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Adequacy of terrestrial fauna surveys for the preparation of environmental impact assessments in the mining industry of Western Australia

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Adequacy of terrestrial fauna surveys for the preparation of Environmental Impact Assessments in the mining industry of Western Australia

By

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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Abstract

The Environmental protection Authority has indicated that terrestrial fauna surveys as undertaken for the purpose of preparing Environmental Impact Assessment (EIA) are not providing adequate information to enable decision-makers to assess development impacts on biodiversity and ecosystems. In the absence of a protocol to assess current standards of terrestrial fauna surveys, 'best practice' was defined through discussions held with an 'expert panel', and quantified through a questionnaire. This study examined current standards of terrestrial vertebrate fauna surveys, prepared for the purpose of EIA, with 'best practice' as defined by relevant expert opinion.

Strengths and weaknesses of terrestrial fauna surveys were examined in consultant reports. The level to which individual reports addressed the respective components of the evaluation varied although the majority of reports preformed poorly against the established criteria. Although some reports addressed many of the issues comprehensively, most failed to mention or adequately address a large proportion of criteria considered essential. All consultant reports failed to employ sufficient trap effort to adequately sample fauna at both the biotope and landscape scales. In addition, few consultants undertook appropriate seasonal trapping.

If fauna surveys undertaken for EIA are to enable decision-makers to adequately assess the impacts of development on biodiversity and particular ecosystems, then they must provide appropriate information. This research has identified deficiencies within current standards that need to be addressed if appropriate information is to be collected within the EIA process. If adequate data collection and relevant ecological information are collected as part of the fauna survey process, not only can EIA processes become more proficient, but knowledge of the States biodiversity can be enhanced. Conclusions and recommendations are made with a view to improving the quality and usefulness of data collected.

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief does not contain any material previously published or written by any other person except where due reference is made in the text.

Signature _____

Date 9th Nov 2001

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A creed for nature lovers

by Ellis Troughton

I believe:

That, because the Australian continent fostered all the fascinating furred animals, birds, and flowers that awaited the coming of civilization, our land must remain the everlasting sanctuary.

That because the forests and trees supply food and shelter for the birds, and unique marsupials like the koala, such forests should not be destroyed without adequate reason and due replacement.

That wild flowers should be gathered only with that appreciative care due to living things of exquisite scent and beauty.

That the nests of birds, built with such patient devotion, should never be destroyed in thoughtless curiosity; that their eggs should be left to bring forth lovely feathered songsters; that the rifling of their homes is no less a crime than theft from our own.

That enjoyment of the living plants and animals will provide a more lasting and universal source of pleasure and education than collecting their remains, save in the name of science, and for exhibitions which increase knowledge and the love of nature.

That we should not destroy living things that are harmless to us, as we hope to avoid harmful things ourselves; that even harmful creatures should be controlled with due regard for their zoological heritage and right to survive.

That any wholesale sacrificing of native animals for monetary gain, in a country so rich in resources of grain, stock, and minerals, is a confession of incompetence and wasteful greed, unworthy of the Australian Commonwealth.

That, because ancient Australian isolation evolved the gentlest and least harmful host of furred animals the world can ever know, they must be conserved with benevolent care and receive adequate sanctuary for their future survival, subject only to the vital economic needs of man.

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CHAPTER 1

1.1 Project overview

This research investigates the quality, usefulness and validity of fauna survey data for the preparation of Environmental Impact Assessment (EIA) in the mining industry of Western Australia (WA). In the absence of current standards 'best practice' was defined through consultation with an 'expert panel' and quantification of expert opinion through a questionnaire. Experts included government and academic researchers and WA environmental consultants. Evaluation criteria were developed from this process and used to assess current standards within recent consultant fauna survey reports. The results of the evaluation are interpreted and discussed in reference to their implications for protecting biodiversity and understanding particular ecosystem values. The project was undertaken in four stages and the thesis format is organized to guide the reader through each of the respective stages.

1.2 Introduction

1.2.1 Background

Western Australia has a highly diverse and unique assemblage of flora and fauna that is of national and international significance for preserving biodiversity (Environmental Protection Authority, 1998). Prompted by a growing concern about biodiversity and protecting undisturbed habitats, Governments in all Australian states and territories have enacted legislation to maintain and protect biodiversity. The most recent legislation includes the *Environment Protection and Biodiversity Conservation Act (1999)* [EPBC Act], *Soil and Land Conservation Act (1999),* and *Protection of Native Vegetation in Western Australia-Position Statement No 2.* (1999). The EPBC Act states that any

action that will have or is likely to have a significant effect on certain aspects of the environment requires prior government approval; furthermore, actions must not incur a significant impact on nationally listed threatened species, ecological communities, and migratory species (Environment Australia, 1999).

Within Australia there are over 300 Acts and ordinances and more than 80 agencies that have an influence on environmental matters (Hughes, 1999). In Australia, as with most developed countries, an EIA is required for development projects that are of major social, economic or environmental importance (Read, 1994; Treweek, 1999). EIA is the major mechanism for assessing the significance of development impacts on the environment. EIA legislation differs between the Commonwealth, States and Territories but the objectives are similar (Fowler, 1985; Bates 1987). The EIA process will be initiated if a proposal appears likely to present significant impacts on the environment (Department of Environmental Protection, 2001a). The objectives of the EIA process are (Environmental Protection Authority, 1993):

- To facilitate environmentally sound proposals by minimising adverse impacts and maximising benefits to the environment.
- To ensure that decisions are taken by the Government following timely, sound and independent environmental advise.
- To encourage and provide opportunities for public participation in environmental aspects of proposals before decisions are taken.
- To ensure that proponents take primary responsibility for protection of the environment relating to their proposals.
- To provide a basis for ongoing environmental management including changes in response to monitoring.

- To promote awareness and education in environmental values.

In WA a number of Government departments have a responsibility to protect flora and fauna. Environmental Impact Assessment procedures were established under the Environmental Protection Act (1986). Assessing the significance of environmental impacts of developments within WA falls under the jurisdiction of the Environmental Protection Authority (EPA), working with the Department of Environmental Protection (DEP). The EPA is an independent environmental authority that provides government with advice on whether projects are environmentally acceptable, what action is required to mitigate any detrimental effects, and what strategies are required to rehabilitate impacted sites. The five member EPA was established under the Environmental Protection Act (1986) and has two objectives:

a) To protect the environment.

b) To prevent, control and abate pollution.

The first of EPA's 17 strategies is to conduct EIA. The EPA defines an EIA as:

> *An orderly and systematic process for evaluating a proposal including its alternatives and objectives and its effect on the environment including the mitigation and management of those effects. The process extends from the initial concept of the proposal through implementation to commissioning and operation, and where appropriate, decommissioning* (Department of Environmental Protection, 2001a).

The EPA determines if an EIA is required, and if so at what level. If potential impacts are considered significant then a formal assessment will be required. Three levels of formal assessment are commissioned by the EPA encompassing:

- Consultative Environmental Review; reserved for proposals with relatively easily managed though significant environmental impact, with public interest restricted to the local community and or special interest groups.
- Public Environmental Review; used for proposals with either major public interest or potential for significant environmental impact.
- Environmental Review and Management Program; the most comprehensive and detailed level of assessment in Western Australia.

The proponent of a development is responsible for preparing an environmental review document. The review document should describe the proposal, examine expected environmental impacts and propose a programme for management of the impacts. EIA is more than an assessment of whether a proposal is acceptable. It also entails a review of expected impacts and the proponent's management plan. Criteria for assessing a proposed development include (Department of Environmental Protection, 2001b):

- Character of the receiving environment.
- Potential impact of the proposal.
- Resilience of the environment to cope with change.
- Confidence in predicting impact.
- Plans, policies or other procedures which provide ways to manage potential environmental impact.

The EPA assess proposals on the basis of the environmental review document, encompassing any issues raised during public review, the proponents response to issues raised, and the Authorities independent research and information provided by expert persons (Environmental Protection Authority 2000a).

1.2.2 Problems within Environmental Impact Assessment

Despite a rapid growth in EIA, increasing legal requirements and public expectation for increasing environmental protection, significant problems have been identified with the EIA process (Treweek, 1996; Wood and Bailey, 1996; Eade, 2000; Li *et al*, 2000). Review of EIA is an ongoing process and standards are continually being reviewed and upgraded worldwide. Recent studies indicate that although significant improvements have been made in the development and use of EIA there is still considerable scope for improvement (Buckley, 1989; Fairweather, 1989; Buckley 1993; Stirling, 1995; Treweek, 1996; Wood and Bailey, 1996; Hickie and Wade, 1998; Wilson, 1998; Barker and Wood, 1999; Rees, 1999; Ortega-Rubio *et al,* 2001; Steinemann, 2001).

Inadequate or inappropriate ecological input into the development of EIA has been criticised as a primary reason for their lack of capacity to predict and evaluate the ecological impacts of proposed disturbances (Beanards and Duinker, 1984; Fairweather, 1984;.Treweek, 1996; Treweek, 1999; Wood *et al*, 2000). Other common criticisms include: lack of sufficient data; poor survey methodology; temporal and spatial constraints; economic constraints; and inadequate data evaluation leading to unreliable impact prediction (Underwood, 1993; Warwick, 1993; Li *et al*, 2000; Wilson, 1998). However, regardless of the level of criticism directed at the EIA process, its use continues to grow within Government policy. EIA continues to be increasingly applied through legislation in Europe, North America, Asia, the Pacific region and Australia (Hughes, 1999).

1.2.3 Terrestrial fauna surveys and Environmental Impact Assessment

Fauna surveys are part of almost any EIA process, and most environmental review documents contain a list of plant and animal species recorded or expected at the proposed project site and its immediate vicinity (Buckley, 1993). For major projects, as undertaken within the mining industry, flora and fauna lists are commonly prepared in conjunction with field surveys carried out by specialist consultants. These fauna surveys are used within the EIA process to assess the significance of developments on biodiversity and ecosystem function (Treweek, 1999; Environmental Protection Authority, 2000a). Furthermore, they provide valuable new information on the flora and fauna within project areas (Read, 1994). In the context of preparing an EIA, the primary purpose of terrestrial fauna surveys includes (Environmental Protection Agency, 1995):

- Correctly identifying the presence of species within a defined habitat (regional, landscape, biotope).
- Identifying the presence of rare, endangered or range restricted species.
- Identifying fauna and their habitat that are important elements of biodiversity and functional ecosystems for the region.
- Developing an understanding of the ecological processes within habitats.
- Developing appropriate rehabilitation programs.

1.2.4 Environmental Impact Assessment and biodiversity

In Australia, EIA legislation and guidelines do not set substantive criteria for granting or refusing development consent on the basis of impacts on biodiversity. The conservation of biodiversity is only one of many aims of the EIA process. In practice, impacts on biodiversity may receive less attention than other potential impacts

(Buckley, 1993). However, the potential effects of disturbance on biota are one of the major considerations (Treweek, 1999). Existing biota is quantified as the basis for developing an EIA through biological surveys. The information reported from biological surveys must provide decision-makers with appropriate information to enable judgement on potentially significant impacts on biodiversity resulting from a proposed development (Environmental Protection Authority, 2001b).

1.2.5 Western Australian context

In 2000, the EPA released its position statement No. 3, *General Requirements for Terrestrial Biological Surveys for Environmental Impact Assessment in Western Australia*. The chairman of the EPA in his foreword states that terrestrial biological surveys are an essential component of EIA. However, the introduction states:

> *The EPA is concerned that, at times, insufficient attention is given to the relevant detail of biological surveys for the purpose of environmental impact assessment, in relation to the scale and the nature of the impact, and the sensitivity of the receiving environment... The EPA recognises that the absence of acceptable standard protocols may also result in inconsistency of effort and value of data collected* (Environmental Protection Authority, 2000b).

The EPA is indicating that it has serious concerns with the way in which biological surveys (for EIA) have been undertaken in the past. Terrestrial fauna surveys are intended to census the fauna within a proposed development site to facilitate prevention of significant impacts on biodiversity and ecosystems (Environmental Protection Authority 2000a; Environmental Protection Authority, 2000b). Defining and quantifying the importance of ecosystem components is a complex and difficult task. Moreover, little is known about interactions between habitat conditions, ecosystem

processes and biodiversity (Tilman, 1999; Doherty *et al*, 2000; Polani *et al*, 2000). What is known is complicated due to the complexity of ecosystems and a paucity of scientific certainty (Nilsson and Grelsson, 1995; Tilman, 1999; Doherty *et al*, 2000; Ehrenfeld, 2000). However, best practice assessment requires that terrestrial fauna surveys encompass two key environmental considerations. Firstly, the 'intrinsic value' at the individual species, population and genetic levels; and secondly, the 'functional value' at the ecosystem level (Environmental Protection Agency, 1995; Environmental Protection Authority, 2000b).

