much wider range of daily temperatures for mesic, arid and semi-arid areas of Australia. The pattern is different in the wet–dry tropics with many species becoming less active and more difficult to trap during the dry season. Commencement of the wet season seems to stimulate both small mammal and reptile activity, and is therefore a more productive trapping period. Other less systematic survey methods such as spotlighting, hand searches, sand plots to detect tracks, hair-traps and

collecting scats are sometimes used by environmental consultants to increase species richness records, but generally provide a poor understanding of relative abundance. No systematic evaluations of the most suitable period for employing these alternative fauna assessment strategies are available in the literature. However, many reptile species become inactive during the cooler months in mesic and arid zones and during the dry in the wet–dry tropics and are unlikely to be detected by most of these less-systematic search strategies. The relative abundance of reptiles and mammals may be significantly influenced by environmental variables such as fires and episodic rainfall events, and these variables should be taken into account when planning fauna surveys. The optimum survey period will therefore vary from region-to-region and may be influenced by seasonal rainfall and daily weather conditions.

The EPA Position Statement No. 3 (2002) makes it clear that terrestrial fauna survey data should be used to assess biodiversity value at the genetic, species and ecosystem levels, and ecological functional value at the ecosystem level. However, Guidance Statement No. 56 makes no reference to how terrestrial fauna survey data should be analysed or interpreted to assess the impact of the proposed disturbance on these aspects of biodiversity. A key phrase in all the EPA's publications is 'functional value at the ecosystem level', but no where does it define what is meant by this phrase, and what issues should be considered in determining whether a development is likely to impact on the functional value of an ecosystem. Given the emphasis that Position Statement No. 3 places on this issue, this is a serious shortcoming of Guidance Statement No. 56.

## 4. Role of proponents, consultants and the EPA in determining the level of assessment

Proponents for a development are mostly government departments acting as land developers or wishing to change the zoning of land, or are private companies that are seeking to mine or utilise the land for a particular purpose. When provided with a range of alternatives or vague guidelines it is reasonable to expect that many developers will adopt the least cost option. Environmental consultants undertake the vast majority of the terrestrial fauna assessments for land developers and mining companies in WA. Often these companies are in a competitive situation when seeking business. If the requirements for terrestrial fauna assessments in tenders are vague and ill defined, then it makes it difficult for consultants to respond. In the absence of clear guidelines, proposed works programs suggested by consultants are often based on what the EPA has approved in the past. Most environmental consultants in WA that undertake terrestrial fauna surveys are well qualified, equipped and capable of undertaking more intensive and comprehensive terrestrial fauna surveys and reporting on these data in an appropriate manner. However, in a price competitive environment, it is understandable when a consultant adopts a minimalist position to contain costs and win contracts even though the survey effort and reporting falls short of EPA guidelines.

The EPA in its Preliminary Position Statement No. 3 (2000) made it clear why there was a need to improve and upgrade standards for terrestrial fauna surveys in WA. What is missing is clarity in what is expected for terrestrial fauna surveys, how the data should be analysed and reported, and for the EPA to more stringently adhere to its published position and guidance statements.

## 5. Fauna assessment guidelines elsewhere in Australia

There is no standard requirement or guidelines for terrestrial fauna surveys for the purposes of preparing EIAs that apply in all Australian states and territories. Environmental impact assessments in each state and territory are undertaken under the auspice of the Commonwealth

Government legislation (i.e. *Environment Protection and Biodiversity Conservation Act 1999*) and the relevant state government legislation (e.g. in WA the *Environmental Protection Act 1986*). Some local government authorities also require an EIA before providing planning approval (e.g. Brisbane City Council). A search of the appropriate web-sites indicated that detailed fauna survey guidelines are not provided by all other Australian state or national environmental protection authorities. However, in South Australia, the government environmental regulators often use the guidelines published by South Australian Parks and Wildlife (Owens, 2000). In New South Wales (NSW) the Department of Environment and Conservation released a draft guideline in 2004 on surveying for threatened species, and the Lower Hunter Central Coast Region of NSW has published fauna survey guidelines for developments in that region. Below is a brief description of the major expectations of the Lower Hunter Central Coast Region, the Department of Environment and Conservation and the South Australian Parks and Wildlife for fauna surveys. This section concludes with a brief summary of the Ecological Society of Australia's position statement on ecological factors to be considered in EIA relevant to fauna surveys. Key features from these guidelines have been incorporated in to the recommendations that conclude this paper.

### *5.1. Lower Hunter Central Coast Region (NSW)*

The Lower Hunter Central Coast Region published a two volume guideline on fauna surveys and assessments; Volume 1: Flora and fauna survey guidelines, Lower Hunter Central Coast Region 2002, and Volume 2 Survey Guidelines to the threatened species of the Lower Hunter Central Coast Region 2002 (Murray et al., 2002). These are comprehensive documents that indicate why fauna surveys should be undertaken, who should undertake the surveys, and the licensing requirements. The focus is on identifying the presence of threatened species and there is a limited commentary on identifying ecological communities or assemblages that are of state or regional significance. The guidelines identify the number of surveys required based on the size of the area and the general trapping effort per survey. Trap-types recommended include small mammal traps, hair traps, Elliott and wire cage traps. Spotlighting, mist-nests, echolocation and hand-foraging are all recommended fauna detection strategies and a survey period is recommended for each fauna group. Detailed information is provided on threatened species known for the area and how their presence should be identified.

