A critical evaluation of the quality of biodiversity inputs to Environmental Impact Assessments in areas with high biodiversity value- experience from the Cape Floristic Region

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"*A man can receive nothing unless it has been given to him from heaven*"
John 3:27

Table of contents

List of figures

List of tables

Abstract

Key terms:

Biodiversity-inclusive EIA, Biodiversity Impact Assessment (BIA), BIA review package, Cape Floristic Region (CFR), Environmental Impact Assessment (EIA), EIA review.

Biodiversity considerations form an essential component of Environmental Impact Assessment (EIA), especially in areas with both a high biodiversity value and development pressure such as the Cape Floristic Region (CFR) in South Africa. Limited research has been conducted within the South African context on the quality of biodiversity inputs to EIA. The aim of this research was to evaluate the quality of biodiversity input to EIA in the CFR. To address this aim, a customised review package was generated to evaluate the quality of 26 Biodiversity Impact Assessment (BIA) reports in the CFR. The results were then compared with international trends of biodiversity input to EIA in order to show how prevalent such trends are within an area with high biodiversity value. This comparison showed that the quality of biodiversity input to EIA in the CFR generally concur with inadequacies identified in international EIA literature. Typically, significant weaknesses identified during the review were the lack of public participation and an insufficient evaluation of alternatives. Specialists also failed to develop adequate monitoring programmes. Furthermore, a very pertinent limitation was that, in general, assessments are conducted during inappropriate seasons and over insufficient time periods. However, some variations to the international trends are also present within the Region. For example, a particular strength was that a precautionary approach was adopted by most of the specialists to avoid negative impacts on biodiversity. In addition, specialists did not merely focus on lower levels (species and habitats) of biodiversity, but incorporated ecological processes in assessment techniques. The inadequacies identified in this dissertation pose particular challenges for biodiversity management and conservation practices. The development and implementation of mechanisms such as Best Practice Guidelines and improved biodiversity related legislation is proposed to improve biodiversity input to EIA.

Opsomming

Sleutelwoorde

Biodiversiteit-insluitende OIB; Biodiversiteitimpakbepaling (BIB); BIB hersieningspakket; Omgewingsimpakbepaling (OIB); OIB hersiening; Kaap Floristiese Streek (KFS)

Biodiversiteit is ongetwyfeld ’n waardevolle komponent van Omgewingsimpakbepaling (OIB), veral in areas waar hoë vlakke van biodiversiteit voorkom en waar ekonomiese ontwikkeling aansienlike druk uitoefen op biologiese hulpbronne, soos waargeneem in die Kaap Floristiese Streek (KFS) van Suid Afrika. Beperkte navorsing was tot hede uitgevoer aangaande die kwaliteit van biodiversiteitsinsette tot die OIB proses binne die Suid Afrikaanse konteks. Die doel van hierdie navorsing was om die kwaliteit van biodiversiteitsinsette tot die OIB proses in die KFS te evalueer. ’n Hersieningspakket was ontwikkel om hierdie doel te bereik deur om die kwaliteit van 26 Biodiversiteitimpakbepaling (BIB) verslae te analiseer, wat saamgestel is deur biodiversiteitsspesialiste, in die KFS. Die resultate was vergelyk met internasionale neigings met betrekking tot biodiversiteitsinsette tot OIB om die vlak te bepaal waartoe sulke neigings binne ’n area met hoë vlakke van biodiversiteit voorkom. Die resultate het getoon dat biodiversiteitsinsette tot die OIB proses in die KFS algemeen die internasionale tekortkominge weerspieël. Publieke deelname word, as voorbeeld, tydens die uitvoering van BIB afgeskeep. Die dataanalise het verder getoon dat alternatiewe van die onderskeie projekte nie doeltreffend geanaliseer is nie en die spesialisverslae het ook beduidende gebrek getoon aan doeltreffende moniteringsprogramme. Die navorsing het verder aangedui dat die uitvoering van BIBs tydens onvanpaste seisoene geskied en genoegsame tyd word nie toegeken vir die studies nie. Die resultate het wel teenstrydighede teenoor die internasionale tekortkominge aangedui. Voorkomingsmaatreëls was byvoorbeeld deur ’n meerderheid van die spesialiste voorgestel om impakte op biodiversiteit te verhoed. Die spesialiste het ook nie slegs gefokus op laer vlakke van biodiversiteit soos spesies en habitatte nie, maar het ook ekologiese prosesse in assesseringstegnieke geïntegreer. Die tekortkominge wat geïdentifiseer is tydens hierdie navorsing toon dat merkwaardige uitdagings in die KFS voorkom vir die effektiewe bestuur en beskerming van biodiversiteit. Die ontwikkeling en implementering van meganismes soos riglyne en verbeterde wetgewing word voorgestel as ’n moontlike metode om hierdie uitdagings te oorkom.