1.3 Research rationale

The ability of researchers and consultants to assess potential environmental impacts is dependent on the quality and coverage of fauna surveying protocols and data analyses. Inadequate or poorly designed fauna surveys, and an incomplete or inappropriate analysis of data leads to incorrect and inappropriate conclusions (Underwood, 1993; Treweek, 1996; Ehrenfeld, 2000). The outcome of this situation is poor quality decision making within the EIA process. The EPA synopsis for poor standards within current protocol includes: a lack of appropriate scale databases and baseline information to allow appropriate assessment in a regional context; a lack of resources being allocated for appropriate surveys; site specific data being collected but not adequately interpreted in a biodiversity context; a lack of reference to the current literature; inappropriate timing of surveys; and a lack of information on habitat condition and requirements (Environmental Protection Authority, 2000b).

1.4 Significance

The EIA is widely acknowledged as an important document in assessing the potential impact of mining disturbance on the environment (Wood and Bailey, 1996; Li *et al*, 2000). Mining companies spend considerable resources, mostly through consultants, undertaking biological surveys for preparation of EIA documents. In addition to assessing potential impacts and contributing to decisions on whether or not applications should proceed, and if so, under what conditions, the survey data are potentially an important base for adding to existing knowledge and for measuring the biodiversity of WA. Rarely is sufficient survey effort conducted to monitor changes in faunal populations prior to, or during development (Environmental Protection Authority, 2000b). Moreover, the EPA (. 00b) has acknowledged that it has historically accepted substandard work; therefore the e is little incentive for consultants or mining companies to improve the quality of their terrestrial biological surveys. If the quality of data collected for this purpose is questionable (i.e., it is inadequate to assess impacts), then it is important that the EPA reviews the data collection processes, identifying the strengths and weaknesses, and puts in place standards or protocols to address the deficient areas. This study seeks to address these issues through evaluating the strengths and weaknesses of current fauna survey standards.

1.5 Aims

This project investigates the quality and usefulness of terrestrial fauna survey data prepared for EIA, in the context of preserving biodiversity and protecting ecosystem function. More specifically, this project aims to:

1. Define and develop evaluation criteria based on 'best practice' fauna survey methodology as defined by the literature and expert opinion.

2. Apply these criteria to evaluate terrestrial fauna surveys undertaken by consultants for the purpose of preparing an EIA for particular mine sites.

3. Identify deficiencies and make recommendations with a view to improving the quality and usefulness of fauna surveys for decision makers judging development impacts on biodiversity and particular ecosystems.

1.7 Study area

Position statement No 3 (EPA, 2000) indicated the EPA would use the Interim Biogeographic Regionalisation of Australia (IBRA) to define the largest area for decision-making. This study focused on mine sites within the vicinity of the 'Coolgardie unit' of the IBRA (Fig 1). Mining in this area is intensive and has a long history (Bingley, 1992; Blainey, 1993). In comparison to other arid zone regions of WA, the biology of the Coolgardie unit has been comparatively well studied. The Department of Conservation and Land Management (CALM) has a considerable fauna and flora database for the area (specifically Eastern Goldfields), that was prepared as part of its biogeography research program. The Biological Surveys Committee undertook a regional biological survey of this area in the 1980s (Dell and How, 1984; McKenzie *et al*, 1994). Furthermore, researchers affiliated with this project also have considerable databases from pitfall trapping programs at either end of the Coolgardie unit (namely Dr. G. Thompson, Centre for Ecosystem Management Edith Cowan University [25,000 pit trap nights at Ora Banda], and Dr. P. Withers, Zoology Department, University of Western Australia [45, 000 pit trap nights at Bungalbin]). In addition, many other biological surveys (encompassing fauna) have been carried out within the region (Bamford *et al*, 1991; Barrett, 1991; Chapman *et al*, 1991; Chapman, 1994). In summary, much work has been carried out within the Coolgardie unit allowing a comprehensive review of current standards.

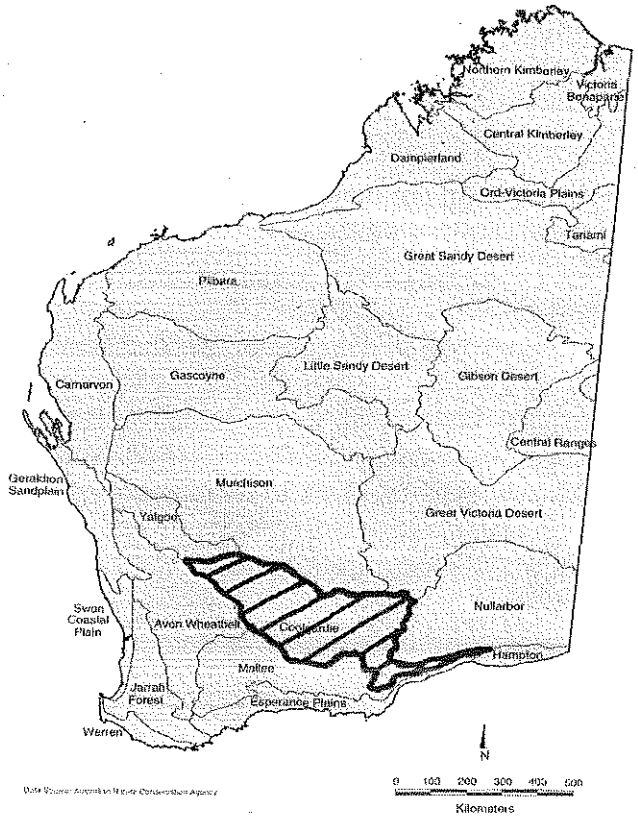

Figure 1. Study area encompassing the 'Coolgardie' unit (marked in grid).

1.6 Delimitations

This study will appraise the quality and validity of reported terrestrial vertebrate fauna surveys undertaken by mining companies and consultants for EIA. Survey reports are selected from the Coolgardie unit of IBRA or in close proximity to this region. Particular attention is paid to the detection of threatened or range-restricted species as they are most vulnerable to disturbance and once extinct constitute a measurable loss in biodiversity (Recher and Majer, 2001). For the purposes of this study small terrestrial vertebrate fauna includes all small mammals (less than 200 g), reptiles and amphibians as targeted within survey trapping but does not include birds, as they are not a component of survey trapping. Bats are not considered, as their capture is highly specialised and rarely included within fauna surveys. Thus, the ability to assess them in the context of this study is not possible.

CHAPTER 2

2.1 Research structure

The format presented in this thesis is a departure from the standard structure of an honours thesis; however, the structure used provides a clear explanation of the research content of the project. Research was undertaken in four stages. The first stage involved identifying a comprehensive list of major issues and concerns pertaining to fauna surveys undertaken for the preparation of an EIA. This was achieved through a search of the literature and information obtained from interviews with an 'expert panel'. The second stage used this information to design a questionnaire that was sent to experts (including all 'expert panel' participants) to further develop and clarify expert opinion on 'best practice' fauna survey standards for EIA. The third stage used information obtained from the questionnaire to develop evaluation criteria for assessing consultant fauna survey reports and to define appropriate seasonal trapping and trap effort. The fourth stage applied these criteria to evaluate recent consultant fauna survey report compliance with 'best practice' as defined by expert opinion. A detailed explanation of each respective stage is discussed below.

2.2 Stage 1 - Identification of major issues and concerns

2.2.1 Literature review

Academic and government databases were accessed to obtain primary literature. Key papers included: Beanards and Duinker, 1984; Environmental Protection Authority, 2000b; Fairweather, 1984; Li *et al*, 2000; Treweek, 1996; Underwood, 1993; Warwick, 1993; Wilson, 1998; and Wood *et al*, 2000. Issues and concerns pertaining to terrestrial vertebrate fauna surveys for EIA were delineated from these papers (Table 1).

Table 1. List of issues and concerns from primary literature (see text for full reference sources).

Failure to mention the presence of designated areas and/or protected species
Failure to consider other important nature conservation resources that are not designated, or which lie outside the actual area of a proposed development
Failure to characterise baseline conditions (i.e. vegetation, soils, habitat condition)
Failure to provide the data needed to identify or predict ecological impacts
Failure to quantify population estimates
Failure to interpret survey in a biodiversity context
Over-reliance on descriptive and subjective methods
Failure to undertake field surveys
Inadequate level of surveying in context of landscapes (i.e. biotope, regional)
Failure to undertake surveys at appropriate times
Bias towards easily surveyed and charismatic taxonomic groups
Inadequate replication
Failure to estimate ecological significance
Failure to describe limitations or constraints on survey methodology
Inadequate or irrelevant literature reviewed
Failure to name author/consultant or to reference sources of data
Concurrent flora and fauna surveys not undertaken

2.2.2 Expert panel

Expert opinion was sought from researchers working in Western Australian Government agencies (CALM; DEP; EPA) and academic institutions (University of Western Australia), and from environmental consultants working in WA. Inclusion of people on the 'expert panel' was based on the extent of their relevant experience undertaking field surveys and/or interpreting terrestrial fauna survey data (arbitrarily defined as a minimum five years). Correspondence (via postal and electronic mail) was sent to available persons introducing the researcher, the project rationale, aims, and notification of subsequent phone contact on designated day and time (Appendix 1). Phone calls were then engaged to ascertain the suitability and availability of relevant experts for the panel. A total of twelve experts agreed to participate in the panel (Table 2).

Table 2. Government, academic and consultant 'expert panel' participants.

Government and academic researchers
Dr Andrew Burbidge - *Department of Conservation and Land Management*
Mr John Dell - *Department of Environmental Protection*
Mr Laurie Smith - *Western Australian Museum*
Mr Norm McKenzie - *Department of Conservation and Land Management*
Dr Philip Withers - *University of Western Australia*
Dr Richard How - *Western Australian Museum*
Private consultants
Mr David Kaesehagen - *Ecoscape*
Mr Gary Connel - *Ecologia*
Ms Jan Henry - *Ninox Wildlife Consulting*
Dr Libby Mattiskie - *Mattiskie Consulting Pty Ltd*
Dr Mike Bamford - *Consulting Ecologists*
Dr Ray Hart - *Hart Simpson and Associates*

2.2.3 Discussion with expert panel

Structured interviews were undertaken in person with all participants and recorded on a dictaphone. Personal information was sought on place of employment and relevant experience in the research area. Interviewees were then asked to identify and discuss the most important issues within the aforementioned list of concerns (Table 1). Furthermore, respondents were also asked to respond to a range of open-ended questions including: their perception of the goals of fauna surveys for application within EIA; adequacy of current survey protocols; strengths and weaknesses of the current protocols; key areas of concern; and factors that influence their opinion. Interviews were transcribed and a summary of all relevant issues and concerns prepared for inclusion within the questionnaire.

2.3 Stage 2 - Questionnaire to quantify expert opinion

2.3.1 Rationale

There are currently no standard protocols available to judge the adequacy of fauna surveys for EIA. The rational for this questionnaire (in the absence of current protocol) is to quantify expert opinion on the essential components of terrestrial fauna surveys to develop criteria for evaluating consultant fauna survey reports. The results of the questionnaire and selection of criteria is outlined in stage 3.

2.3.2 Aims

The questionnaire was compiled with two primary aims: a) to develop a set of criteria for evaluating terrestrial fauna survey reports (Parts 1 - 3 of the questionnaire addressed this aim); and b) to ascertain appropriate seasonal trapping periods and trapping effort at the biotope and landscape levels (Part 4 of the questionnaire). The full questionnaire is included in Appendix 2.

2.3.3 Design and structure

General questionnaire design is based on Deschamp and Tognolini (1988). Within this design consideration was given to clarification and purpose, design and trial, analysis of data, and ethical issues. The option for comments was given within all parts of the questionnaire. The questionnaire was developed on the outcomes of the literature review and 'expert panel' interviews; all relevant issues were collated for inclusion in the questionnaire. All issues were arranged into related groups addressing the major components of a fauna survey within a four-part questionnaire. The structure of the questionnaire is outlined below in reference to the aims.

2.3.3.1 Questionnaire focus in parts 1 to 3

The first three parts of the questionnaire comprised questions addressing components of:

- Desktop surveys (part 1).
- Field sampling design and planning (part 2 – section 1).
- Field sampling data analysis and interpretation (part 2 – section 2).
- Data validity (part 3).

To determine the significance of each issue a level of importance was assigned to each question. Respondents were asked to assign the following nominal scale to each question:

- Not important (does not need to be considered).
- Highly desirable (should be addressed but not essential).
- Essential (must be addressed).
- Undecided.

2.3.3.2 Questionnaire focus in part 4

Appropriate seasonal trapping (Section 1)

Respondents were asked to indicate the importance of trapping with spring, summer, autumn and winter respectively over one annual cycle. Respondents assigned the following nominal scale to each season:

- Mandatory (Season must be included).
- Only in special circumstances.
- Generally not necessary.

Trapping effort at the biotope and landscape scales (Section 2)

Biotope trapping effort

Field trapping quantified at the biotope level was defined as 1-km^2 of homogeneous habitat. Respondents nominated a level of effort for each trapping variable including number of sample sites [1 > 10], pitfall traps [0 > 100], Elliott traps [0 > 100], cage traps [0 > 100], trap nights per season [1 to > 10000], and traps nights for all seasons [1 > 10000].