### *5.2. Department of Environment and Conservation (NSW)*

The Department of Environment and Conservation (2004) released for public comment *Threatened Biodiversity Survey and Assessment: Guidelines for Development and Assessment*. These guidelines were prepared to assist impact assessment and management of threatened biodiversity in NSW, and are complemented by profiles for threatened species populations and communities, and build on numerous earlier reports prepared by the NSW Parks and Wildlife Service. This is a detailed and comprehensive guide that explains the processes, responsibilities of various parties, selection of consultants, licences and permits, ethical considerations and use of the precautionary principle. It recommends a preliminary assessment and some field work, similar to a Level 1 assessment in the EPA Position Statement No. 3. This preliminary information is then used to design and conduct a field investigation. Detailed guidelines are provided on the structure and the content of the report that is required. Field survey guidelines focus on identifying threatened species populations, ecological communities and their habitats. These guidelines

provide information on the stratification, sampling and replication of field surveys. These fauna survey guidelines provide information and specific details on surveying for amphibians, reptiles, diurnal and nocturnal birds, mammals including bats and invertebrates. A diverse range of trap types are recommended, including Elliott traps, wire cage traps, hair-tube traps and pit-fall traps. Tracks, scats and scratchings, spotlighting, sand plots, call playback, mist nets and echolocation call identification for bats are also discussed. An indication of the trapping effort required is provided for most trapping strategies.

### 5.3. South Australian Parks and Wildlife

The South Australian Parks and Wildlife Department has published comprehensive guidelines intended to provide consultants, local government, conservation groups and government employees with information on how to undertake vertebrate fauna surveys. This document (Owens, 2000) provides a standard protocol for South Australia that matches the field survey work conducted under the auspice of the Biological Survey Coordination Committee. These guidelines are in three sections; pre, during and post-survey methodology, with specific information on licensing and permits, animal ethics, vouchering, validation of data, data entry and editing. Considerable detail is provided on the various trapping protocols, types of traps to be used (e.g. pit-fall traps, Elliott traps, cage traps, micro-pitfall traps for invertebrates), hand-foraging, spotlighting and opportunistic observations, observational recording of birds, use of mammal tracks and scats and bat detection strategies. Information is provided on what data should be collected for the various taxa and the suggested formats for recording information. These guidelines do not provide an EIA context for undertaking fauna surveys, nor do they provide advice on how the data collected should be analysed or used.

### 5.4. Ecological Society of Australia

The Ecological Society of Australia (2006) exists to promote scientific research in ecology and to facilitate the communication and application of this knowledge. It has published a Position Statement on *Ecological Factors in Environmental Impact Assessment*. The ESA recommends that EIA reports be peer reviewed to assess the competence and scope of the work. It also recommends that adequate time and resources should be allocated to undertake comprehensive ecological studies when these are justified, and that experienced scientists in the assessing agencies should provide clear ecological survey guidelines for each specific development proposal. The ESA also recommends the use of monitoring programs to rigorously assess the impacts of developments, particularly those of a large scale.

### 5.5. Summary

The focus is mostly on threatened species, sometimes extending to threatened species habitats and assemblages. The WA EPA is one of the very few government agencies that requires an assessment of biodiversity value for an area at the genetic, species and ecosystem level and the ecological functional value at the ecosystem level in the EIA report. The level of detail in describing the protocols and effort that is required in fauna surveys varies in the detail and level of prescription. The fauna survey guidelines provided by the WA EPA are less detailed than those provided by the South Australian Parks and Wildlife, the NSW Department of Environment and Conservation and the Lower Hunter Central Coast Region of New South Wales and there is scope

for improvement. The ESA present a strong argument for clear guidelines by government agencies and a peer review process.

## 6. Improved guidelines for terrestrial fauna surveys

Guidance Statement No. 56 should provide more detailed and specific information on trap-types to be employed, areas to be sampled, and the trapping effort required for Level 2 detailed or comprehensive surveys. What follows is a brief overview of how terrestrial vertebrate fauna surveys should be conducted for the purposes of preparing an EIA. This is clearly not the place to provide an alternative guidance statement, so I will only address some of the key issues that are not adequately addressed in Guidance Statement No. 56 and suggest an alternative assessment process. I will not address the sampling of birds, bats, large mammals and invertebrates as space does not permit.

## 7. Trapping effort

Time of year, prevailing weather conditions and habitat are three of the primary variables that influence catch rates at any particular site. There is generally little point undertaking a site survey and catching only 30–40% of the reptile and half the small mammal species in the area, as these data can generally be inferred from a search of museum databases (e.g. *FaunaBase*; http://www.museum.wa.gov.au/faunabase/prod/index.htm).

In almost all cases a near complete list of species and a good appreciation of relative abundance of reptile and small mammals in the area will be required. Species accumulation curves are a very useful tool in determining the effort necessary to catch a proportion of the species estimated to be in the area (Thompson et al., 2003b; Thompson et al., in press) and can provide a useful insight in to the assemblage structure (Thompson and Withers, 2003). Other