List of acronyms

Acronym	Description
BIA	Biodiversity Impact Assessment
BA	Basic Assessment
CEAA	Canadian Environmental Assessment Agency
CEQ	Council on Environmental Quality
CBD	Convention on Biodiversity
CFR	Cape Floristic Region
EAP	Environmental Assessment Practitioner
ECA	Environment Conservation Act, No. 79 of 1989
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMF	Environmental Management Framework
EMP	Environmental Management Programme
EPA	Environmental Protection Agency
EU	European Union
IA	Impact Assessment
I&APs	Interested and Affected Parties
MPRDA	Minerals and Petroleum Resources Development Act, No. 28 of 2002
NBF	National Biodiversity Framework
NBSAP	National Biodiversity Strategy and Action Plan
NEMA	National Environmental Management Act, No. 107 of 1998
NEM: AQA	National Environmental Management: Air Quality Act, No. 39 of 2004
NEM: BA	National Environmental Management: Biodiversity Act, No 10 of 2004
NEM: WA	National Environmental Management: Waste Act, No. 59 of 2008
NEPA	National Environmental Policy Act of 1969
ToR	Terms of Reference

Preface

This section provides an overview of the dissertation, commencing with a short description of the format that was used, followed by a description of each section.

Format of the dissertation

The article format is used for this dissertation and it is the intention of the researcher to publish the article in a scientific journal, namely Environmental Impact Assessment Review. One article is incorporated in the dissertation, with the title:

- A critical evaluation of the quality of biodiversity inputs to Environmental Impact Assessments in areas with high biodiversity value – experience from the Cape Floristic Region

Due to the unique (stand-alone) nature of the article format, each chapter has a separate bibliography. The referencing style of the above mentioned journal was utilised. To enable the reader to effectively analyse the document, the Biodiversity Impact Assessment (BIA) review package, the abbreviated BIA review package as well as the Guide for Authors for the Journal have been added as appendices. For the sake of reader-friendliness, graphs and tables have been inserted in appropriate places. These elements will be extracted and integrated into the article manuscript for publication purposes. The numbering of the headings of the article manuscript is continuous with relation to the preceding chapters and will be changed prior to publication. Moreover, the descriptions of acronyms will be used once-off and the manuscript will be revised prior to publication.

Chapter division

This dissertation consists of four chapters and a description of each chapter is provided below.

Chapter 1: Introduction

This chapter includes the specific problem at hand and is substantiated by the gaps identified in the international EIA literature. The chapter also stipulates the overarching aim of the research as well as the objectives, which were derived from the gaps identified.

Chapter 2: Literature review

This chapter provides a broad overview of the literature, with specific reference to guidelines and legal requirements for incorporating biodiversity in EIA, which laid the foundation to conduct this research. In addition, this chapter also indicates international weaknesses pertaining to biodiversity input to EIA that were compared with weaknesses identified for the CFR.

Chapter 3: Article manuscript

This chapter comprises of the article manuscript consisting of four sections, commencing with a theoretical background to the research. This is followed by a thorough description of the methodology implemented to achieve the research aim. The results from the review are then presented and compared with international trends to show common denominators and quality trends. Lastly, concluding remarks are provided.

Chapter 4: Conclusion and recommendations

The last chapter provides concluding remarks along with several recommendations to improve biodiversity input to EIA. Finally, recommendations for further research on the topic are provided.

Chapter 1: Introduction

1.1 Problem statement and substantiation

Human-induced impacts ranging from habitat loss, the overexploitation of biological resources, the invasion of alien species and pollution are causing the mass destruction of biological diversity (biodiversity) across the planet (Butchart *et al.*, 2010; Leadley *et al.*, 2010; Miller and Spoolman, 2011). As a response, many countries, including South Africa, have developed tools such as trans-frontier conservation initiatives, new or improved biodiversity related legislation, and different Impact Assessment (IA) mechanisms to combat further biodiversity loss (CBD, 2010). Environmental Impact Assessment (EIA) is globally utilised to identify, predict and evaluate environmental consequences associated with development activities. EIA aims to mitigate negative environmental consequences and enhance positive impacts (Barrow, 2006; Glasson *et al.*, 2005; Morrison-Saunders *et al.*, 2001; Petts, 2009; Wood, 1999).

EIA often requires input, as necessary, from various specialised disciplines, including the study of biodiversity, to provide a scientific basis for the description of baseline environmental conditions, performing impact analysis and the development of mitigation measures (DEAT, 2002; Geneletti, 2002; Treweek, 1999). South Africa is a signatory party of the Convention on Biological Diversity (CBD). Article 14 of the CBD (CBD, 1993) binds signatory parties to enhance the incorporation of biodiversity considerations in EIA, especially for projects with the potential to cause significant impacts on biodiversity. Moreover, biodiversity has become a crucial theme in EIA since the Conference of Parties to the CBD made provision in 2002 for the enhanced incorporation of biodiversity in EIA (CBD, 2002). Biodiversity is therefore internationally regarded as a key element of EIA and should form an integral component thereof.