Landscape tapping effort

Field trapping quantified at the landscape level was defined as 10 heterogeneous habitats within a 100-km^2 area. Respondents nominated a level of effort for each trapping variable including number of pitfall traps [0 > 1500], Elliott traps [0 > 1500], cage traps [0 > 1500], trap nights per season [1 > 10000], and traps nights for all seasons [1 > 100000] for the entire area.

2.3.4 Distribution

Thirty-eight potential respondents were identified through reference to the Environmental Consultants Register (Environmental Consultants Association, 2000) and discussions held with the 'expert panel' participants. Personal contact was made (via phone calls) with all potential respondents prior to mailing out of the questionnaire. Discussion was undertaken during this contact to ensure that persons had relevant experience and were available to complete the questionnaires in the required time frame. Of 38, 24 respondents agreed to participate. The questionnaire was then forwarded with a letter of introduction, giving background to the project and outlining

the aims and expected out comes, requesting respondent details and signing of a consent form (Appendix 3).

2.4 Stage 3 - Questionnaire results

2.4.1 Overview

Return rate for the questionnaire was 80% (number of respondents n=20). Response rate for individual questions within respective parts of the questionnaire was as follows: parts 1 and 2 (n=18 to 20); part 3 (n=17 to 20); part 4 (n=16 to 19). Respondents comprised six government employees, 10 consultants and one academic researcher, with three anonymous responses. All returned questionnaires were included in analysis. The results of each part of the questionnaire are described in turn.

2.4.2 Results for parts 1 to 3

2.4.2.1 Desktop surveys – Part 1

Issues indicated as essential by the majority of respondents (>50%) were included as evaluation criteria. All issues, excepting searches of the Environment Australia database, were considered essential by 65 to 95% of respondents (Table 3). These essential issues were search of the CALM and WAM databases for declared rare and endangered fauna (75% & 70%), and priority taxa (70% & 60%); search of the WAM database for all taxa that may occur within any potential impact site (65%); review of both published and unpublished literature (90% & 75%); and discussion on the conservation status of fauna, including declared rare/endangered fauna and priority taxa, both recorded and expected within the survey area (90 & 95%). Less than half of

respondents indicated that a search of the Environment Australia database was essential for either threatened species or ecological communities (42% & 48%).

Table 3. Importance of various aspects of the desktop survey (response as percentages, n = sample size).

Questions	Respondent View*				
	E	HD	NI	U	n
1. Search of CALM database for:					
a) declared rare/endangered fauna database.	75	10	5	10	20
b) priority taxa (as defined by CALM).	70	15	5	10	20
2. Search of the Western Australian Museum database for:					
a) declared rare/endangered taxa.	70	15	5	10	20
b) priority taxa (as defined by CALM).	60	25	5	10	20
c) all taxa that may occur in any potential impact areas.	65	20	0	15	20
3. Search of Environment Australia database for:					
a) threatened species	42	37	16	5	20
b) threatened ecological communities	48	42	5	5	20
4. A review of published literature relevant to the survey area.	90	10	0	0	20
5. A review of unpublished literature/reports	75	25	0	0	20
6. Discussion on the conservation status of:					
a) declared rare/endangered fauna recorded in the survey area.	95	5	0	0	20
b) priority taxa recorded in the survey area.	90	10	0	0	20
c) declared rare/endangered fauna expected in the survey area.	95	5	0	0	20
d) priority taxa expected within the study area.	90	10	0	0	20

*Key: E=essential; HD=highly desirable; NI=not important; U=undecided

2.4.2.2 Field sampling parameters; design and planning – Part 2 section 1

Issues indicated as essential by the majority of respondents (>50%) were included as evaluation criteria. Four issues were viewed as essential by most respondents (60 to 85%) (Table 4). These essential issues were fauna sampling over one annual cycle; description of key fauna habitats; searches for rare/endangered-priority taxa; description of opportunistic fauna observations; and surveys undertaken or supervised by a qualified zoologist. Fauna sampling over more than one annual cycle was viewed by most respondents as highly desirable (79%).

Table 4. Importance of various aspects of the design and planning stages of fauna surveys (response as percentages, n = sample size).

Questions	Respondent View*				
	E	HD	NI	U	n
1. Fauna sampling to be undertaken for:					
a) one annual cycle	84	11	0	5	18
b) more than one annual cycle	5	79	5	11	19
2. Concurrent flora and fauna surveying	11	53	31	5	19
3. Description of key fauna habitat components (i.e. rocky outcrops, termite mounds, free water, etc.)	85	15	0	0	20
4. A component of the field survey protocol designed to search for:					
a) rare/endangered taxa	80	15	5	0	20
b) priority taxa (as defined by CALM)	75	20	5	0	20
c) threatened fauna	80	15	5	0	20
d) feral animal taxa	25	45	30	0	20
5. Notation of opportunistic fauna observations to be:					
a) described	70	30	0	0	20
b) quantified	16	37	42	5	19
6. All surveys undertaken or supervised by a qualified zoologist	60	25	10	5	20

*Key: E=essential; HD=highly desirable; NI=not important; U=undecided

2.4.2.3 Data interpretation and reporting – Part 2 section 2

Issues indicated as essential by the majority of respondents (>50%) were included as evaluation criteria. All issues, excepting peer review of reports and evaluation of population estimates, were viewed as essential by 60 to 80% of respondents (Table 5). These essential issues were a written statement explaining the limitations and constraints of the study; rational of survey methodology; data interpretation in the context of regional data sets; data analysis with reference to local/regional biodiversity values; evaluation of assemblage/community structure for mammals (75%), reptiles (75%), and amphibians (75%); reference to fauna identification sources; assessment of the field data within an ecological context; and identification of personnel that carried out the field survey, and data analysis/interpretation (60%).

Table 5. Importance of various aspects of the data interpretation and reporting stages of fauna surveys (response as percentages, n = sample size).

Questions	Respondent View*				
	E	HD	NI	U	n
1. A written statement explaining the constraints and limitations of the study	80	20	0	0	20
2. Rational of survey methodology within reporting to the EPA	75	20	0	5	20
3. Data interpretation in the context of regional data sets	63	32	5	0	19
4. Data analysed with reference to local/regional biodiversity values	73	17	5	5	18
5. Evaluation of assemblage/community structure for:					
a) Mammals	75	20	5	0	20
b) Reptiles	75	20	5	0	20
c) Amphibians	70	25	5	0	20
6. Reference to sources used for fauna identification.	65	25	10	0	20
7. Assessment of the field data, within an ecological context, highlighting key relationships existing between species and habitat	75	20	5	0	19
8. Peer review of fauna survey report:					
a) 'In house'	22	47	5	5	19
b) Contractor/mining company arranged	5	37	10	5	19
c) EPA arranged	31	42	4	5	19
9. Evaluation of population estimates for:					
a) rare/endangered taxa,	45	35	25	5	20
b) priority taxa	35	35	25	5	20
10. Identification of personnel that carried out the:					
a) field survey	60	30	10	0	20
b) data analysis/interpretation	60	30	10	0	20

*Key: E=essential; HD=highly desirable; NI=not important; U=undecided

2.4.2.4 Data validity – Part 3

Issues indicated as essential by the majority of respondents (>50%) were included as evaluation criteria. Three issues were considered essential by the majority of respondents (53 to 95%) (Table 6). These essential issues were: species lists conforming to WAM nomenclature (53%); verification by WAM (via voucher specimens) of all trap deaths (65%), and where there may be doubt, confusion or potential for incorrect identification (95%).

Table 6. Importance of various aspects of data validity for fauna surveys (response as percentages, n = sample size).

Questions	Respondent View*				
	E	HD	NI	U	n
1. Identification based solely on reference guides and prior field experience.	46	18	18	18	17
2. Species lists conforming to current WAM nomenclature.	53	37	5	5	19
3. Verification by WAM (via voucher specimens):					
Vouchering a representative sample of all species collected	20	25	55	0	20
b) All trap deaths submitted for WAM reference collections.	65	35	0	0	20
c) Species identification supported by voucher specimens for range extensions only.	42	37	5	16	19
d) Where there may be some doubt, confusion or potential for incorrect identification.	95	5	0	0	20

*Key: E=essential; HD=highly desirable; NI=not important; U=undecided

2.4.3 Results for part 4

2.4.3.1 Appropriate seasonal trapping

Seasons indicated as mandatory by the majority of respondents (>50%) are defined as providing appropriate seasonal trapping (over one annual cycle). Spring was unanimously indicated as 'mandatory' (100%), with autumn also viewed as 'mandatory' by the majority of respondents (67%) (Table 7). Both summer and winter had a low importance for mandatory trapping at 29% and 25% respectively. Fifty nine percent indicated summer 'only in special circumstances', and 44% viewed winter as 'generally not necessary'. Appropriate seasonal trapping over one annual cycle is defined as encompassing both spring and autumn.

Table 7. Importance of seasonal sampling over one annual cycle (response as percentages, n = sample size).

Questions	Respondent View*			
	M	OSS	GNN	n
Field surveying within the seasonal interval of Summer (Dec-Feb).	29	59	12	17
Field surveying within the seasonal interval of Autumn (Mar-May).	67	22	11	18
Field surveying within the seasonal interval of Winter (Jun-Aug).	25	31	44	16
Field surveying within the seasonal interval of Spring (Sep-Nov).	100	0	0	18

*Key: M=mandatory; OSS=only in special circumstances; GNN=generally not necessary.

2.4.3.2 Trapping effort at the biotope and landscape scales

The mean value of trapping effort defined for each variable is used as a 'set criterion' of effort. (Tables 8). Total trap effort is defined as total trap nights for all seasons at the biotope and landscape scales respectively.

Table 8. Questionnaire response to biotope and landscape trapping effort (mean, response range, and n = sample size).

Variable	Questionnaire response									
	Biotope					Landscape				
	Mean	Response range			n	Mean	Response range			n
Sample sites	3	1	to	5	19	~	~	~	~	~
Pitfall traps	10	7	to	30	19	166	51	to	600	19
Elliott traps	12	0	to	30	19	198	51	to	1000	19
Cage traps	4	0	to	15	18	56	0	to	300	18
Trap nights per season	137	8	to	575	19	1371	1	to	6750	19
Trap nights all seasons	409	1	to	1945	19	3630	1	to	10 000	19

2.5 Stage 4 - Consultant report evaluation

2.5.1 Overview

The evaluation assessed the respective major components of consultant reports. All 15 consultant reports were evaluated using criteria for the components of desktop surveys, field sampling design and planning, field sampling data analysis and interpretation, and data validity (raw scores are provided in Appendix 4). Appropriate seasonal trapping and trapping effort at the biotope and landscape levels were evaluated within ten and seven reports respectively. The evaluation results for each component are described in turn.

2.5.2 Fauna survey reports

Reported terrestrial fauna survey data for EIA was obtained from two sources: a) terrestrial fauna survey reports prepared for mining companies, as part of the legislated environmental approvals process (accessed directly from mining companies); and b) publicly available fauna surveys within EIA reports accessed through Government libraries (CALM; DEP; EPA). A total of 15 recent fauna survey reports (dated 1994 to 2000) were obtained for evaluation.

2.5.3 Ethics

Ethics approval for the project was obtained from Edith Cowan University (ECU) Ethics Committee. Edith Cowan University Ethics Policy requires that the anonymity of participants and commercial interests be respected. In some cases confidentiality agreements were entered into in order to obtain access to material from mining companies. Under these agreements reports are to be used under the proviso that no

reference is made in any written material to the mining companies, individual consultants or their companies in the thesis or subsequent publication. A further stipulation of ECU Ethics Policy requires that opinions and comments referred to in any written material do not identify individuals without their prior written consent. Furthermore, the location of individual reports is not referenced to ensure they remain anonymous. However, where distinction is necessary the 15 reports have been assigned a letter from A to O.

2.5.4 Limitations

Reports and data sets from studies undertaken for mining companies remain the property of the proponent (Mattiske *et al*, 1995). Use of these reports is constrained by consent from the relevant sources. Report selection could not be random as report availability was limited. The most recent 15 reports, obtained after a thorough search of Government libraries, and contact with mining companies and their consultants, have been selected for use in the study. The most recent reports reflect current practice within the industry. It is recognised that this is a small number of the reports assessed by the EPA, and conditions and factors might vary among mine leases and between regions. However, the time constraints of an honours project limited the nature and scope of the study to one biogeographic region and 15 reports. In addition, it must be noted that eight of the 15 reports used field data from previous surveys or other sources of reported data. While it is recognised that this thesis has concentrated on a specific component of biological surveys in a specific section of the state and in relation to a specific industry, many of the principles still apply to other areas and development sectors.

2.5.5 Application of evaluation criteria

Report compliance to individual criteria was scored on a four point ordinal scale, applied to each issue as follows:

0) Did not mention the issue.

1) Mentioned but did not adequately address the issue.

2) Addressed the issue to a moderate standard.

3) Comprehensively addressed the issue.

The scoring system is applied on two scales: a) a number of the questions are scored on the presence or absence of criteria within reports (attracting a score of 0 or 3 respectively); and b) remaining questions required scoring to quantify the level to which the criterion was addressed (attracting a score of 0, 1, 2, or 3). In order to carry out the evaluation as objectively as possible an evaluation key was used to assess each of the 15 consultant reports (Tables 9a to 9d).