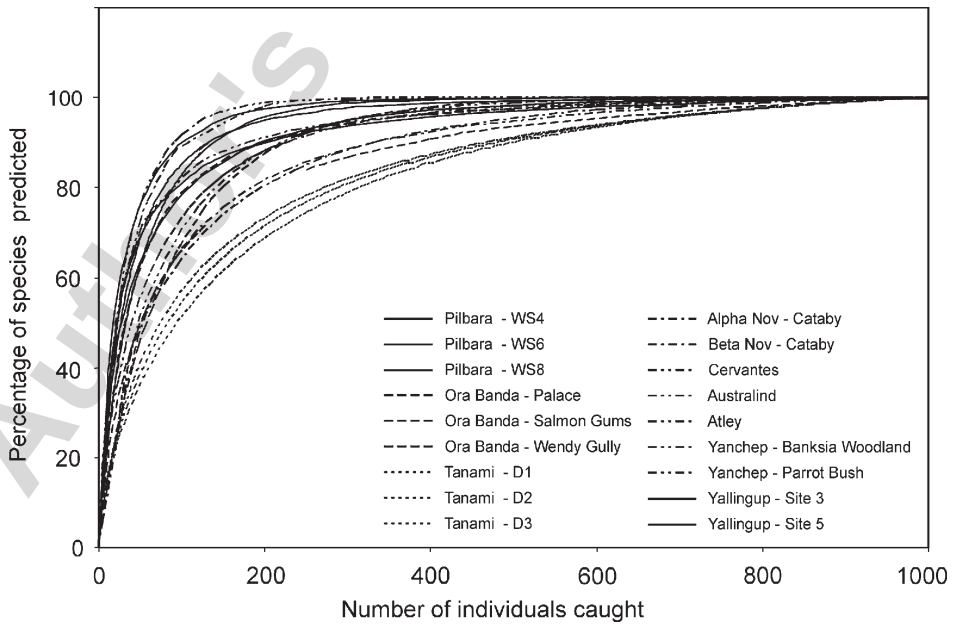


Fig. 2. Averaged species accumulation curves for reptiles and mammals for habitats at numerous sites in Western Australia based on the predicted number of species recorded after 1000 individuals have been caught (from Thompson et al., in press).

techniques to assess species richness such as first and second order jackknife estimates (Palmer, 1990, 1991) are also useful. Fig. 2 contains averaged species accumulation curves from 18 mesic, semi-arid and arid sites in Australia that can be used to estimate the trapping effort required to catch a nominated percentage of the species in a habitat. It is anticipated that when similar data are available for the wet–dry tropics they will not differ appreciably from this information. These curves vary in accordance with the assemblage structure (Thompson and Withers, 2003; Thompson et al., in press), trapping period and local environmental conditions during the trapping period. Therefore, they should only be used for planning purposes and be substituted with the averaged species accumulation curve for the particular site as the data become available. These curves and information provided by Thompson et al. (in press) indicated that between 70–100 small vertebrates will need to be trapped to record about 80% of the species in a habitat, and between 90 and 200 small vertebrates need to be trapped to record 90% of the species in a habitat. High species richness and a high number of rare species in the sample increase the number of individuals that need to be trapped to record a nominated proportion of the species in that habitat. Given that this information is generally not known before a survey is undertaken, fauna surveys should plan to catch a minimum of 150 individuals if they intend to detect 80–90% of the species in the area. Although it is desirable to record all species that are in or use a particular habitat, this is rarely done, as some species are difficult to detect, some are in very low abundance, and other only utilise the area occasionally. In addition, the cost of intensive surveys conducted at multiple times can be difficult to justify unless there is evidence to suggest the habitat may contain species of conservation significance that are in very low abundance.

## 8. Areas to sample

Position Statement No. 3 clearly indicates that it requires the fauna survey data to report on the potential impacts of the development on ecosystems and ecological functional values. This is best done for each major habitat type. Habitats are defined in Guidance Statement No. 56. Thompson et al. (2003a) demonstrated that the reptile assemblage as represented by pit-trap captures varied appreciably among adjacent habitat types at Bungalbin and Ora Banda. In the Bungalbin example, all 12 habitats were on a gently undulating sand plain along a track and within 10 km of each other. Habitat varied from areas sparsely vegetated with spinifex and *Acacia* shrubs, to areas that were densely vegetated with trees and shrubs that were higher than 2 m. Similar differences in fauna assemblages were recorded at 10 sites within 25 km of each other around Ora Banda and for four adjacent habitat types (flat, base, slope and crest of sand ridges) in the Great Victoria Desert (Pianka, 1996). Survey sites at Ora Banda were in habitats ranging from Eucalypt–Casuarina–Mulga woodlands interspersed with *Acacia*, to sparsely distributed spinifex (*Triodia* spp.) and shrubs (*Acacia* spp.) to dense shrubs (*Acacia* spp., *Atriplex* spp., *Allocasuarina* spp.). Therefore, to adequately describe the small vertebrate assemblage in an area that contains a number of habitat types, each of the major habitats should be sampled.

## 9. Target species searches

Terrestrial vertebrates that are difficult to catch using Elliott traps, pit-traps, funnels and cage traps, and that are likely to be in an area and are of conservation significance, require species-specific searches and trapping strategies (e.g. *Macrotis lagotis*). This will often mean returning to an area when environmental conditions are appropriate to maximise the chance

of individuals being observed or caught (e.g. arid-adapted frogs only emerge after significant rains, many pythons become active immediately before and after rains). Analysis of hairs in predatory mammal scats (e.g. *Notoryctes caurinus*; see Paltridge, 1998) or systematic searches of an area for scats (e.g. *Dasyurus hallucatus*), burrows and tracks (e.g. *Macrotis lagotis, Dasycercus cristicauda*) might be useful techniques for other difficult-to-locate mammals of conservation significance. Hair traps might be useful in detecting the presence of small mammals in some areas (Lindenmayer et al., 1994, 1999; Wilson and Delahay, 2001). Baited arboreal pit-traps are also useful in catching some arboreal species of mammals and reptiles.

## 10. Level of fauna assessment

In most cases until a desktop study and reconnaissance site visit have been undertaken neither the proponent nor the EPA are in a position to decide whether a Level 2 terrestrial fauna survey is required, and if it is, the extent of the survey effort that is required. At present a judgement is often made on whether a Level 1 or 2 survey is necessary without the EPA having knowledge of the area or habitat to be disturbed.