Biodiversity specialists utilise various techniques to provide input to the EIA process and the adequacy of such input is essential for the sound management and conservation of biodiversity. Biodiversity Impact Assessment (BIA) is a sub-discipline of EIA that is utilised by specialists to identify, quantify and evaluate the potential impacts of a project on biodiversity (Atkinson *et al.*, 2000; Geneletti, 2002; Treweek, 1999). BIA demands an in-depth scientific analysis of potential impacts on biodiversity and should form an integral component of EIA (Brooke, 1998). Hence, measuring the quality of BIA is one method that

can be utilised to evaluate the quality of biodiversity input to EIA. Typically, reviewing the quality of BIA practice can ensure the consistency and reliability of the information captured. In addition, it can be utilised to ensure sound assessment practices and the development of proper mitigation measures (Brownlie, 2005; Keatimilwe and Ashton, 2005). The quality of biodiversity input to EIA is especially pertinent in areas with high biodiversity value and development pressure such as the Cape Floristic Region (CFR) global biodiversity hotspot. Quality review should form an integrated component of BIA practice in the CFR in order to prevent inadequate impact assessment in the Region that may lead to further degradation of the Region's remarkable biodiversity.

Best Practice Guidelines (Brownlie, 2005; De Villiers *et al.*, 2005; Keatimilwe and Ashton, 2005) have been developed by the Western Cape Province (South Africa) to provide a basis to conduct specialist studies, including BIA. The CFR covers a large section of the Western Cape Province and therefore these guidelines are applicable to the Region. These guidelines aim to standardise specialist studies in the Region and to improve the quality thereof. In addition, regulations published under the National Environmental Management Act, No 107 of 1998 (NEMA) (South Africa, 1998) contain requirements for specialist studies that can be employed by specialists as Terms of Reference (ToR) for BIAs. Determining the degree to which these guidelines and legal requirements have been incorporated in BIAs in the CFR can give an indication of the quality of biodiversity input to EIA in the Region.

Even though biodiversity is recognised as a key component of EIA, various inconsistencies and inadequacies still linger internationally within biodiversity-inclusive EIA (Bagri *et al.*, 1997; Beanlands and Duinker, 1983; Brownlie *et al.*, 2005; Brownlie *et al.*, 2006; Gontier *et al.*, 2006; Rajvanshi *et al.*, 2009; Treweek, 1999; Wegner *et al.*, 2005). Some of the prevalent inadequacies include inappropriate seasons and insufficient timeframes in which biodiversity assessments are conducted (Byron *et al.*, 2000; Mandelik *et al.*, 2005; Thompson *et al.*, 1997; Treweek, 1996). Biodiversity specialists, generally, focus on lower levels of biodiversity, neglecting ecosystem processes (Brownlie *et al.*, 2006; Byron *et al.*, 2000; Rouget *et al.*, 2003; Treweek, 1999). Moreover, only cosmetic mitigation measures such as landscaping are generally proposed by biodiversity specialists (Mandelik *et al.*, 2005; Treweek *et al.*, 1993) and monitoring is also neglected in biodiversity-inclusive EIA (Byron *et al.*, 2000; Mandelik *et al.*, 2005; Söderman, 2005; Söderman, 2006; Treweek, 1996; Treweek *et al.*, 1993; Warnken and Buckley, 1998). Comparing these inadequacies with the quality of biodiversity input to EIA in the CFR can give an indication of how prevalent international inadequacies are in an area with high biodiversity value.

Limited research has been conducted within the South African context on the quality of biodiversity input to EIA. An analysis of the relevant literature suggests that a specifically designed review package to evaluate the quality of BIA reports has not yet been developed for the international EIA community or for South Africa specifically. This dissertation will generate a 'customised' review package to determine the quality of a sample BIAs in the CFR. Therefore, answering the question: What is the quality of biodiversity input to EIA in an area with high biodiversity value? Furthermore, the results will be compared with international trends of biodiversity input to EIA. This will show the degree to which international trends are evident in an area with high biodiversity value.

1.2 Research aim and objectives

This dissertation will evaluate the quality of BIA reports in the CFR biodiversity hotspot, with the aim of determining the quality of biodiversity input to EIA processes in an area with high biodiversity value.

To ultimately achieve the outcome of this dissertation, the following objectives need to be accomplished:

- Conduct an investigation of relevant literature to reveal the prevalent international quality trends of biodiversity input to EIA.
- Develop a customised review package to analyse the quality of BIA reports.
- Utilise the review package to perform a quality review of a sample of BIA reports in the CFR.
- Analyse the review results to establish common denominators and compare with international quality trends.
- Where appropriate, formulate recommendations for the improvement of BIA practice.

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Chapter 2: Literature review

This chapter consists of six sections. The first section describes the purpose and evolution of EIA, including a description of relevant South African legislation pertaining to EIA. The second section briefly describes what biodiversity is and the importance thereof, followed by an overview of the biodiversity profile of the CFR. The third section includes a description of the importance of biodiversity input to EIA processes. This section also provides a discussion on guidelines and legislation pertaining to biodiversity input to EIA from an international, national and area (CFR) specific perspective. The fourth section illustrates the importance of reviewing the quality of EIA processes, with specific reference to the importance of reviewing biodiversity input to EIA. The fifth section describes international trends pertaining to the quality of biodiversity input to EIA, indicating prevalent inadequacies identified in the literature review. The last section concludes the chapter with a brief summary of the literature review.