Table 9a. Evaluation key for desktop survey criteria.

1. Search of CALM database
   0 = No written conformation of database search within report
   3 = Written conformation of database search within report
2. Search of the Western Australian Museum database
   0 = No written conformation of database search within report
   3 = Written conformation of database search within report
3. A review of published literature relevant to the survey area
   0 = Published literature not cited in references
   3 = Published literature cited in references
4. A review of unpublished literature/reports
   0 = Unpublished literature not cited in references
   3 = Unpublished literature cited in references
5. Discussion on the conservation status of:
   a) Declared rare/endangered fauna recorded/expected
      0 = Issue not discussed
      1 = Mentioned the issue briefly without reference to local or regional significance
      2 = Mentioned the issue with reference to only local or regional significance respectively
      3 = Issue discussed in reference to local and regional context
   b) Priority fauna recorded/expected
      0 = Issue not discussed
      1 = Mentioned the issue briefly without reference to local or regional significance
      2 = Mentioned the issue with reference to only local or regional significance respectively
      3 = Issue discussed in reference to local and regional context

Table 9b. Evaluation key for field survey design and planning criteria.

1. Fauna sampling to be undertaken for one annual cycle, encompassing Autumn and Spring
   0 = Sampling does not encompasses both Autumn and Spring
   3 = Sampling encompasses both Autumn and Spring
2. Description of key fauna habitat components
   0 = Not mentioned
   3 = Key components described
3. A component of the field survey protocol designed to search for rare/endangered, priority, and threatened fauna categories
   0 = Not searched for
   3 = Protocol designed to search for all relevant aforementioned categories
4. Notation of opportunistic fauna observations to be described
   0 = Not mentioned
   3 = Notation referred to within report
5. All surveys undertaken or supervised by a qualified zoologist
   0 = Not mentioned
   3 = Referred to within report

Table 9c. Evaluation key for field survey data interpretation and analysis criteria.

1. A written statement explaining the constraints and limitations of the study
   0 = Not mentioned
   3 = Discussed
2. Rational of survey methodology
   0 = Not mentioned
   3 = Discussed
3. Data interpretation in the context of regional data sets
   0 = Regional data sets not used
   3 = Regional data sets used
4. Data analysed with reference to local/regional biodiversity values
   0 = Issue not discussed
   1 = Mentioned the issue briefly without reference to local or regional significance
   2 = Mentioned the issue with reference to only local or regional significance respectively
   3 = Issue discussed in reference to local and regional context
5. Evaluation of assemblage/community structure for mammals, reptiles, and amphibians
   0 = Not mentioned in report
   1 = Discussed but not evaluated
   2 = Discussed and evaluated for some fauna
   3 = Discussed and evaluated for relevant aforementioned fauna
6. Reference to sources used for fauna identification
   0 = Not mentioned in report
   1 = N/A
   2 = Mentioned in references
   3 = Taxonomic reference sources specifically delineated
7. Assessment of the field data, within an ecological context, highlighting key relationships existing between species and habitat
   0 = Not mentioned in report
   1 = N/A
   2 = General reference to key habitat components and species that pertain to each
   3 = Specific reference to key habitat components and species that pertain to each
8. Identification of personnel that carried out the field survey, and data analysis and interpretation
   0 = Not mentioned in report
   1 = Mentioned without distinction being made between personnel that carried out the field survey, and data analysis and interpretation
   2 = N/A
   3 = Mentioned with distinction being made between personnel that carried out the field survey, and data analysis and interpretation

Table 9d. Evaluation key for data validity criteria.

1. Species lists conforming with current WAM nomenclature
   0 = Not mentioned
   3 = Species lists referred to as conforming
2. Verification by WAM (via voucher specimens):
   b) All trap deaths submitted
      0 = Not mentioned
      3 = Mentioned in report
   d) Where there may be some doubt, confusion or potential for incorrect identification
      0 = Not mentioned
      3 = Mentioned in report

2.5.5.1 Results

Desktop survey component

Searches of both the CALM and WAM databases respectively were carried out in only three consultant reports. Published literature was reviewed in all reports, and unpublished literature reviewed in 13 of the 15 reports (Table 10). Discussion on the conservation status of respective fauna groups was comprehensively addressed in 13 reports.

Table 10. Number of reports addressing desktop survey components.

Criterion	Evaluation score*			
	0	1	2	3
1. Search of CALM database	**12**	~	~	**3**
2. Search of the Western Australian Museum database	**12**	~	~	**3**
3. A review of published literature relevant to the survey area	~	~	~	**15**
4. A review of unpublished literature/reports	**2**	~	~	**13**
5. Discussion on the conservation status of threatened fauna	**1**	**1**	~	**13**

*Key: 0=did not mention the issue; 1=mentioned but did not adequately address the issue; 2=addressed the issue to a moderate standard; 3=comprehensively addressed the issue.

Field sampling design and planning component

Three criteria were not mentioned or addressed within 12 of the 15 consultant reports, namely; fauna sampling within one annual cycle, searches for rare/endangered and priority fauna, and surveys undertaken or supervised by a qualified zoologist (Table 11). Description of key fauna habitat components was addressed in 10 reports, with five mentioning but not addressing the criteria.

Table 11. Number of reports addressing field survey design and planning components.

Criterion	Evaluation score*			
	0	1	2	3
1. Fauna sampling to be undertaken for one annual cycle	12	~	~	3
2. Description of key fauna habitat components	~	5	2	8
3. A component of the field survey protocol designed to search for rare/endangered, priority, and threatened fauna categories	12	1	~	2
4. Notation of opportunistic fauna observations to be described	1	~	~	14
5. All surveys undertaken or supervised by a qualified zoologist	12	~	~	3

*Key: 0=did not mention the issue; 1=mentioned but did not adequately address the issue; 2=addressed the issue to a moderate standard; 3=comprehensively addressed the issue.

Field sampling data analysis and interpretation component

Three criteria were comprehensively addressed within most consultant reports, namely; data interpretation in the context of regional data sets (13 reports), reference to biodiversity values (12 reports), and reference to fauna identification sources (12 reports) (Table 12). Constraints and limitations of fauna surveys were comprehensively addressed in only four reports. Evaluation of community assemblage/structure, and assessment of field data within an ecological context, was comprehensively addressed in three reports. The personnel who carried out the field survey and/or data analysis were mentioned in seven reports, and not mentioned in the remaining eight.

Table 12. Number of reports addressing field survey data analysis and interpretation components.

Criterion	Evaluation score*			
	0	1	2	3
1. A written statement explaining the constraints and limitations of the study	5	2	4	4
2. Rational of survey methodology	1	1	5	8
3. Data interpretation in the context of regional data sets	2	~	~	13
4. Data analysed with reference to local/regional biodiversity values	2	1	~	12
5. Evaluation of assemblage/community structure for mammals, reptiles and amphibians	5	~	7	3
6. Reference to sources used for fauna identification			3	12
7. Assessment of the field data, within an ecological context	3	1	8	3
8. Identification of personnel that carried out the field survey , and data analysis and interpretation	6	~	2	7

*Key: 0=did not mention the issue; 1=mentioned but did not adequately address the issue; 2=addressed the issue to a moderate standard; 3=comprehensively addressed the issue.

Data validity component

One criterion only was addressed to any level within any consultant reports (Table 13). Namely, two reports mentioned verification of specimens where there is doubt, confusion or potential for incorrect identification. All reports failed to mention species list conforming with Western Australian Museum nomenclature, and submission of trap deaths to the Museum.

Table 13. Number of reports addressing data validity components.

Criterion	Evaluation score*			
	0	1	2	3
1. Species lists conforming with current WAM nomenclature	15	~	~	~
2. Verification by WAM (via voucher specimens): All trap deaths submitted	15	~	~	~
3. Verification by WAM (via voucher specimens): Where there may be some doubt, confusion or potential for incorrect identification	13	~	~	2

*Key: 0=did not mention the issue; 1=mentioned but did not adequately address the issue; 2=addressed the issue to a moderate standard; 3=comprehensively addressed the issue.

2.5.5.2 Overall consultant report compliance to criteria

The level to which individual reports addressed the respective components varied. The majority of reports addressed approximately half of the criteria within all components to a moderate or comprehensive standard (Fig 2). Thirteen reports addressed approximately half of the desktop survey criteria, with one report (E) addressing all criteria (Fig 3). Sixty percent of field sampling design and planning criteria was not mentioned or addressed within 11 reports (Fig 4). In contrast, 12 reports addressed 60% or more of the field sampling data interpretation and analysis, within two reports (D and O) addressing all criteria (Fig 5). Only two reports addressed any of the data validity criteria (Fig 6).

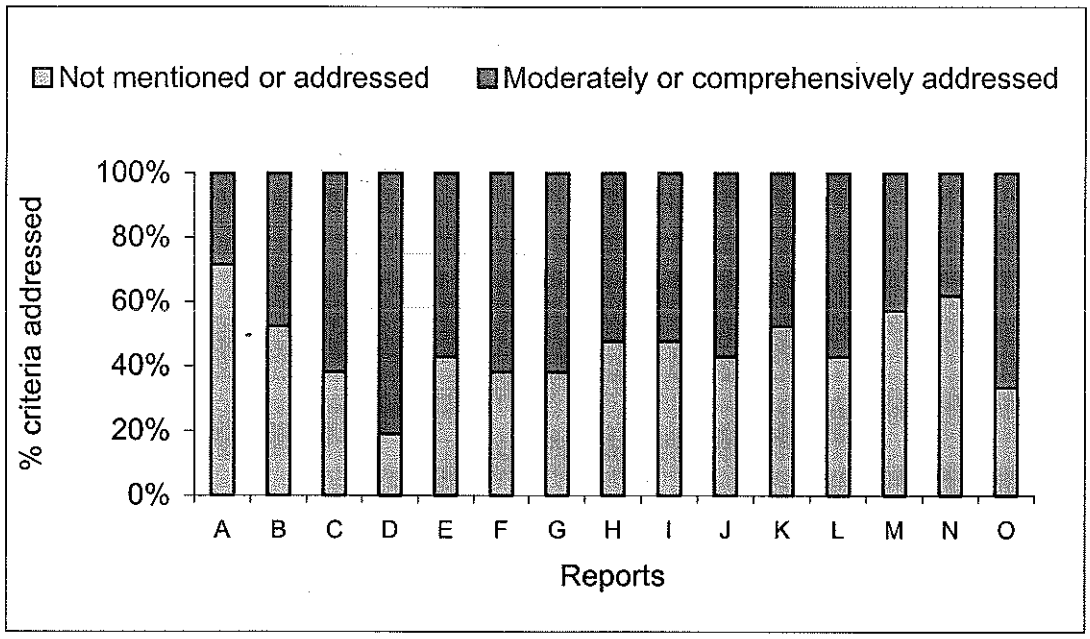

Figure 2. Percent of all criteria (desktop surveys, field sampling parameters and data validity) addressed within individual consultant reports.

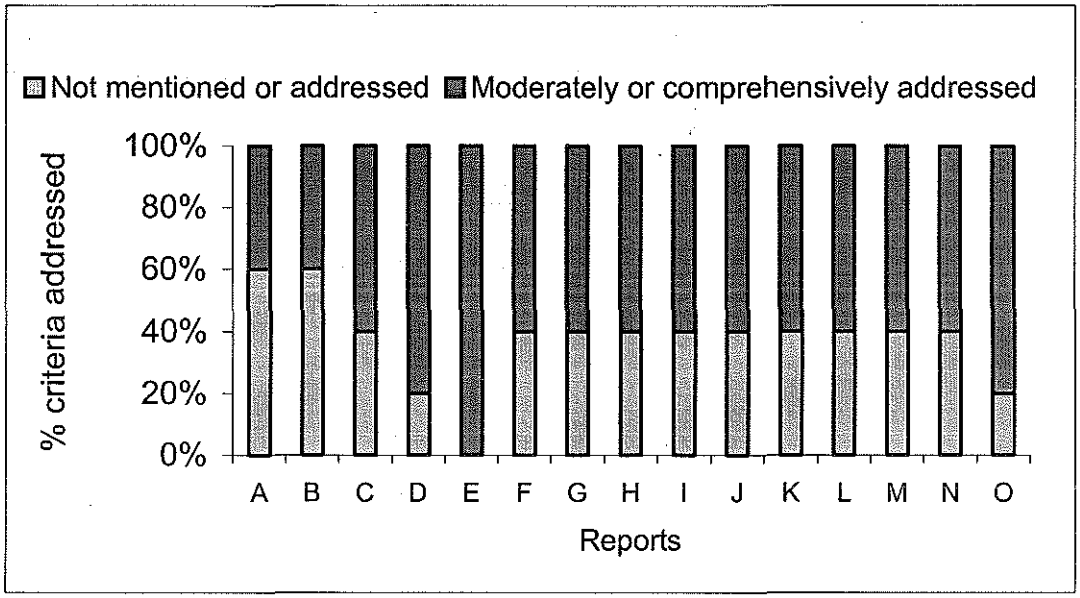

Figure 3. Percent of desktop survey criteria addressed within individual consultant reports.