In the context of the EPAs Level 1 and 2 assessments, Fig. 3 outlines a better sequence for planning the assessment of the impact of a development on the terrestrial vertebrate fauna and

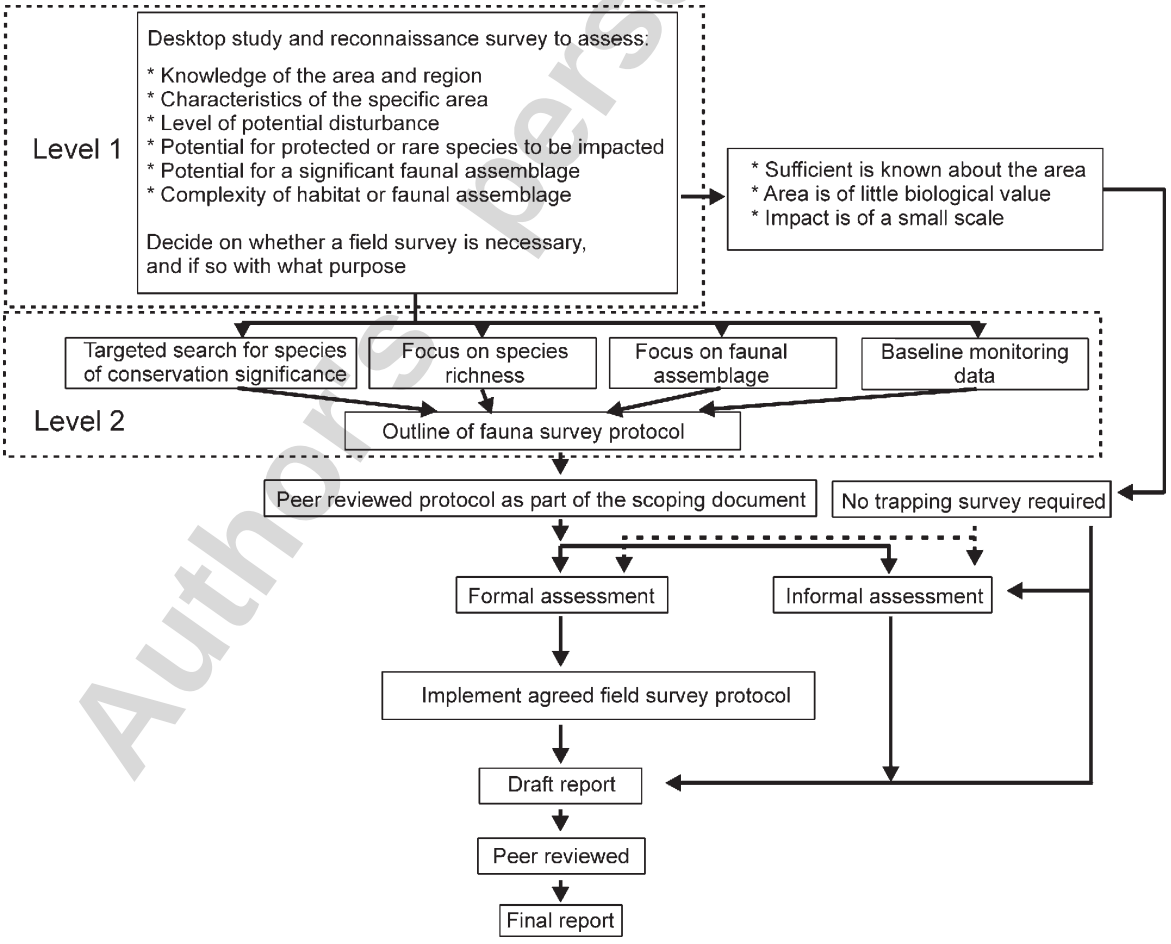


Fig. 3. The sequential process for assessing the potential impact of a disturbance on the faunal assemblage at a particular site.

deciding on the extent and intensity of terrestrial fauna surveys. The first stage in the process is to undertake a desktop study and reconnaissance visit to the site (Level 1). Data from these two investigations should then be used to:

- provide specific information on the potential flora, fauna and habitats of the site and region;
- assess the level of potential disturbance;
- assess the potential for protected, rare or species of conservation interest in the area;
- assess the potential for the occurrence of significant faunal assemblages; and
- assess the complexity of habitat or faunal assemblage.

Based on this analysis, the proponent can argue that:

- sufficient is known about the area (e.g. adequate prior survey data);
- the area is of little biological value (e.g. site is highly degraded);
- the scale of the potential impact is small in absolute terms; or
- the scale of the potential impact is relatively insignificant in the context of the available habitat and faunal assemblages, and no on-site survey should be required.

Or, if additional terrestrial fauna surveys are to be undertaken, a detailed survey protocol can be developed that describes the objectives, extent and timing of the survey(s), and what species-specific targeted searches are required taking in to account whether the primary purpose of the survey is to:

- document species richness;
- describe the fauna assemblage (e.g. species richness and relative abundance);
- search for species of conservation significance; or
- produce baseline monitoring data (see Fig. 4).

Fauna surveys can have four foci (Fig. 4) for the purposes of preparing an EIA:

1. Targeted species searches — where the primary purpose is to search for species that are considered to be threatened, vulnerable or approaching extinction (e.g. *D. cristicauda, Egernia stokesii badia; M. lagotis*). Most often species-specific search strategies will be employed to maximise the detection of individuals and identifying their habitats. These strategies will be based on the known ecology of the species, for example, searches for *M. lagotis* will require grid searches of the area looking for burrows and scratchings, and searches for *E. s. badia* will focus on finding scat piles around old buildings, hollow trees and rubbish piles.
2. Species richness — where the primary purpose is to understand what species are in the area and will be impacted on.
3. Faunal assemblages — where an understanding of both species richness and relative abundance are required to assess the impact of the disturbance. This type of survey would be necessary when assessing the impact of a disturbance on the biodiversity and ecosystem functional value.
4. Baseline monitoring — when the data are to be used to monitor the impacts of a development on the adjacent faunal assemblages or to measure the success of rehabilitation programs (e.g. Thompson, 2004).