2.1 EIA: purpose and origin

This section provides a background on the purpose and evolution of EIA within the international as well as the South African context. Furthermore, a description of relevant South African legislation pertaining to EIA is provided.

2.1.1 International context for EIA

EIA is a strategic environmental management tool that is internationally utilised to identify, predict, evaluate and communicate potential positive and negative environmental consequences associated with development activities prior to their commencement. EIA strives to combine aspects of planning, analysis and public involvement in order to consider alternative development options, mitigate potential negative environmental impacts, and to enhance potential positive impacts of projects. Moreover, information captured during EIA processes is used to inform decision makers on whether or not projects should proceed from an environmental perspective. The ultimate aim of EIA is to achieve an integrated approach to environmental management and so to create a sustainable basis for development (Glasson *et al.*, 2005; Kidd and Retief, 2009; Morrison-Saunders *et al.*, 2001; Petts, 2009).

EIA was first introduced in the early 1970`s alongside the promulgation of the National Environmental Policy Act of 1969 (NEPA) in the United States (Petts, 2009; Sowman *et al.*, 1995; Wood, 1999). The NEPA was primarily developed as a response to pressure from civil society due to the exposure of environmental issues by research publications such as 'Silent Spring' by Rachel Carsens and increased public awareness of environmental issues (Silveira, 2000). Several other countries, mostly from the western world, followed suit in the 1970s (Kolhoff *et al.*, 2009). During the 1980s the application of EIA became widespread, with numerous countries such as Turkey, Tunisia and all of the European Union (EU) member states implementing EIA for a wide range of projects (Ahmad and Wood, 2002; Arts *et al.*, 2012). The application of EIA spread throughout the world and by 1997 more than a hundred countries had an EIA system in place (Kolhoff *et al.*, 2009). Over 40 years after its initiation, various IA mechanisms are now utilised in all but two countries across the world (Pope *et al.*, 2013).

2.1.2 Evolution of EIA legislation in South Africa

Compared to the trends in more highly developed countries, South African environmental legislation has developed relatively slowly. The first provision for environmental policies came into effect in 1989 with the enactment of the Environment Conservation Act, No. 79 of 1989 (ECA) (South Africa, 1989). However, the establishment and implementation of EIA regulations under the ECA occurred only in 1997. The ECA regulations contained a set of activities which prompted mandatory EIA application for certain projects that triggered these activities (Kidd and Retief, 2009; Sandham *et al.*, 2013). Prior to the enactment of the ECA regulations, EIAs were conducted on a voluntary basis for a few controversial projects (Wood, 1999). The first comprehensive environmental management legislation came into effect in the late 1990s with the promulgation of the NEMA (South Africa, 1998a). The ECA regulations were replaced in 2006 with the promulgation of new regulations under the NEMA, which was a key stepping stone towards a more streamlined EIA system. These regulations were further amended in 2010 with modifications to the EIA system (Sandham *et al.*, 2013).

2.1.3 Legislation governing EIA in South Africa

Since the promulgation of the NEMA, South African environmental legislation has developed tremendously and various pieces of legislation contain provisions for EIA. The NEMA is the main act governing EIA in South Africa, of which Section 24 and the associated regulations

(GN R. 543, 544, 545 & 546) (South Africa, 2010) provide a comprehensive framework for EIA. GN. R. 543 contains general guidelines for the EIA process. Projects that trigger the activities listed in GN. R. 544 must undergo a Basic Assessment (BA) and projects that trigger activities listed in GN. R 545 must undergo Scoping and a Full EIA must be conducted. Furthermore, GN. R.546 contains province specific activities. The triggering of these activities requires a BA to be conducted. In addition, NEMA Section 2 contains a set of generic principles that guide environmental management and EIA in South Africa. Section 28 (1) of NEMA requires a person that causes or may cause significant harm to the environment, including biodiversity, to take reasonable measures to "*minimise or rectify degradation of the environment*," and these measures may include tools to "*investigate, assess and evaluate the impact on the environment*". As discussed below, several other acts other than NEMA also make provision for EIA in South Africa.

Environmental assessments are required when a person triggers a waste management activity(ies) listed in GN. 718 (South Africa, 2008b), published under Section 19 of the National Environmental Management: Waste Act, No. 59 of 2008 (South Africa, 2008a). When triggering these activities, a Waste Management Licence must be obtained and a BA must be conducted for Category A activities, and a full EIA and Scoping are required for Category B activities. The NEMA EIA process must still be followed.

A person is required to apply for an Atmospheric Emission Licence to conduct activities listed in GN. R. 892, published under the National Environmental Management: Air Quality Act, No. 39 of 2004 (South Africa, 2004b) (NEM:AQA). The triggering of activity 5 of GN.R. 545 requires that a Full EIA must be conducted for activities that require a permit or licence in terms of national legislation governing the release of emissions, pollution or effluent. Therefore, a Full EIA and Scoping are required for activities listed in GN. R. 248 (South Africa, 2004b). The same applies for a person that must obtain a Water Use Licence in terms of Section 21 of the National Water Act, No. 36 of 1998 (NWA) (South Africa, 1998b) for the disposal (release) of waste or water containing waste into a water resource.