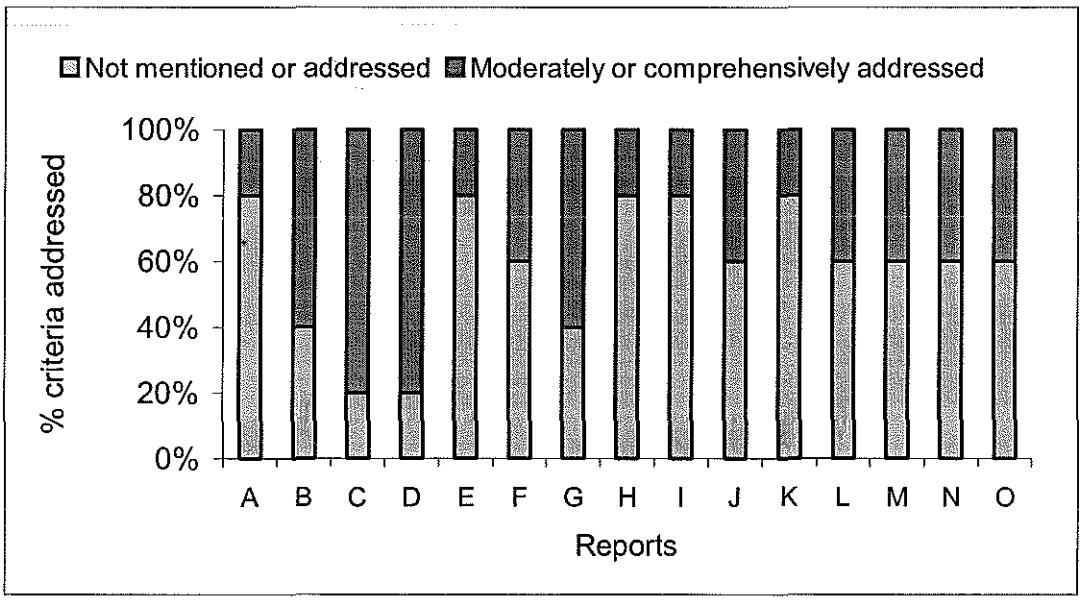

Figure 4. Percent of field sampling design and planning criteria addressed within individual consultant reports.

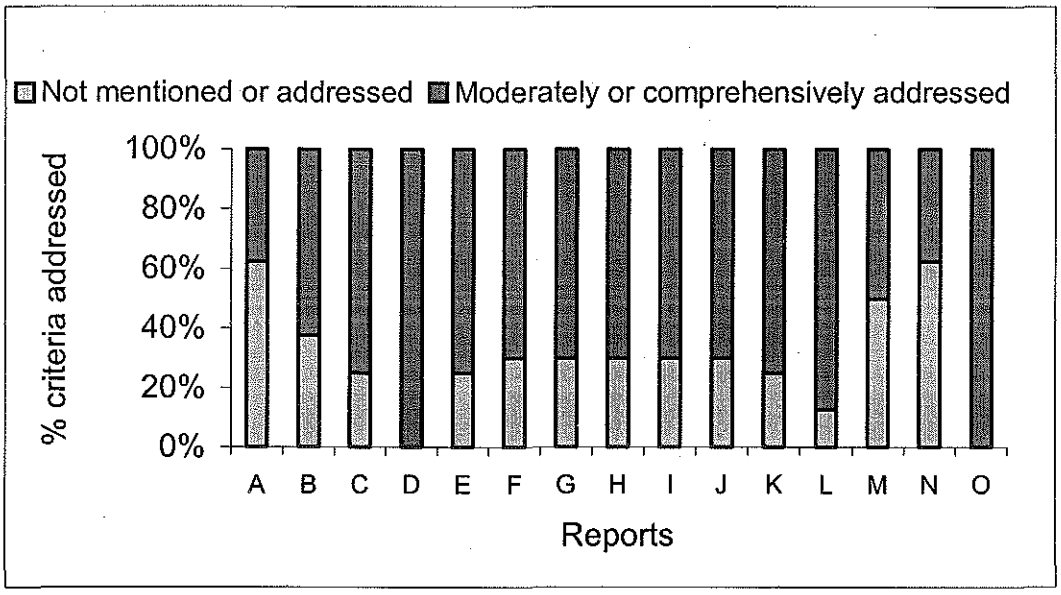

Figure 5. Percent of field sampling data analysis and interpretation criteria addressed within individual consultant reports.

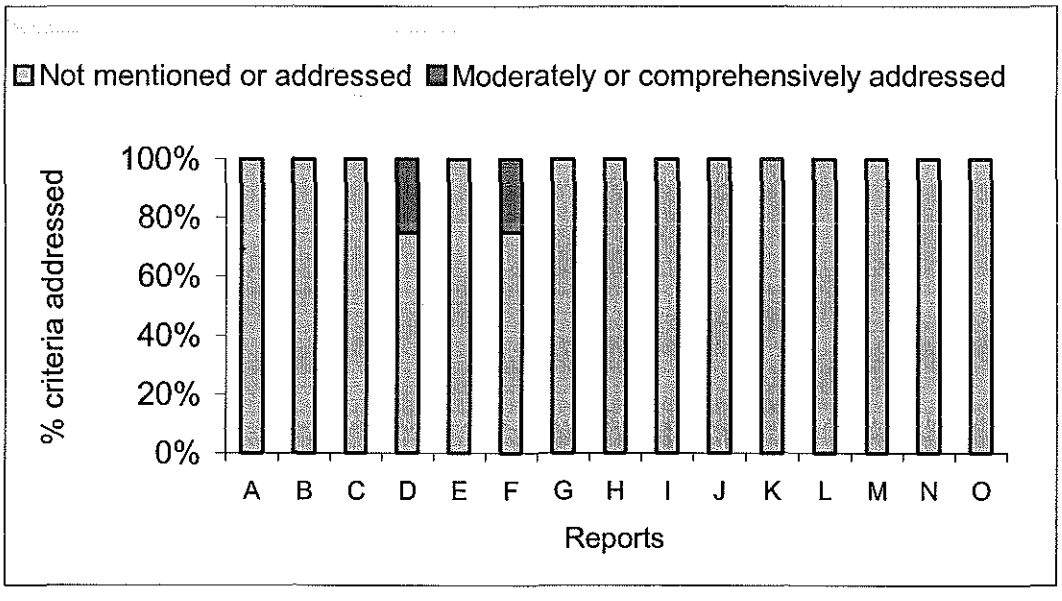

Figure 6. Percent of data validity criteria addressed within individual consultant reports.

2.5.6 Appropriate seasonal trapping within consultant reports

Appropriate seasonal trapping over one annual cycle (defined as Spring and Autumn) was compared to the seasonal trapping within consultant reports. Ten reports were evaluated as the fauna data used within the remaining five reports made no reference to the season/s in which data was collected.

Results

Three reports undertook appropriate seasonal trapping, with the remaining seven reports trapping within one season only (Table 14).

Table 14: Seasonal trapping within consultant reports over one annual cycle.

Season	Consultant reports														
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Spring			X	X		X			X		X	X			X
Summer	X														
Autumn			X	X				X		X					X
Winter			X												

2.5.7 Trapping effort within consultant reports

The 'set criterion' are directly compared to the level of trapping effort within consultant reports at the biotope and landscape scales. Seven reports were evaluated as the remaining eight had not provided an adequate explanation of trapping methodology. As a measure of total trap effort, the total number of trap nights were given in all seven consultant reports and directly compared to the 'set criterion'. The level of effort for each trap type as described within individual consultant reports was not consistent. Therefore the mean level of effort over all sites was used for each trap type.

Results

Total trap effort (trap nights all seasons) was below the evaluation criteria within all consultant reports at both the biotope and landscape scales (Table 15a and 15b). The level of trap effort undertaken within individual reports was inconsistant for all trap types and for total trap effort.

Table 15a: Comparison of biotope trapping effort within consultant reports to set criteria.

Trapping effort variables	Reports							Set criteria
	C	D	F	H	J	L	O	
No sample sites	1	1	1	1	1	1	1	3
No pit traps	6	5	8	10	10	10	10	10
No Elliott traps	3	20	6	12	10	10	13	12
No cage traps	1	0	1	0	1	1	2	4
No traps nights per season (total trap effort)	80	104	119	176	126	210	150	137
No trap nights all seasons (total trap effort)	160	209	119	176	126	210	150	409

Table 15b: Comparison of landscape trapping effort within consultant reports to set criteria.

Trapping effort variables	Reports							Set criteria
	C	D	F	H	J	L	O	
No pit traps	69	55	80	70	70	100	90	166
No Elliott traps	43	220	60	84	70	100	69	198
No cage traps	11	0	10	0	7	10	18	56
No traps nights per season (total trap effort)	924	1150	1189	1232	966	1666	1350	1371
No trap nights all seasons (total trap effort)	1848	2300	1189	1232	966	1666	1350	3630

CHAPTER 3

3.1 Discussion

This study compared standards adopted in recent terrestrial vertebrate fauna surveys to criteria considered essential by relevant experts. Inherent strength and weakness were identified in consultant reports. This study defined a set of criteria and level of trapping effort considered essential for fauna surveys to meet the expectations of EIA as discussed in Chapter 1. Although reports addressed many of the issues comprehensively, many failed to mention or adequately address a large proportion of essential issues. If fauna surveys as undertaken for EIA are to enable decision-makers to adequately assess the impacts of development on biodiversity and particular ecosystems, then they must provide the appropriate information. This research has identified deficiencies within current standards that need to be addressed if appropriate information is to be available within EIA for decision makers. Key areas of concerns include:

- Information used in desktop surveys.
- Adequacy of surveys to assess the diversity and status of fauna.
- Level of trapping effort required for field surveys.
- Adequacy of field surveys to detect threatened fauna.
- Usefulness of trapping data for predicting impacts.
- Standards within data collection.

These issues are discussed in detail in the subsequent sections below.

3.1.1 Information used in desktop surveys

The evaluation of the reported desktop component of fauna surveys suggests that valuable information is not being used as few consultants indicated that they searched government databases. These specimen-based databases (WAM and CALM) comprise historical records and the most up-to-date verified inventories for both common and threatened species within any given area. Mattiske *et al* (1995) undertook a review of fauna studies for EIA and reported that researchers in Western Australia do not routinely search these databases. It is appreciated that historical museum collections have some inherent shortcomings, most notably geographic gaps due to the ad hoc nature of collections (Ponder *et al*, 2001). For example, there is a paucity of records in the WAM database for many of the more remote areas of WA (Withers and Edward, 1997). Nonetheless, museum collections are extremely valuable in providing known and predictive distributional information (Ponder *et al*, 2001). Where field surveys are to be undertaken for impact assessments, desktop surveys are typically undertaken as a preliminary source of information to guide subsequent fieldwork. Desktop surveys may also be used as the primary source of information on the distribution of species. If desktop surveys for EIA are to include the best available information, use of government databases can provide accurate and up-to-date data for compiling species lists.

In addition, respondents did not view searches of the Environment Australia database for gazetted threatened species and ecological communities as essential. Under the EPBC Act (1999), the presence of gazetted threatened species and ecological communities is a trigger of the EIA process. A significant impact is defined as one that affects such species or communities. Therefore, searches of this database should be

routinely undertaken during the desktop component of fauna surveys for preparation of an EIA, in order to comply with the EPBC Act.

All native fauna are protected under legislation, covered in WA by the Wildlife Conservation Act (1950-79), and nationally in the EPBC Act (1999). In the absence of reference to data held by CALM and WAM any review of the significance of fauna species is dependant on the knowledge of the specialist consultant. The lack of reference to current databases can lead to potential legal issues where a project may impinge on a previously unknown population of protected fauna.

Conclusions

Desktop surveys are a primary component of the fauna survey process. This study identified that searches of government databases are not routinely undertaken. If surveys are to include the best available information, access of government databases can provide accurate and up-to-date data. As these databases are not routinely searched, research needs to be undertaken on the availability and usefulness of existing databases to predict the presence of species in a defined area and furthermore, appropriate use of existing databases to maximize their benefit to fauna surveys for EIA.

3.1.2 Adequacy of surveys to assess the diversity and status of fauna

Consultant reports evaluated in this study provided species inventories to quantify the diversity and status of fauna using fieldwork conducted over a single season or year. The majority of fieldwork was undertaken in one season, with only three of the ten reports assessed surveying for one annual cycle (spring and autumn), and no trapping was undertaken over more than one annual cycle. Mattiske *et al* (1995) concurs with

this view that seasonal effects and the need for multiple stages of data collection was generally lacking in fauna surveys undertaken for EIA reporting in Western Australia.

Preliminary fauna surveys are part of almost any EIA process, and most environmental review documents contain a list of plant and animal species recorded or expected at the proposed project site and its immediate vicinity (Buckley, 1993). For major projects, as undertaken within the mining industry, flora and fauna lists are commonly prepared in conjunction with field surveys carried out by specialist consultants (Read, 1994), and to that extent may represent new information on fauna diversity and status generated by the EIA process.