EPA Guidance Statement No. 56 indicates that the EPA does not have the resources to systematically review all fauna surveys and reports, and to ensure standards are adequate a proportion of projects will be randomly selected for audit. The Guidance Statement goes on to indicate where peer reviews might be used and the elements of the peer review process. Not all staff that are assessing fauna survey reports and preparing recommendations for the EPA have the required knowledge and experience to determine the adequacy of surveys and the associated reports. It is therefore recommended that all Level 2 fauna survey protocols be sent to independent peer review before the scoping report is made public and before surveys are commenced. It would not be very time consuming nor an expensive process for an appropriately experienced professional to comment of the adequacy of the proposed survey; particularly if an adequate Level 1 assessment had already been completed as is being suggested. Such a process will avoid the expensive situation where the EPA/DEC have approved of a fauna survey as part of the scoping report, the work is undertaken but subsequently been shown to be inadequate and the proponent is required to undertake further survey work to complete the task. This recommended process will also avoid undertaking expensive terrestrial fauna surveys in areas that have little biological/ecological value, where there is a comprehensive understanding of the fauna of the area from previous surveys, or where the area of impact is small and any loss of habitat is unlikely to have a significant impact on the fauna in the area. The opportunity to redesign the survey based on the peer review report should be available along with the capacity to negotiate an agreed survey protocol. Peer reviews can be organised by the authoring environmental consultant or the government agency, as is the current situation. These peer reviews should be appended to the final report.

Fig. 4 provides a succinct summary of the key elements of three of these four types of terrestrial fauna survey protocols described above for a Level 2 assessment. Obviously, these can only be general guidelines given the limited space, and these guidelines should be adjusted to the local circumstances and environment.

## 11. Trap types

Various trap types sample the small vertebrate fauna differently (Bauer and Sadler, 1992; Bury and Corn, 1987; Catling et al., 1997; Enge, 1997a; Fitch, 1992a,b; Greenberg et al., 1994; Jacob et al., 2002; Lobert et al., 2001; Thompson et al., 2005a,b), and each has its own bias. Therefore a mixture of trap types is advisable. As a general guideline, buckets as pit-traps catch more reptiles, particularly the smaller ones, than pipes as pit-traps, whereas, pipes catch more mammals than buckets (Thompson and Thompson, 2005). Funnel traps rarely catch small mammals but catch more of the medium and large terrestrial, diurnal snakes, more of the widely-foraging, medium-sized skinks, more of the medium-sized dragon lizards and arboreal geckos that climb out of PVC pit-traps. Elliott traps catch the same suite of small mammals as pipes when used as pit-traps, but they also catch some of the large trappable mammals (e.g. *Rattus* sp.) that readily jump out of pit-traps. Cage traps are useful for trapping some of the larger skinks (e.g. *Tiliqua* sp.) and small-to-medium sized mammals such as possums and bandicoots that are unlikely to be caught in pit and funnel traps. It is therefore suggested that pit-traps and funnel traps should be used in most surveys. Where a prior investigation has indicated that small-to-medium sized mammals (100–3000 g) should be targeted in the survey, then cage traps should also be used. Many fauna surveyors use 30 m of fly-wire as a drift fence along which they place a number of pit-traps. If this is used as a standard unit, then for each 30 m of fly-wire drift fence, it is suggested that three 150 mm PVC pipes (500 mm deep), three

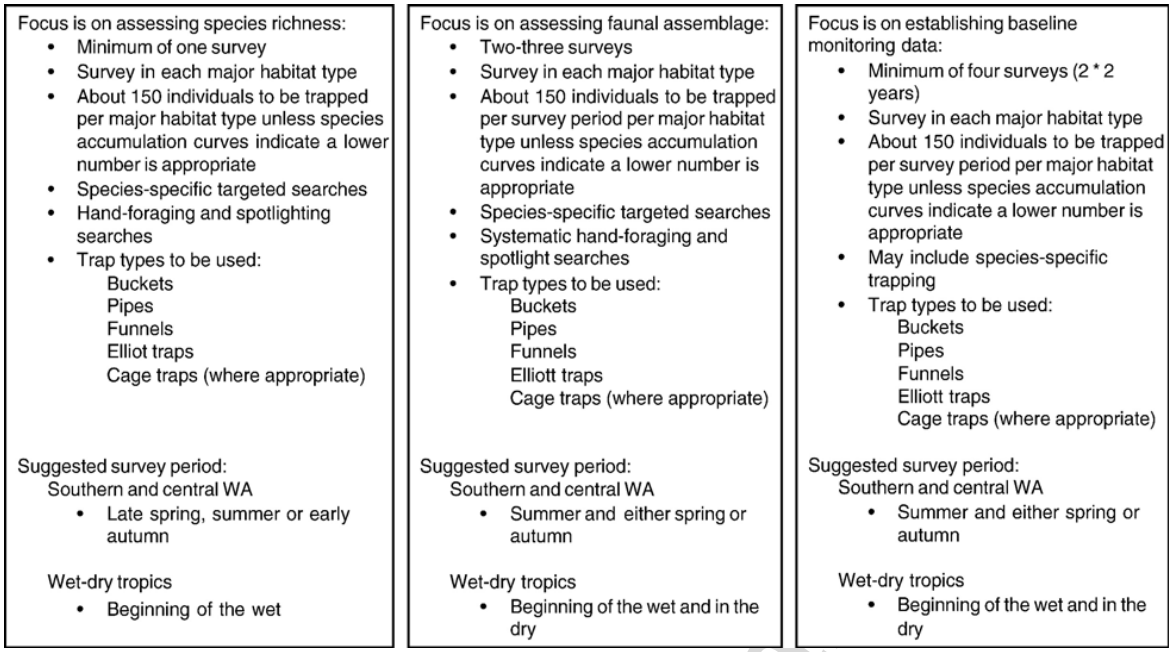


Fig. 4. Suggested trapping guidelines for terrestrial fauna surveys for EIA.