Additionally, the Minerals and Petroleum Resources Development Act, No. 28 of 2002 (MPRDA) (South Africa, 2002) Section 39 requires a person to conduct an EIA when applying for a mining right or permit. An EIA in terms of the MPRDA must follow a process different from that of the NEMA EIA process. Regulations encapsulated in GN. R. 527 (South Africa, 2004a) stipulate specific requirements for the MPRDA EIA process.

2.2 The value and dynamics of the biodiversity within the CFR

This section describes what biodiversity entails and an explanation will be given of the value of biodiversity. In addition, the biodiversity dynamics of the CFR is indicated in this section.

2.2.1 Biodiversity and its value

Biodiversity is defined as "*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems*" (CBD, 1993). This definition encompasses three levels, or spheres, of biodiversity, including the diversity of genes, species and ecosystems. Genetic diversity provides a basis for evolutionary processes that give origin to diversity of individuals within species and diversity between species. For instance, every individual zebra will have different characteristics due to its distinct genetic make-up and zebras are different from other mammals or amphibians. Ecosystem diversity entails the distinct manners in which species coexist and interact with each other and the abiotic (non-living) environment in which they live (IAIA, 2005; Slootweg, 2009).

Biodiversity provides essential ecological resources (food, building material, medicine etc.) and services (water and air purification, pollination of crops etc.) that people and natural processes depend on for survival. Even though biodiversity plays a vital role in supporting human livelihoods and natural processes (Corvalán *et al.*, 2005; Naumann, 1998; Salafsky and Wollenberg, 2000), impacts precipitated by people, including habitat destruction and overexploitation of biological resources, are causing severe degradation of biodiversity across the planet (Butchart *et al.*, 2010; Leadley *et al.*, 2010; Miller and Spoolman, 2011). Therefore, the protection of biodiversity plays an essential role in sustainable development, which is the intended outcome of EIA.

2.2.2 Biodiversity dynamics of the CFR

The CFR contains a remarkable diversity of endemic faunal (animal) and floral (plant) species and is globally listed as a Centre of Plant Diversity, an Endemic Bird Area and a Global 200 Ecoregion (Cowling *et al.*, 2003). Olson *et al.* (2001: 933) define an ecoregion as "*a relatively large unit of land or water containing a characteristic set of natural communities*

that share a large majority of their species, dynamics, and environmental conditions". The Global 200 Ecoregions were selected due to their unique biodiversity as well as severe development pressure. Furthermore, the CFR hosts 1406 Red Data Book plant species and is known as one of the highest concentrations of such species in the world (Cowling *et al.*, 2003).

According to Myers *et al.* (2000), a Global Biodiversity Hotspot is an area that contains 1500 or 0.5% of the 300 000 plant species on the planet. The CFR contains an estimated 9030 plant species (3% of the world's total plant species), of which 68.7% are endemic to the region (Goldblatt and Manning, 2002). For this reason, the CFR is globally recognised as a Biodiversity Hotspot and is a designated World Heritage Site (UNESCO, 2004). The CFR also provides invaluable ecosystem goods and services (Brownlie, 2005). For example, the Region is a centre of endemism for bees and provides a habitat for high concentrations of other pollinating insect species (Turner, 2012) which performs a vital function in crop production.

Human activities and associated impacts, ranging from unsustainable agricultural practices, urbanisation and the invasion of alien plants, are causing immense devastation of biodiversity within the CFR. Furthermore, approximately 30% (26 367.6 km^2) of the Region has been completely transformed (Rouget et al., 2003). As illustrated in Figure 1, the 2011 South African National Biodiversity Assessment (SANBA) (Driver et al., 2011) rated the Fynbos biome (located in the South-Eastern part of South Africa), which covers a large portion of the CFR, as the most threatened biome in South Africa.

Consequently, it is essential to develop and implement sound biodiversity management practices in the CFR to prevent further degradation of the Region's rich biodiversity. Environmental management tools, including Environmental Management Frameworks (EMF), Environmental Auditing, Action Plans (such as the Cape Nature Action Plan) and EIA can be utilised to combat further degradation of biodiversity within the CFR.