Due to the nature of arid environments, large-scale population and community changes can occur over relatively short periods of time (Buckley, 1993; Treweek, 1999). The ability to trap the suite of animals present over an annual cycle varies greatly as different groups are most active at certain times of the year (Read, 1992; Treweek, 1999). If the objectives of field surveys are to record a representative sample of faunal groups in an area to understand community structure, then trapping must be undertaken when animals are most active. Boone and Krohn (2000) identified the need for fauna studies to encompass climatic variation to adequately identify the species richness of arid zone mammals, reptiles and amphibians. Long-term surveys, conducted over a range of climatic extremes are required to determine the status and population composition of arid zone reptiles and amphibians (Morton *et al*, 1988; Read, 1992; Morton *et al*, 1993). Studies spanning several years of above average rainfall are required to fully assess the presence of small mammal fauna in arid locations (Read, 1994; Cole and Woinarski, 2000). Furthermore, amphibians only surface after heavy

rains and are unlikely to be recorded unless surveys are undertaken at the appropriate time (Grigg, 2000).

Read (1994) evaluated how effective the fauna component of an EIA for the Olympic Dam mine operations (South Australia) was in predicting the diversity and status of the local fauna. Since the original preliminary fauna survey there have been 10 years of intensive monitoring (1984-1993). The preliminary fauna study involved three days of fieldwork and was carried out to verify the findings of the desktop study. The preliminary fieldwork identified 10 of a potential 53 species of reptiles and six of 29 potential mammal species. Subsequent studies undertaken at the site revealed the brief field survey to be a poor substitute for the subsequent detailed investigation. In hindsight, Read (1994) reported that the desktop survey alone would have been a sufficient precursor to the subsequent detailed investigation. Importantly, the long-term monitoring program (as a component of the EIA) proved to be accurate in determining the fauna composition of a previously poorly known region with identification of 87% of mammals, 98% of reptiles and 100% of amphibians. A well-designed long-term survey can identify the key determinates of species distribution and abundance, providing useful insights into ecological patterns and processes (Taylor *et al*, 1984; Read, 1994; Smith, 1997; Catling and Coops, 1999; Boone and Krohn, 2000).

Conclusions

The amount of information that can be collected within a single season or year cannot provide more than a cursory understanding of the diversity or status of local or regional fauna. Currently there is no standard in Western Australia that requires a set amount of fauna survey effort to be employed prior to, during or after a project has been

commissioned (Department of Environmental Protection, 2001a). This study suggests that long-term studies are not typically undertaken within recent fauna surveys for EIA. If long-term monitoring programs are to be implemented as part of the EIA process then the ability to ascertain the diversity and status of fauna can be greatly improved

3.1.3 Level of trapping effort required for field surveys

The level of trapping effort undertaken within consultant reports assessed in this study varied appreciably, with few reports meeting the evaluation criteria. Total trapping effort was well below the 'set criteria' at the biotope and landscape levels (as a measure of trap nights for all seasons). Low trapping effort may reflect commercial pressure from development proponents requiring consultants to adopt the lowest cost option in data collection strategies. Consultants proposing to undertake more comprehensive data collection than currently accepted as the minimum requirement by the EPA (which is not formally defined) risk not winning the job because their tender price is too high. Environmental consultants actively working with mining companies would welcome published minimum standards, as it would take the guesswork out of what is required (pers. comm. E Mattiske). Furthermore, it would limit the opportunity for proponents to allocate less than adequate resources.

Research is currently underway that will provide guidelines on the amount of trapping effort required to ascertain the number of species at the biotope and landscape scales (G. Thompson; P. C. Withers; E. R. Pianka; and S. A. Thompson, unpublished manuscript). This research suggests that current effort is inadequate to ascertain species diversity and status (pers. comm. G. Thompson). Preliminary analysis of their data suggests that enough data is not yet available to enable preparation of guidelines on the level of effort

required. The EPA may wish to support this research with a view to releasing guidelines on the level of trapping effort required to monitor development impacts on species composition (at the biotope and landscape scales) or to measure rehabilitation success in disturbed habitats.

Conclusions

This study provides a preliminary defensible standard based on quantified expert opinion of a level of trapping effort appropriate for field surveys at both the biotope and landscape levels. However, this standard needs to be verified or amended based on further research. The EPA should consider supporting this research with a view to developing appropriate trapping effort standards. Nonetheless, the standard defined by the 'expert panel' suggests that current effort is well below that considered appropriate.

3.1.4 Adequacy of field surveys to detect threatened fauna

This study found that the majority of field surveys undertaken by consultants failed to employ species-specific strategies for threatened fauna. Standard survey designs explained in consultant reports have had little success in trapping priority taxa. This is of concern as such species are inherently difficult to trap due to low numbers and they are often cryptic in nature (McArdle, 1990). Moreover, the propensity for rare, but important species to be caught in 'rapid assessment' is low (pers. comm. G Thompson). The level of trapping effort required to detect the presence of threatened species within standard trapping programs is usually impractical due to time and resource constraints (McArdle, 1990; Morton, 1990; Read, 1994). Therefore, development of species-specific search strategies would be extremely beneficial. With an improved understanding of the ecology of threatened species it may be possible to target habitat

areas which are vital for their persistence, allowing surveys to target priority species relatively quickly and efficiently (Morton, 1990).

Often the primary purpose of an EIA is to identify rare, endangered or range restricted species whose habitat might be altered or put at risk if the proposed development was to proceed. Detection of threatened or range-restricted species is important as they are most vulnerable to disturbance and once extinct constitute a measurable loss in biodiversity. An inability of currently adopted fauna surveys strategies to locate threatened species is a serious drawback of the EIA process (Read, 1994). Existing survey methods used by consultants are generally inadequate to identify the presence of threatened species (EPA, 2000b), therefore negating the purpose of the EIA.

Conclusions

Identification of threatened species is a primary goal the EIA process. This study identified that species-specific search strategies are not typically carried out within fauna surveys. It would be beneficial if appropriate strategies were documented and made available for consultants to identify the presence of rare, endangered or range restricted species. Development of such strategies would facilitate fauna surveys to provide up-to-date data on the presence and status of threatened fauna, allowing increased accuracy in decision making on development impacts. This is an area of research that the EPA might review.

3.1.5 Usefulness of trapping data for predicting impacts

This study suggests that data collected by consultants has a major weakness in predicting potential impacts on fauna populations. Specifically short-term field studies

(a few days/single season) seriously limiting the ability of researchers to detect natural variation in the population. Current survey practice fails to provide the necessary level of data for assessment of abundance in the context of natural variation over time (Treweek, 1999). A review of EIA standards undertaken by Beanlands and Duinker (1984) concluded that pre-project biological surveys usually consisted of no more than reconnaissance studies, a view that is supported by the data here. Experiments were seldom constructed to detect biological changes, and statistically adequate baselines against which subsequent changes could be detected through long-term studies were rare (Beanlands and Duinker, 1984; Buckley, 1993).

A common criticism of the EIA process is the failure to undertake statistically based impact predictions (Beanlands and Duinker, 1984; Smith, 1997; Treweek, 1999). Typically, forecasts of biological impacts suffer from a paucity of real data (Read, 1994; Culhane, 1987). This is often due to time and resource constraints, with impact assessment based on 'expert opinion' rather than statistically rigorous scientific study (Smith, 1997; Treweek, 1999), again a view supported by this research. The current time and resource constraints applied to the EIA process mean that it is generally not possible to undertake trapping programs required to meet normally accepted confidence limits in statistical analysis (Beanlands and Duinker, 1984; Treweek, 1999). However, although it is not always possible to adopt classical experimental designs for impact assessment studies, much greater use could, and should, be made of statistically based designs (Smith, 1997; Treweek, 1999).

It has been suggested that a lack of a rigorous statistical analysis of field survey data has resulted in a plethora of EIA information that has severely limited the ability of

decision-makers to assess the acceptability of proposals (Beanlands and Duinker, 1984; Smith, 1997; Treweek, 1999), particularly in the context of protecting biodiversity (Buckley, 1993). In this context it is necessary to consider the variability inherent in most ecological phenomena. If survey data are to be quantitatively analysed, relevant methodology should be employed and furthermore, it should be guided by the ecological questions that need to be answered. For this purpose a fauna survey for EIA should be designed to (Modified from Smith, 1997):

- Identify an initial set of valued ecosystem components (i.e. threatened fauna) to provide a focus for subsequent research.
- Define a context within which the significance of changes in the valued ecosystems components can be defined (i.e. changes in population abundance).
- Show clear temporal and spatial contexts for the study and analysis of expected changes within a statistical framework.
- State impact predictions explicitly, and demonstrate how the studies to be undertaken will meet this aim.
- Demonstrate and detail a commitment to a well-defined program for monitoring project effects.

Conclusions

The study results indicate that the level of data collected in fauna surveys limits the ability to detect natural variability within fauna populations. This situation limits the accuracy of impact predictions on fauna. Where predictions are used to evaluate impacts then verification should compare predictions with field data from the project area within a statistical framework. Due to the inherent complexity of statistical analysis, appropriate designs should be explored to quantify specific impacts (i.e.,

changes in population composition). Development of appropriate statistical analysis of data and testing of predictions would enhance the accuracy of impact predictions.

3.1.6 Standards within data collection

The extent of field trapping and seasons in which trapping was undertaken varied among consultant reports. There was no verification of field data with current WAM nomenclature, and verification of specimens where there is potential for incorrect identification was mentioned in only two reports. Both of these issues are especially important if collected data are to be used in ongoing or future assessments of the local and regional environment (Mattiskie *et al*, 1995). A recent review of fauna data collected for EIA in WA suggests that compilation of data is constrained by a lack of standards within survey methodology and the quality of data collected (Mattiske *et al*, 1995).

Conclusions

A lack of standardisation within reporting and quality of data is limiting the comparative value of data collected. If quality data were collected within a standardised format, the ability for analysing and interpreting fauna surveys regionally in a biodiversity and ecosystem context would be greatly improved.

CHAPTER 4

4.1 Concluding statements

Decision-makers (in WA the Environmental Protection Authority) base their assessment of the acceptability of proposed development upon the information supplied within EIA documents (EPA, 1993). This study has clearly indicated that for the purpose of preparing an EIA consultants are not addressing many of the essential components of terrestrial fauna surveys. This study suggests that fauna surveys currently undertaken as a basis for EIA reports provide inadequate information for decision makers to assess the potential impacts of development on biodiversity and particular ecosystems, a view expressed by the Environmental Protection Authority in Position Statement No. 3 (EPA, 2000b). However, fauna surveys have the potential to supply valuable information on the current status of biodiversity and provide valuable insight into particular ecosystem components. If adequate data collection and relevant ecological information are collected as part of the fauna survey process not only can EIA become more useful, but our knowledge of the States biodiversity can be enhanced.

If the information within EIA documents is inadequate for decision makers to access the impacts of development, then these deficiencies must be addressed. Review of fauna surveys within this study suggests they typically do not involve ongoing monitoring or specific focus on identifying threatened species. There is a short-term approach to describing the environment and a lack of focus on the variability of natural phenomenon. This situation provides limited opportunity for any rigorous analysis and prediction of potential impacts as described within the EIA process.

4.2 Recommendations

This study has identified (by expert opinion) numerous essential components of fauna surveys necessary to provide adequate information for EIA. However, additional research is required before the necessary protocols can be prepared. This study will in part help to guide formation of standards or guidelines for terrestrial fauna surveys as undertaken for EIA. The following recommendations are made with a view to improving the quality and usefulness of data collected:

1. Searches of Conservation and Land Management, Western Australian Museum and Environment Australia databases routinely undertaken within desktop surveys.

2. All species lists to conform with the current Western Australian Museum nomenclature.

3. Trapping protocols and standards be made available to consultants and mining companies to indicate the amount of field effort required to assess the fauna at a site. Additional research will be required before these standards can be adequately supported by the appropriate data. However, the expert opinion documented here would provide a useful preliminary outline for a terrestrial fauna protocol.

4. The EPA to provide guidelines to consultants and mining companies on the long-term monitoring requirements to meet the expectations of EIA. Further research will likely be required before these guidelines can be prepared.

5. Guidelines on species-specific search strategies to be employed within field surveys to determine the location and status of threatened fauna. This will require further research, however, there is considerable information on searching and locating many of the states threatened species in the literature that needs to be collated and documented.

6. Where predictions are to be used to evaluate impacts (i.e. the project will not significantly impact a threatened species), then fauna surveys should be designed to compare predictions with future field data from the project area within a statistical framework.

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Appendix 1. Initial correspondence to invite experts to participate on 'expert panel'.