20 L PVC buckets and three pairs of funnel traps be evenly spaced (a trapping line; Fig. 5) for an effective configuration. In addition, two Elliott traps, and where appropriate, one wire cage trap should be set with each trapping line. A similar arrangement can be made along three 10 m fly-wire drift fences. Most often Elliott traps and cage traps are baited with a mixture of peanut butter, fish oil or sardines, rolled oats and occasionally honey. Buckets should contain shade covers in the bottom (egg cartons or styrene sheets); and Elliott traps, wire cage and funnel traps require a suitable shade cover. All traps need to be cleared daily, and if the maximum daily temperature is likely to get above the high 20s $^{o}$C then every effort should be made to clear all traps before the midday sun penetrates to the bottom of the pit-traps. Where ambient temperatures are likely to reach the mid-30s $^{o}$C and above then even shade covers over Elliott traps, cage traps and funnels traps are inadequate and traps need to be cleared earlier in the morning. Small vertebrates can die in exposed traps when they cannot find the protection of shade during the hottest part of the day in many areas of WA.

## 12. Reporting results of terrestrial fauna surveys

The EPA Position Statement No. 3 provides clear guidelines on the issues it wants proponents to address in an EIA report based on the terrestrial fauna survey data, but it does not make it clear how it wants proponents to go about this task. Recent public environmental reports (see Table 1) reviewed and released by the EPA for public comment do not address some of the key issues required by Position Statement No. 3. One possible reason for this is that the authors of these reports were unsure what information the EPA required in the terrestrial fauna survey reports due to inadequate guidelines.

The methods section of the report should include information on who undertook the fauna survey, when it was undertaken, details of the trapping protocols and the perceived limitations of the survey effort. The results section should include a list of species caught and an indication of assemblage structure for each of the major habitat types. Averaged species accumulation curves

Table 1
Checklist and assessment of recently released fauna surveys and reports for the purpose of preparing EIAs

| Reports | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| Sampling effort reflects the likely faunal diversity based on complexity of vegetation and habitat types | 2 | 3 | 2 | 2 | 1 | 1 | 1 |
| Appropriate timing of surveys | 2 | 2 | 3 | 2 | 1 | 2 | 1 |
| Adequacy and efficacy of sampling methods per major habitat type using: | | | | | | | |
| Pit-traps | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cage traps | ND | 4 | 2 | 3 | 1 | ND | 1 |
| Funnel traps | ND | 2 | 1 | ND | 2 | ND | 1 |
| Elliott traps | 4 | 4 | 4 | 3 | 4 | ND | 1 |
| Bat echolocation/mist nets | 3 | ND | 2 | 3 | 4 | 3 | 2 |
| Opportunistic searches | 3 | 4 | 3 | 3 | 3 | 3 | 3 |
| Adequacy of survey effort to assess: | | | | | | | |
| Rare and protected species | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| Species richness per major habitat type | 1 | 3 | 3 | 2 | 1 | 1 | 1 |
| Assemblage structure per major habitat type (e.g. abundance) | 1 | 2 | 2 | 1 | 1 | 1 | 1 |
| Ecosystem functional values | 1 | 2 | 2 | 1 | 1 | 1 | 1 |
| Seasonal and temporal variations | ND | 2 | 3 | ND | ND | ND | ND |
| Faunal data presented and discussed based on major habitat types | 1 | 3 | 2 | 1 | 1 | 1 | 1 |
| Assessment of biodiversity value considered at: | | | | | | | |
| Species level | 2 | 3 | 2 | 3 | 3 | 3 | 3 |
| Ecosystem level | 1 | 2 | 2 | 1 | 1 | 1 | 1 |
| Ecological function value | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| In a regional context | 2 | 3 | 2 | 2 | 1 | 1 | 1 |

Rating system ND = not done or not used, 1 = barely addressed or done very poorly, 2 = less than adequate or done poorly, 3 = adequate, 4 = well done, 5 = very well done or adequately meets the required standards.
A = Beagle Bay Big Tree Country Tropical Timber Plantation Project Fauna Assessment Survey March 2004 (Ecologia, 2004).
B = Coburn Mineral Sand Project Public Environmental Review July 2005, Appendix K Vertebrate Fauna Survey Report (Ninox Wildlife Consulting, 2005b).
C = Kimberley Diamond Company Ellendale Project, June 2005 (Ninox Wildlife Consulting, 2003; Ninox Wildlife Consulting, 2005a).
D = Fauna Habitat and Fauna Assemblage Survey of the Western Tanami Project Area (Coyote and Larranganni Deposits) (Biota Environmental Sciences, 2005b).
E = Goldsworthy Extension Project, Environmental Protection Statement, Appendix D Biological Assessment (Ecologia Environmental Consultants, 2005).
F = Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage A Rail Corridor (Biota Environmental Sciences, 2004).
G = Fauna Habitats and Fauna Assemblage of the Proposed FMG Stage B Rail Corridor and Mindy Mindy, Christmas Creek, Mt Lewin and Mt Nicholas Mine Areas (Biota Environmental Sciences, 2005a).



should be provided for each faunal group (e.g. birds, mammals and reptiles) caught in the trapping/search program to indicate the adequacy of the survey effort, or alternatively, estimates of species richness calculated using one of the other accepted methods (e.g. Diaz-Frances and Soberon, 2005; Palmer, 1990, 1991).