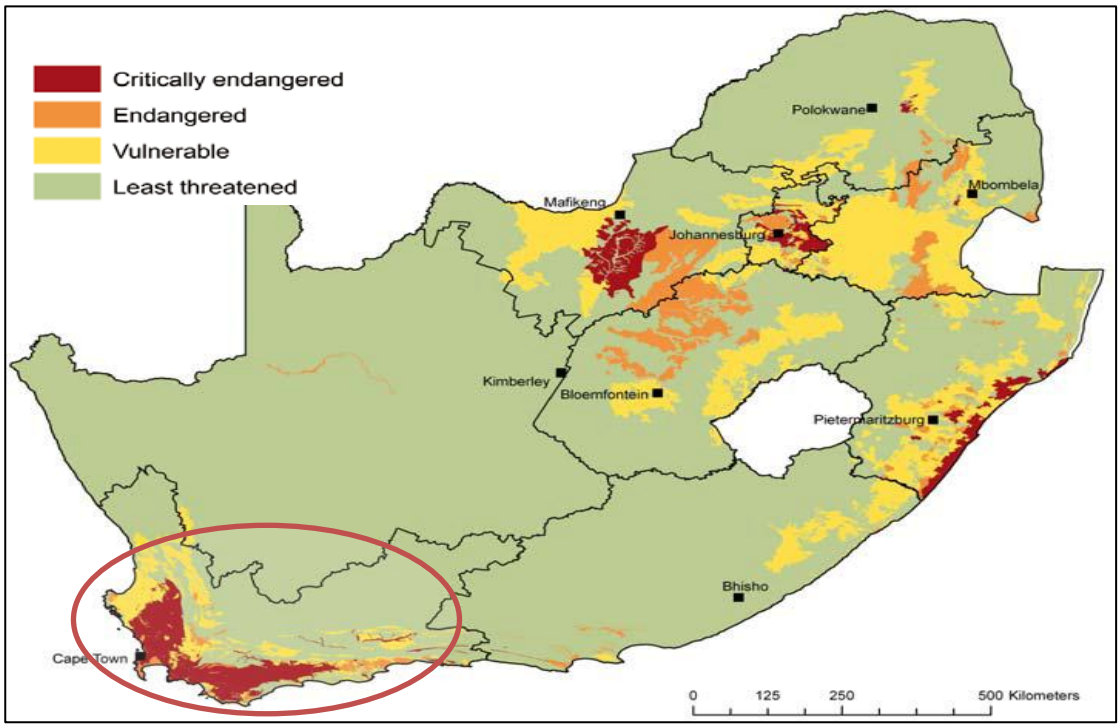

Figure 1: Ecosystem threat status for terrestrial ecosystems in South Africa (Driver *et al.*, 2011)

2.3 Biodiversity specialist input to EIA

EIA is a powerful tool that has the potential to achieve enhanced incorporation of biodiversity considerations in planning and development in order to establish a basis for effective biodiversity management and conservation practices (Rajvanshi *et al.*, 2009). Biodiversity should form an integral component of EIA and not be regarded as a separate, isolated, feature. It should be incorporated into all the stages of an EIA, from pre-application screening through scoping and impact assessment, and also in decision making and monitoring (Brownlie *et al.*, 2006a). This section discusses international as well as South African legislation and guidelines for incorporating biodiversity in EIA.

2.3.1 International legislation and guidelines for incorporating biodiversity in EIA

The development and enactment of legislation play a key role in the effectiveness of management practices implemented to conserve and protect biodiversity. Hence, various international and national legal instruments have been developed to manage human activities that pose threats to the sustainability of biodiversity. The Convention on Biodiversity (CBD) is the main international legislative body governing the management of biodiversity (Algotsson, 2009). The CBD's purpose is to provide a basis for the conservation of biodiversity, the sustainable use of its components and the fair and equitable sharing of

biological resources. Article 14 of the CBD (CBD, 1993) binds signatory parties to "*introduce appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity*". Moreover, biodiversity has become a vital theme in EIA since the Conferences of Parties to the CBD made provision in 2002 for enhanced incorporation of biodiversity in EIA (CBD, 2002).

Other international conventions such as the Convention on Migratory Species and the Ramsar (Wetlands) Convention, to which South Africa is a signatory party, also make provision to include biodiversity as part of EIA. The Ramsar Convention requires signatory parties to employ rigorous EIA practices for activities that may cause adverse impacts on wetlands. Furthermore, the Convention on Migratory Species requires parties to implement appropriate methods to prevent or minimise impacts on migratory species (Rajvanshi *et al.*, 2009).

Various international guidelines have been developed to enhance biodiversity input to EIA. For instance, guidelines published by the European Commission specifically relate to biodiversity and climate change. They recognise the importance and urgency of combatting further biodiversity loss across the globe and in Europe specifically. The main aim of the guidelines is to assist the IA community to better integrate biodiversity and climate change into assessment practices (European Commission, 2013).

In 2002, the Conference of Parties to the CDB endorsed the development of voluntary guidelines for enhanced incorporation of biodiversity in EIA. Consequently, guidelines were published by the CBD in 2006 to guide the signatory parties to effectively and adequately incorporate biodiversity in assessment instruments and procedures (CBD, 2006).

Guidelines published by the International Association for Impact Assessment (IAIA) (Brownlie *et al.*, 2006a) present a framework to improve biodiversity input to EIA and also to provide guidance on how to approach decision making pertaining to biodiversity in EIA. This document aims at capacity building in biodiversity-inclusive EIA in Southern Africa. In 2002, the Conference of Parties to the CDB endorsed the development of voluntary guidelines for enhanced corporation of biodiversity in EIA. Consequently, guidelines were published by the CBD in 2006 to guide signatory parties to effectively and adequately incorporate biodiversity in assessment instruments and procedures (CBD, 2006).