Dr Allan Burbidge
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Woodvale Research Centre
Wildlife Place
Woodvale
WA 6026

Mr Jason Fraser
Edith Cowan University
School of Natural Sciences
100 Joondalup Drive
Joondalup
WA 6027
[redacted]

Dear, Dr Burbidge,

I am an Honours student in the School of Natural Sciences at ECU, supervised by Dr D. Moro and Dr G. Thompson. My Honours project will investigate strengths and weaknesses of terrestrial fauna surveys that lead up to the preparation of environmental impact assessments (EIA), in the mining industry of Western Australia. The Environmental Protection Authority (EPA) has recently suggested there is a need to improve existing terrestrial biological survey standards for EIA reporting (EPA 2000, Position statement No.3, *General Requirements for Terrestrial Biological Surveys*). The EIA is widely acknowledged as an important document in assessing the potential impact of mining disturbance on the environment. Although mining companies spend considerable resources undertaking biological surveys, sufficient survey effort is rarely conducted to adequately understand faunal populations and ecosystem interrelationships prior to mining, or for monitoring rehabilitation initiatives after mining disturbance. If the quality of data collected for this purpose is questioned (i.e., it is inadequate to assess impacts), then it is important that the EPA reviews the data collection processes, identifying the strengths and weaknesses of existing protocols, and puts in place new standards or protocols to address the deficient areas.

The EPA has historically accepted substandard work; therefore there is little incentive for consultants or mining companies to improve the quality of their terrestrial fauna surveys. The EPA's synopsis for poor standards within current protocol includes:

- A lack of appropriate scale databases and baseline information to allow appropriate assessment in a regional context

- A lack of resources being allocated for appropriate surveys
- Site specific data being collected but not adequately interpreted in a biodiversity context
- A lack of reference to the current literature
- Inappropriate timing of surveys; and
- A lack of information on habitat condition and requirements.

The ability of researchers and consultants to assess potential environmental impacts is dependent on the quality and coverage of fauna surveying protocols and data analyses. Inadequate, incomplete or poorly designed fauna surveys, and incomplete or inappropriate analyses of the data lead to incorrect conclusions. This project will investigate the quality and usefulness of terrestrial fauna survey data presented within EIA reports that have been presented to the EPA for decisions on the potential impacts of mining development, in the context of preserving biodiversity and protecting ecosystem function. The specific objectives of this study are to:

I) Define and develop evaluation criteria based on expert opinion and a literature review of 'best practice' fauna survey methodology to assess the quality and validity of past terrestrial fauna surveys used as a basis for preparing environmental impact assessments within the Interim Biogeographic Regionalisation of Australia (IBRA), Coolgardie unit.

II) Use these criteria to evaluate the quality and validity of 12 terrestrial fauna surveys that have been used as the basis for preparing environmental impact assessments.

III) Make recommendations to the Department of Environmental Protection on how terrestrial fauna surveys might be improved based on a literature review, and existing deficiencies in terrestrial fauna surveys (based on the outcomes of the aforementioned criteria).

To facilitate improvement of current terrestrial fauna survey protocols, I am seeking to quantify expert opinion to assess current standards of terrestrial fauna surveys with a view to making recommendations on how surveys might be improved. For the purpose of evaluating current standards it is pertinent to canvass expert opinion from within both public and private sectors. I am seeking expert opinion from researchers working in Western Australian Government agencies and academic institutions, and from WA environmental consultants, on the strengths and weaknesses of terrestrial fauna surveys for the purpose of preparing EIA's for mining activity in Western Australia.

Opinions will be obtained and quantified via a two-stage process. Stage one involves obtaining the views of experts, such as yourself, on the strengths, weaknesses, problems and issues associated with terrestrial fauna survey protocols that are currently being used. I have attached a list of issues that are raised in the literature that I would like to discuss with you during an interview. In addition, I would like your views and comments on a range of questions including:

- Perceptions of the goals of fauna surveys for application within EIA
- Adequacy of current survey protocols,
- Key areas of concern; and
- Methods of determining the validity of the data being collected

I will collate the views of all experts in conjunction with information obtained from the literature. During stage two of the process, each expert will be mailed the compiled list of criteria seeking feedback on the importance of each criteria. You will be asked to assign a rating to each criteria based on a seven point Likert scale. Follow up discussion may be required to clarify or develop issues that arise during stages one or two. I will then apply these criteria to evaluate 12 recent EIA reports. Results of the study are to be written up as an Honours thesis, and will be submitted to the EPA for its consideration. This project is supported by the Environmental Protection Authority, and the Department of Conservation and Land Management. These agencies view this project as providing selected representatives of the industry with an opportunity to contribute their expertise to the development of future standards.

I an eager to obtain your views as a person that has had considerable expertise in terrestrial fauna surveys. I expect the interview will take about 45 minutes. I also request your consent to record the interview on a cassette tape recorder so that I may go over the interview at a later time to ensure I have a record of all of the points you have made. I will destroy the record of the interview at the conclusion of the study and the individual views of an expert will not be identified in any written material, but summarised anonymously in accordance with the university's Ethics Committee requirements.

Yours Sincerely

Jason Fraser

CONSENT FORM

Project title: Adequacy of terrestrial fauna surveys for the preparation of Environmental Impact Assessments in the mining industry of Western Australia.

I (the participant) have read the information in the attached letter and any questions I have asked have been answered to my satisfaction.

I agree to participate in this activity, realising that I may withdraw at any time.

I agree that the research data gathered for this study may be published provided I am not identifiable or, understanding that I may be identified with my prior written consent.

Participant or authorised representative date:

Signed (please print full name):

Attachment 1: Concerns identified within the literature for stage 1.

Failure to mention the presence of designated areas and/or protected species
Failure to consider other important nature conservation resources that are not designated, or which lie outside the actual area of a proposed development
Failure to characterise baseline conditions (i.e. vegetation, soils, habitat condition)
Failure to provide the data needed to identify or predict ecological impacts
Failure to quantify population estimates
Failure to interpret survey in a biodiversity context
Over-reliance on descriptive and subjective methods
Failure to undertake field surveys
Inadequate level of surveying in context of landscapes (i.e. biotope, regional)
Failure to undertake surveys at appropriate times
Bias towards easily surveyed and charismatic taxonomic groups
Inadequate replication
Failure to estimate ecological significance
Failure to describe limitations or constraints on survey methodology
Inadequate or irrelevant literature reviewed
Failure to name author/consultant or to reference sources of data
Concurrent flora and fauna surveys not undertaken

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Appendix 2. Questionnaire to quantify expert opinion on essential components of terrestrial fauna surveys as undertaken for Environmental Impact Assessment.

QUESTIONNAIRE

PART ONE – Desktop surveys

Desktop surveying is a standard part of the EIA biological survey process, being used both as a primary source of data and as a primer for subsequent field surveys. Please indicate your view on the need to incorporate the following components in the desktop survey.

Please put a '√' in the appropriate box.

Desktop surveying questions	**RESPONDENT VIEW**			
	Not Important	**Highly Desirable**	**Essential**	**Undecided**
1. Search of CALM database for:				
a) declared rare/endangered fauna database.				
b) priority taxa (as defined by CALM).				
2. Search of the Western Australian Museum database for:				
a) declared rare/endangered taxa.				
b) priority taxa (as defined by CALM).				
c) all taxa that may occur in any potential impact areas.				
3. Search of Environment Australia database for:				
a) threatened species				
b) threatened ecological communities				
4. A review of **published** literature relevant to the survey area.				
5. A review of **unpublished** literature/reports (if available).				
6. Discussion (within EIA report) on the conservation status of:				
a) **declared rare/endangered** fauna **recorded** in the survey area.				
b) **priority** taxa **recorded** in the survey area.				
c) **declared rare/endangered** fauna **expected** in the survey area.				
d) **priority** taxa **expected** within the study area.				

<u>COMMENTS</u> (please indicate question number/s that your comments are pertaining to [add extra comments overleaf])

PART TWO – Field sampling parameters

To delineate the potential impacts for any given development, an understanding of the terrestrial vertebrate fauna, their habitat and the interaction between these, must be explored and reported on. For this purpose there are many ecological parameters that can be measured. The following questions have been compiled based on the criteria/issues identified by the 'expert panel', and within the literature. Moreover, once the need for a field survey has been identified the following components can be considered as part of the fieldwork phase of the process.

Please put a '√' in the appropriate box.

SECTION 1: Survey design and planning.

Design and planning for baseline field fauna surveys (for impact assessment in the Coolgardie IBRA region) should encompass:	**RESPONDENT VIEW**			
	Not Important	**Highly Desirable**	**Essential**	**Undecided**
1. Fauna sampling to be undertaken for:				
a) **one** annual cycle				
b) **more than one** annual cycle				
2. Concurrent flora and fauna surveying				
3. Description of key fauna habitat components (ie. rocky outcrops, termite mounds, free water, etc.), included in EIA report for each biotope				
4. A component of the field survey protocol designed to search for:				
a) rare/endangered taxa				
b) priority taxa (as defined by CALM)				
c) threatened fauna				
d) feral animal taxa				
5. Notation of opportunistic fauna observations to be:				
a) described				
b) quantified				
6. All surveys undertaken or supervised by a qualified zoologist				
COMMENTS (please indicate question number/s that your comments are pertaining to [add extra comments overleaf]				

SECTION 2: Data interpretation and reporting

Interpretation and reporting for baseline field fauna surveys (for impact assessment in the Coolgardie IBRA region) should encompass:	**RESPONDENT VIEW**			
	Not Important	**Highly Desirable**	**Essential**	**Undecided**
1. A written statement explaining the constraints and limitations of the study included in the report to the EPA				
2. Rational of survey methodology within reporting to the EPA				
4. Data interpretation in the context of regional data sets (e.g., WAM/CSIRO biological surveys of the eastern goldfields)				
5. Data analysed with reference to local/regional biodiversity values				
6. Evaluation of assemblage/community structure for:				
a) Mammals				
b) Reptiles				
c) Amphibians				
d) Birds				
7. Reference to sources used for fauna identification.				
8. Assessment of the field data, within an ecological context, highlighting key relationships existing between species and habitat				
9. Peer review of fauna survey report:				
a) 'In house'				
b) Contractor/mining company arranged				
c) EPA arranged				
10. Evaluation of population estimates for:				
a) rare/endangered taxa,				
b) priority taxa				
11. Identification of person/s that carried out the:				
a) field survey				
b) data analysis/interpretation				

COMMENTS (please indicate question number/s that your comments are pertaining to [add extra comments overleaf])

PART THREE – Data validity

Many 'expert panel' members indicated the importance of ensuring data quality, not only to validate field data for impact assessments, but also to enhance our knowledge of biodiversity and ecosystem function in Western Australia. The following have been suggested as providing acceptable methods for verifying data quality. Please indicate your view of the importance of the following methods for verification of field survey data.

Please put a '√' in the appropriate box.

Validity of data collection	Not Important	Highly Desirable	Essential	Undecided
1. Identification based solely on reference guides and prior field experience.				
2. Species lists conforming with current WAM nomenclature.				
3. Verification by WAM (via voucher specimens):				
a) Vouchering a representative sample of **all** species collected (for any given survey).				
b) All trap deaths submitted for WAM reference collections.				
c) Species identification supported by voucher specimens for range extensions only.				
d) Where there may be some doubt, confusion or potential for incorrect identification.				

COMMENTS (please indicate question number/s that your comments are pertaining to [add extra comments overleaf])

PART FOUR – Minimum field sampling standards

Discussions held with 'expert panel' members identified the need for an established minimum level of field trapping effort as a practical way of standardising baseline surveys for impact assessment. The following set of questions is aimed at quantifying an acceptable minimum sampling strategy for the Coolgardie IBRA region, for the purposes of baseline fauna surveys for EIA in mining.

SECTION 1: Appropriate seasonal trapping

Please put a '√' in the appropriate box.

Seasonal timing of survey effort	Mandatory	Only in special circumstances	Generally not necessary
Field surveying within the seasonal interval of Summer (Dec-Feb).			
Field surveying within the seasonal interval of Autumn (Mar-May).			
Field surveying within the seasonal interval of Winter (Jun-Aug).			
Field surveying within the seasonal interval of Spring (Sep-Nov).			

COMMENTS (please indicate question number/s that your comments are pertaining to [add extra comments overleaf])

SECTION 2

I would like you to consider the next set of questions on two biogeographic scales;

a) The biotope (one defined habitat type) level where the habitat is homogenous and the area is often quite small, and

b) landscape scale, that is a large heterogeneous habitat, containing **TEN** defined habitats.

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a) Biotope or homogenous habitat level: assume 1 sq km area of homogeneous habitat is being sampled

Please circle the response you believe is most appropriate.

Minimum number of sample sites within the area being sampled.

1	2	3	4	5	6	7	8	9	10	11+

Minimum number of pitfall traps per sample site.

0	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101+

Minimum number of Elliott traps per sample site.

0	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101+

Minimum number of cage traps per sample site.

0	1	2	3	4	5	6	7	8	9	10	11-15	16-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101+

Minimum number of trap nights per single sampling site **per season**.

1 to 7	8 to 14	15 to 25	25 to 35	35 to 50	50 to 75	75 to 115	115 to 170	170 to 255	255 to 385	385 to 575	575 to 865	865 to 1300	1300 to 1945	1945 to 2920	2920 to 4340	4340 to 6570	6570 to 9850	10000+

Minimum **total** number of trap nights per single sampling site for all seasons.

1 to 7	8 to 14	15 to 25	25 to 35	35 to 50	50 to 75	75 to 115	115 to 170	170 to 255	255 to 385	385 to 575	575 to 865	865 to 1300	1300 to 1945	1945 to 2920	2920 to 4340	4340 to 6570	6570 to 9850	10000+

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b) Landscape or heterogeneous habitat level: Assume a 100 sq km area of heterogeneous habitat, including TEN defined habitat types (biotopes), is being sampled

Please circle the response you believe is most appropriate.