The discussion section should include an analysis of the similarities and differences among the surveyed assemblages, and these assemblages placed in a regional context (e.g. how similar or different are the assemblages to others in the region). Rare, protected, short-range endemics and disjunct assemblages should be identified and an assessment made of the proposed development impacts on these taxa and their ecological and conservation significance. The functional value of the fauna component of each of the ecosystems should be assessed in the

context of how unique it is, how representative of the area it is, how widespread each of the faunal assemblages are distributed based on habitat characteristics, the consequences resulting from this loss of biodiversity if the development is to proceed and the potential for it to be re-established during the rehabilitation process. The impact of the disturbance on the fauna should be assessed, and management options and strategies should be provided to minimise this impact. A detailed protocol needs to be provided to monitor the impact of the disturbance on the adjacent ecosystems if this was considered an issue. If the terrestrial fauna survey data are to be used as baseline information to monitor impacts or rehabilitation success, then seasonal and year-to-year natural variation in populations should be adequately documented, along with the trapping protocols.

All Level 2 terrestrial fauna survey reports should be subject to independent peer review. This will also enable the EPA to demonstrate to the public that its assessment processes are striving for industry best practice. It will also provide a level of comfort to the public that appropriate fauna assessments and reporting practices have been adopted in the preparation of the EIA.

## Appendix A. Criteria for assessing the adequacy of terrestrial fauna surveys for the purpose of EIA

The EPA (2004) indicated that Guidance Statement No. 56 details the minimum requirements for when a survey is required, the type and extent of survey required and the minimum standards of interpretation of survey data. I have therefore adopted Guidance Statement No. 56 as the minimum acceptable standards to develop the assessment criteria described below. The assessment criteria are the key issues contained in Position Statement No. 3 and Guidance Statement No. 56. For each criterion, a five point rating scale was used to assess each survey and report or alternatively it was rated as 'not done or not used'; ND. At the conclusion of the descriptions for each of these criteria, a brief description is provided of the author's approach to rating each of the reports against each criterion.

*Criterion 1 – Sampling effort reflects the likely faunal diversity based on complexity of vegetation and habitat types* – Guidance Statement No. 56 indicates that the intensity of sampling should reflect the likely faunal diversity based on the complexity of the vegetation and habitats to be disturbed (pp. 12–13, Table 3). When read in conjunction with Table 3 in the Guidance Statement No. 56, this was taken to mean that each of the distinctly different habitat types (biotopes) should be surveyed with sufficient intensity to record 80–90% of the small vertebrate species in the area and their relative abundance. Based on information in Thompson et al. (2003a, 2005a,b, in press; Fig. 2) approximately 150 small terrestrial vertebrates need to be caught in each habitat type to be confident that you have caught about 80–90% of the species in the area presuming you have used a range of trap types. The alternative was for the report to present species accumulation curves for each faunal group or another metric to demonstrate the adequacy of the assessment.

*Criterion 2 – Appropriate timing of surveys* – Guidance Statement No. 56 indicates that 'survey(s) over multiple years may be required where a single year's data is not adequate to determine the faunal assemblages or to address environmental factors' (pp. 10, see pp. 11, 13) and 'in general fauna and faunal assemblage surveys conducted for baseline information should be multiple surveys conducted in each season appropriate to the bioregion and the faunal group' (pp. 12). Reports by How (1998), Cowan and How (2004), How and Dell (2004), Thompson et al. (2003a) and Thompson and Thompson (2005) indicated that multiple season surveys are required for baseline monitoring data and that at least one of these survey should be carried out in the hotter

months (late spring or summer) in southern and central WA and at the beginning of the wet season for the wet–dry tropics when using pit-traps to ensure most of the species are captured. Surveys in autumn and winter caught fewer individuals and few species. Maron et al. (2005) clearly demonstrated the shortcomings of a single short-term survey of the avian fauna to assess species richness and relative abundance. These data are collectively interpreted to mean that at least two season surveys are required to assess species richness and relative abundance and where baseline monitoring data are required then surveys in multiple years are necessary.

*Criterion 3 – Adequacy and efficacy of sampling methods per major habitat type using a variety of trap types* – Guidance Statement No. 56 indicates that the relative efficacy of sample methods for terrestrial vertebrate has been analysed for different parts of WA and the EPA expects that the analysis of faunal assemblage data will take cognisance of sampling bias (pp. 13–14). Numerous reports (Catling et al., 1997; Enge, 1997a,b, 2001; Fitch, 1951, 1992a; Greenberg et al., 1994; Ryan et al., 2002; Sutherland, 1996; Thompson et al., 2005a,b) indicated that multiple trap types are necessary to adequately survey the small terrestrial fauna of an area, including pit-fall traps, Elliott traps, cage traps and funnel traps. These trap-based protocols can be supplemented by opportunistic sightings, hand-foraging, sand traps, hair tube traps and systematic searches of the area. Where bats are to be assessed, then mist nets, harp traps, trip lines or echolocation detection protocols are required. Wet and dry pit-traps are useful for sampling invertebrates. Cage traps are used to catch mostly small-to-medium mammals (100–3000 g) that have relatively large activity areas; Elliott traps focus mostly on smaller mammals (5–100 g) that also forage widely; pit-traps are effective for catching small mammals (5–50 g), reptiles, frogs and invertebrates that have varying size activity areas; and funnel traps are useful for trapping reptiles, in particular snakes, pygopods, widely-foraging skinks and medium-sized varanids. Drift fences increase trapping success when used with pit-traps and funnel traps. Trapping lines need to be placed throughout the habitats that are being surveyed. It is suggested that the ratio of trap types employed should approximate: cage trap:Elliott-trap:pit-trap:funnel-trap 1:2:6:6 (see Fig. 5). Cage traps should only be employed when the Level 1 assessment indicated a targeted search was required for small-to-medium size mammals (100–3000 g) of conservation significance.