The guidelines also provide a framework for national EIA authorities to improve the incorporation of biodiversity-related considerations during the revision of a country's EIA system.

Other international guidelines for incorporating biodiversity in EIA include but are not limited to guidelines developed by the Council on Environmental Quality (CEQ) and the Environmental Protection Agency (EPA) in the USA, the Canadian Environmental Assessment Agency (CEAA) and the World Bank Commission for Environmental Assessment etc. (Rajvanshi *et al.*, 2009).

2.3.2 South African legislation and guidelines for incorporating biodiversity in EIA

South Africa has developed legislation to incorporate biodiversity in EIA. Regulation 32 of GN R. 543 (South Africa, 2010), published under NEMA Section 24, contains requirements for specialist studies, including descriptions of assessment methodologies, mitigation measures, findings made during the studies etc. These regulations can, therefore, be used as a basis for the ToR for biodiversity assessments, conducted as part of the EIA process. BIA is utilised by specialists to provide insight into the potential impacts on biodiversity that may arise from a development activity. In addition, BIA is implemented to prescribe mitigation measures and formulate monitoring programmes to manage potential biodiversity impacts (Atkinson *et al.*, 2000; Geneletti, 2002; Treweek, 1999). The extent to which specialists have incorporated the requirements of GN R. 543 in BIA may give a degree of legal compliance in BIA practice.

South Africa, as a signatory party to the CBD, has developed a National Biodiversity Framework (NBF) (South Africa, 2009) and the National Biodiversity Strategy and Action Plan (NBSAP) (DEAT, 2005). These documents have been developed as a response to the CBD's requirement for the enhanced incorporation of biodiversity in EIA. Priority action 3 of the NBF makes specific provision for the development of ecosystem guidelines and generic ToR for biodiversity specialist studies in EIA. In addition, Activity 1.4.7 of the NBSAP motivates for enhanced integration of biodiversity considerations in EIA. Province-specific guidelines have been developed by the Gauteng Province to provide assistance with the incorporation of biodiversity in EIA (GDARD, 2012).

2.3.3 Guidelines for incorporating biodiversity in EIA in the CFR

As already stated, the CFR contains biodiversity of international significance, but the Region's rich fauna and flora is under tremendous pressure from human activities. The National Environmental Management: Biodiversity Act, No. 10 of 2004 (South Africa, 2004c) Section 4 binds provincial governments to implement measures to manage, conserve and sustain South Africa's biodiversity. The CFR covers a large portion of the Western Cape Province and the provincial government is therefore obliged to protect the biodiversity within the Region. Consequently, the Province has developed various tools to combat the loss of biodiversity. Some of these tools include recently developed provincial legislation, such as the Western Cape Biosphere Reserves Act, No. 6 of 2011(Western Cape, 2011), reporting mechanisms such as the Western Cape Province State of Biodiversity Report (Turner, 2012), EMFs, Nature Reserves (47 reserves under CapeNature), action plans etc.

Furthermore, the Western Cape Province has developed a series of Best Practice Guidelines to improve the efficiency, effectiveness and quality of specialist, including biodiversity, input to EIA processes. These guidelines aim to improve the capacity of EIA role players such as Environmental Assessment Practitioners (EAPs), Specialists, Authorities etc. to adequately incorporate specialised fields such as biodiversity in EIA and decision making, taking into account the timing, scope and quality of specialist input (Münster, 2005). Guidelines from this series, specifically related to biodiversity, include the following:

- Guideline for the review of specialist input in EIA processes – hereinafter referred to as Specialist Review Guidelines (Keatimilwe and Ashton, 2005); and
- Guideline for involving biodiversity specialists in EIA processes – hereinafter referred to as Biodiversity Inclusive EIA Guidelines (Brownlie, 2005).

In addition, De Villiers *et al.* (2005) recognised the urgency of the need to protect biodiversity within the CFR and developed guidelines to assist EIA stakeholders to incorporate biodiversity in EIA, with specific reference to the unique ecosystems contained in the CFR. These guidelines aim to incorporate the functionality and value of ecosystems in EIA and environmental decision making.

These guidelines provide an adequate basis to assess the degree to which best practice has been incorporated into BIA practice in the CFR.

2.4 Quality review of biodiversity input to EIA

In order to provide a background on quality review, this section commences with a description of the purpose of incorporating quality review in EIA, in general, and follows that with a description of the preferred method of EIA review. Subsequently, the purpose of reviewing biodiversity input to EIA is provided with a description of essential generic factors that should be taken into account when developing a BIA review package. This provides a platform for the actual development of the BIA review package that was generated to analyse the quality of a sample BIA reports CFR (see Chapter 3).