Minimum number of pitfall traps spread across the entire area.

0	1 to 10	11 to 20	21 to 35	36 to 50	51 to 75	76 to 100	101 to 150	151 to 200	201 to 300	301 to 400	401 to 500	501 to 600	601 to 700	701 to 800	801 to 900	901 to 1000	1001 to 1250	1251 to 1500	1500+

Minimum number of Elliott traps spread across the entire area.

0	1 to 10	11 to 20	21 to 35	36 to 50	51 to 75	76 to 100	101 to 150	151 to 200	201 to 300	301 to 400	401 to 500	501 to 600	601 to 700	701 to 800	801 to 900	901 to 1000	1001 to 1250	1251 to 1500	1500+

Minimum number of cage traps spread across the entire area.

0	1 to 10	11 to 20	21 to 35	36 to 50	51 to 75	76 to 100	101 to 150	151 to 200	201 to 300	301 to 400	401 to 500	501 to 600	601 to 700	701 to 800	801 to 900	901 to 1000	1001 to 1250	1251 to 1500	1500+

Minimum number of trap nights **per season**.

1 to 7	8 to 14	15 to 25	25 to 35	35 to 50	50 to 75	75 to 115	115 to 170	170 to 255	255 to 385	385 to 575	575 to 865	865 to 1300	1300 to 1945	1945 to 2920	2920 to 4340	4340 to 6570	6570 to 9850	10000+

Minimum **total** number of trap nights **including all seasons**.

1 to 50	51 to 100	101 to 250	251 to 500	501 to 750	751 to 1000	1001 to 2500	2501 to 5000	5001 to 7500	7501 to 10000	10001 to 15000	15001 to 20000	20001 to 25000	25001 to 50000	50001 to 75000	100000+

END OF QUESTIONNAIRE

If you would like a summary of the finalised questionnaire results mailed to you, please tick the box below and provide contact details (e-mail is preferred).

☐ **Thank you once again for your time and I look forward to receiving your**

Appendix 3. Introductory letter, respondent details and consent form.

Jason Fraser
School of Natural Sciences
Edith Cowan University
Joondalup
WA 6027
[redacted]

25th July

Dear Dr Burbidge,

I am an Honours student at the Centre for Ecosystem Management, School of Natural Sciences, Edith Cowan University, supervised by Dr's Dorian Moro and Graham Thompson. My Honours project is investigating the strengths and weaknesses of terrestrial vertebrate fauna surveys that lead up to the preparation of environmental impact assessment (EIA). This project emerged from the Environmental Protection Authority (EPA) position statement No. 3 (*General Requirements for Terrestrial Biological Surveys for Environmental Impact Assessment in Western Australia*; May 2000).

The approach that I have adopted is to quantify expert opinion on the major issues and concerns identified. The outcomes will be used to evaluate a random set of 12 recent fauna survey reports, prepared for EIA's. Experts (from the public and private sectors) have been selected based on their recent experience in undertaking terrestrial fauna surveys. Interviews with the 'expert panel' participants (of which you may have been one [see attachment [a] for listing]), provided a wide range of issues that should be addressed in undertaking and analysing fauna survey data. Issues addressed in the enclosed questionnaire arose from the comments of the expert panel and the literature.

This questionnaire has the aim of exploring aspects of fauna survey protocols used to collect baseline information to assess biological diversity and quantify ecosystem function. Questions relate specifically to terrestrial vertebrate fauna surveys undertaken in the Coolgardie IBRA region of Western Australia (see attachment [b] for map). Furthermore, it is to be taken in the context of compulsory EIA prepared for proposed mining disturbance.

This part of my project is designed to develop an objective set of criteria that might be applied to 12 recent EIA reports, to determine their adequacy to enable the EPA to assess the potential impacts of a proposed disturbance will have on biodiversity and functional values of an ecosystem. You are asked to assign a level importance to each of the criteria to be used for evaluation. The three levels of importance used are as follows:

a) Not important (does not need to be considered)
b) Highly desirable (should be addressed but not essential)
c) Essential (must be addressed)
d) Undecided

The collective importance ranking assigned by questionnaire respondents will be used to assess the 12 EIA reports. The success of this project is dependent on development of an appropriate set of evaluation criteria. Your co-operation in completing and returning this questionnaire (via enclosed stamped-self addressed envelope) by 1st August would be gratefully appreciated.

The individual views of respondents will not be identified in any written material, but summarised anonymously in accordance with the university's Ethics Committee requirements. This project is supported by the Environmental Protection Authority, and the Department of Conservation and Land Management, and is viewed as an opportunity for persons involved within the industry to contribute their expertise to the development of future standards. Results of the study are to be written up as an Honours thesis, and will be submitted to the EPA for its consideration. Your participation will be acknowledged and is greatly appreciated. Please, do not hesitate to contact me if you have any further queries (I am most easily contacted via e-mail). I look forward to your reply.

Yours Sincerely

Jason Fraser

Enc.

Attachment

a) Expert panel participants

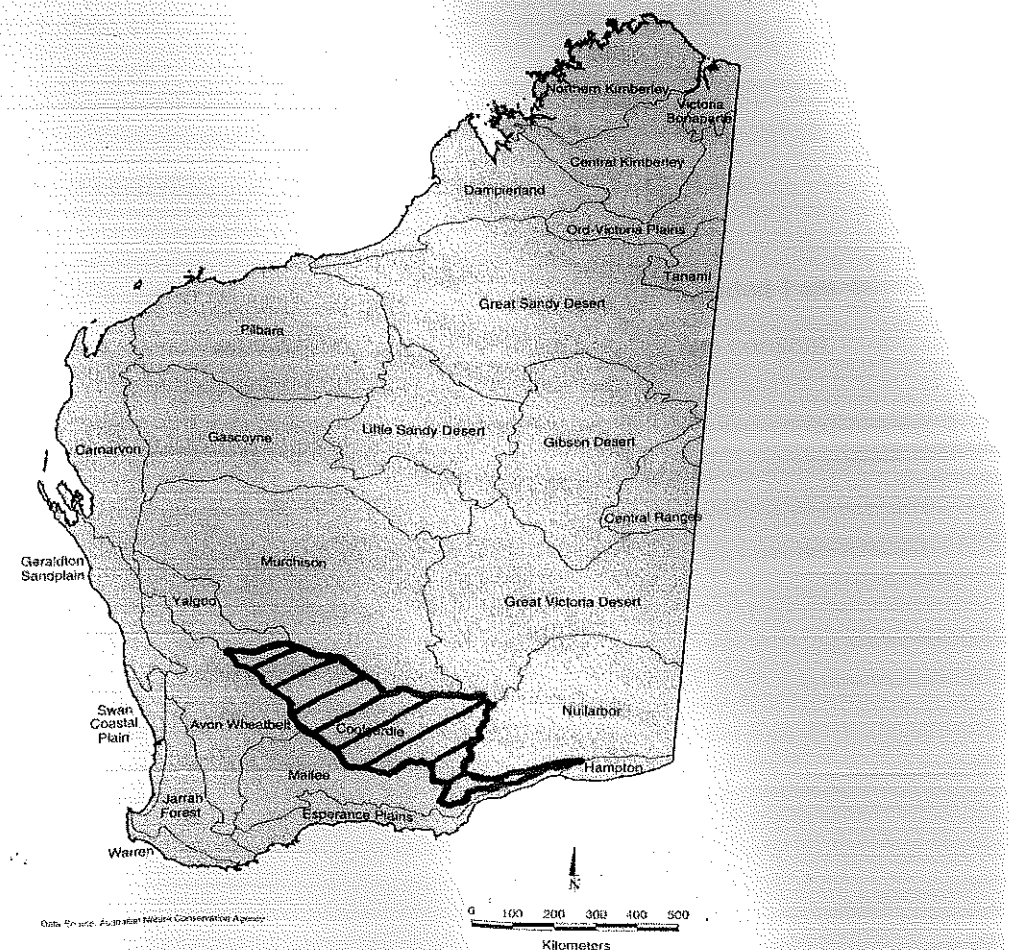
RESEARCHERS

- Mr John Dell - *Department of Environmental Protection*
- Dr Andrew Burbidge - *Department of Conservation and Land Management*
- Dr Richard How - *Western Australian Museum*
- Mr Laurie Smith - *Western Australian Museum*
- Mr Norm McKenzie - *Department of Conservation and Land Management*
- Dr. Philip Withers - *University of Western Australia*

CONSULTANTS

- Dr Mike Bamford - *Consulting ecologists*
- Dr Ray Hart - *Hart Simpson and Associates*
- Dr Libby Mattiskie - *Mattiskie Consultancy*
- Mr Gary Connel - *Ecologia*
- Ms Jan Henry - *Ninox Wildlife Consultancy*
- Mr David Kaesehagen - *Ecoscape*

b) Coolgardie Region (defined by the Interim Biogeoregional Regionalisation of Australia [IBRA]).



RESPONDENT DETAILS (please return this form with questionnaire)

Name:

Title:

Occupation:

Years experience within terrestrial fauna surveying (please circle your response)

1	2	3	4	5	6	7	8	9	10	10+

CONSENT FORM

Project title: Adequacy of terrestrial fauna surveys for the preparation of environmental impact assessments in the mining industry of Western Australia.

I (the participant) have read the information in the attached letter and any questions I have asked have been answered to my satisfaction.

I agree to participate in this activity, realising that I may withdraw at any time.

I agree that the research data gathered for this study may be published provided I am not identifiable or, understanding that I may be identified with my prior written consent.

Participant or authorised representative date:

Signed (please print full name)

Appendix 4. Raw evaluation scores for individual consultant report performance to criteria.

EVALUATION CRITERIA	CONSULTANTS REPORTS														
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Desktop surveys criteria															
1. Search of CALM database	0	0	0	0	3	0	0	0	0	3	3	0	0	0	0
2. Search of the Western Australian Museum database	0	0	0	3	3	0	0	0	0	0	0	0	0	0	3
3. A review of published literature relevant to the survey area	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
4. A review of unpublished literature/reports	0	0	3	3	3	3	3	3	3	3	3	3	3	3	3
5. Discussion on the conservation status of threatened fauna	3	3	3	3	3	3	3	3	3	0	1	3	3	3	3
Sub-total	**6**	**6**	**9**	**12**	**15**	**9**	**9**	**9**	**9**	**9**	**10**	**9**	**9**	**9**	**12**
Field sampling design and planning criteria															
1. Fauna sampling to be undertaken for one annual cycle	0	0	3	3	0	0	0	0	0	3	0	0	0	0	0
2. Description of key fauna habitat components	1	2	2	3	3	3	3	1	1	1	1	3	3	3	3
3. A component of the field survey protocol designed to search for rare/endangered, priority, and threatened fauna categories	0	0	3	1	0	3	0	0	0	0	0	0	0	0	0
4. Notation of opportunistic fauna observations to be described	3	3	3	3	0	3	3	3	3	3	3	3	3	3	3
5. All surveys undertaken or supervised by a qualified zoologist	0	3	0	3	0	0	3	0	0	0	0	0	0	0	0
Sub-total	**4**	**8**	**11**	**13**	**3**	**9**	**9**	**4**	**4**	**7**	**4**	**6**	**6**	**6**	**6**

Continued over leaf…

EVALUATION CRITERIA	CONSULTANTS REPORTS														
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Field sampling data analysis and interpretation criteria															
1. A written statement explaining the constraints and limitations of the study	1	2	2	3	1	2	2	0	0	0	0	0	3	3	3
2. Rational of survey methodology	0	2	2	3	1	2	3	3	3	2	2	3	3	3	3
3. Data interpretation in the context of regional data sets	3	3	3	3	3	3	3	3	3	3	3	3	0	0	3
4. Data analysed with reference to local/regional biodiversity values	3	3	3	3	3	3	3	3	3	3	0	3	1	0	3
5. Evaluation of assemblage/community structure for mammals, reptiles and amphibians	0	0	0	3	3	2	2	2	2	2	3	2	0	0	2
6. Reference to sources used for fauna identification	2	3	2	3	3	2	3	3	3	3	3	3	3	3	3
7 Assessment of the field data, within an ecological context	0	2	2	3	2	2	2	1	2	2	2	3	0	0	3
8. Identification of personnel that carried out the field survey , and data analysis and interpretation	0	0	0	2	2	0	0	3	3	3	3	3	3	0	3
Sub-total	**9**	**15**	**14**	**23**	**18**	**16**	**18**	**18**	**19**	**18**	**16**	**20**	**13**	**9**	**23**
Data validity cruteria															
1. Species lists conforming with current WAM nomenclature	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Verification by WAM (via voucher specimens): All trap deaths submitted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Verification by WAM (via voucher specimens) where there may be some doubt, confusion or potential for incorrect identification	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0
Sub-total	**0**	**0**	**0**	**3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
GRAND TOTAL	**19**	**29**	**34**	**51**	**36**	**37**	**36**	**31**	**32**	**34**	**30**	**35**	**28**	**24**	**41**