*Criterion 4 – Adequacy of survey effort to assess rare and protected species, species richness, assemblage structure, ecosystem functional values and temporal variations* – Position Statement No. 3 indicates that the EPA expects proponents to ensure that terrestrial biological surveys provide sufficient information to address both biodiversity conservation and ecological function values (pp. 12, 17). Neither of these phrases are defined by the EPA, but for the purposes of this

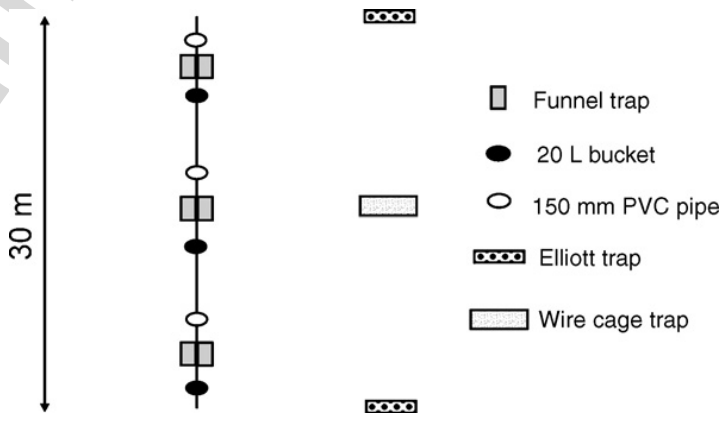


Fig. 5. Suggested trapping line.

assessment this criterion has been interpreted to mean the survey effort should be adequate to detect the presence and location of rare and protected species (which may require species-specific targeted searches), 80–90% of the small vertebrate species likely to be in each habitat type, an appreciation of relative abundance for each species, whether the assemblage structure is similar to or differs from other habitats in the bioregion, and the extent to which seasonal and year-to-year natural variations can be described.

*Criterion 5 – Faunal data presented and discussed based on major habitat types* – Position Statement No. 3 (pp. 12) indicates that the survey effort needs to be sufficient to provide information on biodiversity conservation value at the genetic, species and ecosystem levels, and ecological function values at the ecosystem level. Given that ecosystems and ecological function value are likely to differ appreciably among different habitat types this criterion has been interpreted to indicate that the faunal data must be assessed based on each major habitat type.

*Criterion 6 – Assessment of biodiversity value considered at the species level, ecosystem level, ecological function value, and in a regional context* – Position Statement No. 3 (pp. 12) requires an assessment of the terrestrial fauna data for its biodiversity value at the genetic, species and ecosystem levels, and its ecological function value at the ecosystem level. Both EPA reports indicate the difficulty of assessing the value at a genetic level due to a lack of adequate data; as a consequence this aspect of the criterion has been excluded. Appreciating the biodiversity conservation value of species and ecosystems requires that the data be assessed in a bioregional context. Given that Guidance Statement No. 56 (pp. 10) indicates that the EPA expects a high degree of rigour in reporting not only to describe the fauna assemblages but to facilitate EPA assessment, this has been interpreted to indicate that the fauna survey report should adequately address each of these values. A subjective assessment of what is adequate has been applied.

### *A.1. Rating system*

If the issues associated with a criterion were not addressed or discussed in any meaningful manner, then a rating of 'not done or not used' (ND) was applied. If the issue was addressed then a five point rating system was applied to each criterion. This was a subjective assessment of the extent to which the survey addressed or covered the criterion, as it was not possible to quantify compliance or adherence with these types of criteria in a measured manner. Given that the rating system was a subjective assessment, it is therefore based on the author's experience with fauna surveys, knowledge of the literature and a detailed assessment of the adequacy of small vertebrate fauna trapping programs (see end of text references and references therein to judge the authors experience). A rating of 1 indicated the criterion had been either barely addressed, poorly done or was inadequate. Whereas, a rating of 5 indicated that the survey and report was very well done, adequately met the required standard or comprehensively addressed the criterion. No judgement was applied to whether the author agreed with the views or assessment contained in the report. This can best be illustrated with an example of the adequacy and efficacy of the sampling methods criterion (criterion 3). It is important that a diverse range of trap types are used (e.g. pipes and buckets as pit-traps, funnel traps, Elliott traps and cage traps) to comprehensively survey small vertebrate fauna in a variety of habitats in WA. The non-use or under-utilisation of funnels traps, for example, will result in the under sampling of snakes, large varanids, widely-foraging skinks and large pygopods. Thompson et al. (in press) and Thompson and Thompson (in press) demonstrated the need to catch 70–100 individuals in a habitat to record 80% of the species, and

90–200 individuals to record 90% of the species in a habitat. The higher the species richness and the higher the proportion of rare species in the sample, the higher the number of individuals that needed to be caught. The author's unpublished data indicate that catch rates for pit-traps and funnel traps vary from 5–15% in any 24 h period during the optimal sampling season, and vary depending on habitat type, fauna density and the daily weather conditions. To trap 90% of the species in a habitat with 10% of traps catching an individual requires 900–2000 trap-nights. If a survey approached this level of trapping effort or 90–200 individuals were caught, then it was rated a 5. A progressively lower rating was applied for a lower trapping effort or number of individuals caught.

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