2.4.1 Purpose and preferred method of EIA review

Examining the effectiveness of EIA is an essential step in ascertaining the legitimacy and credibility of environmental decisions that are based on information captured during EIA processes. An Environmental Impact Report (EIR) contains relevant information on which decisions are based and the quality thereof reflects the effectiveness of EIA. During quality review, the content of EIRs is scrutinised with reference to certain predetermined review criteria. Quality reviews are, therefore, conducted to indicate the validity and effectiveness of an EIA and to determine the degree to which EIA objectives have been accomplished (Badr *et al.*, 2011; DEAT, 2004; Peterson, 2010; Sandham and Pretorius, 2008).

Review packages are commonly used within international EIA literature to assess the adequacy and quality of information captured in EIRs. During the application of a review package, the content of an EIR is scrutinised with reference to a set of criteria to evaluate the adequacy of information captured. A rating scale is used to determine the degree to which the information conforms to the criteria (Canelas *et al.*, 2005; Cashmore *et al.*, 2002; Sandham *et al.*, 2013). Although various EIA review packages exist, the most commonly applied package is the so-called Lee and Colley EIA review package. This package was originally developed to evaluate the quality of EIRs in the United Kingdom (Lee *et al.*, 1999). However, its application has spread to numerous countries across the globe, including South Africa. Its wide application may be ascribed to the practical and systematic approach prescribed to evaluate the quality of EIRs (Sandham *et al*., 2013). As described in the Article Manuscript (Chapter 3), the procedural methodology proposed by Lee and Colley will be utilised during this dissertation to evaluate the quality of biodiversity input into EIA in the CFR.

2.4.2 Review of biodiversity input to EIA in the CFR

The review of specialist studies, including biodiversity assessments, forms an essential component of EIA and serves several purposes for various EIA role-players, including the proponent, EAPs, Interested and Affected Parties (I&APs) etc. Typically, reviews are conducted to ensure the consistency and reliability of the information captured in order to enhance the legitimacy of environmental decisions. Furthermore, reviews are utilised to ensure that specialists have the relevant experience and qualifications necessary to conduct the respective specialist studies. Reviews also provide an indication of whether key issues or impacts have been adequately assessed and whether reasonable alternatives have been properly considered. In addition, reviews provide an indication of the adequacy and practicability of the proposed mitigation measures and monitoring programmes (Brownlie, 2005; Keatimilwe and Ashton, 2005).

Specialists focusing on biodiversity provide an invaluable scientific basis for EIA processes. They utilise specialised techniques such as BIA to assess potential impacts on biodiversity and to formulate mitigation measures and monitoring programmes to manage impacts on biodiversity (Brownlie, 2005; Geneletti, 2002). Hence, biodiversity has an obvious role in EIA and the adequacy of such input is especially pertinent in areas with high biodiversity value and severe development pressure such as the CFR.

An analysis of the relevant literature suggests that a specifically designed review package to evaluate the quality of BIA reports has not yet been developed for the international EIA community or for South Africa specifically. This shows that a particular gap exists and it is essential to develop a review package to evaluate the quality of BIAs.

The UNEP (2002) presents generic criteria for the development of review packages, including i.e. the legal requirements, the applicable environmental guidelines or criteria, and specific environmental impacts. Therefore, prior to the development of a BIA review package for a specific area, the unique biodiversity dynamics and legal requirements as well as the Best Practice Guidelines for the particular area should be taken into account. For this reason, the Western Cape Biodiversity Inclusive EIA Guidelines (Brownlie, 2005) and Specialist Review Guidelines (Keatimilwe and Ashton, 2005), as well as the NEMA legal requirements for specialist reports should be incorporated into the development of a “custom” BIA review package for the CFR. Employing this “custom” package to conduct a review of BIA practice in the CFR could provide an indication of the quality of biodiversity

input into EIA in an area with high biodiversity value. Refer to Annexure A for the complete "custom" BIA review package developed for the purpose of this dissertation to review the quality of biodiversity input into EIA in the CFR.

2.5 International trends of biodiversity input into EIA

As already mentioned, biodiversity is recognised as a key component of EIA, yet various inconsistencies and inadequacies remain internationally within biodiversity-inclusive EIA (Bagri *et al.*, 1997; Beanlands and Duinker, 1983; Brownlie *et al.*, 2005; Brownlie *et al.*, 2006b; Gontier *et al.*, 2006; Rajvanshi *et al.*, 2009; Treweek, 1999; Wegner *et al.*, 2005). International research studies, generally, focus on the quality of biodiversity considerations in EIRs, employing review packages or checklists to analyse the quality of biodiversity considerations in such reports. An investigation of these studies indicated that various recurring inadequacies, as discussed below, prevail within the international EIA arena.

2.5.1 Seasons and time frames for biodiversity assessments

A prevalent finding among several researchers (Byron *et al.*, 2000; Mandelik *et al.*, 2005; Thompson *et al.*, 1997; Treweek, 1996) is that biodiversity assessments are conducted over insufficient time periods and during inappropriate seasons. The authors indicate that the on-site biodiversity cannot be accurately determined when assessments occur in inappropriate seasons and when insufficient time is allocated for assessment. For instance, Mandelik *et al.* (2005) found that only 21% of the biodiversity surveys he analysed were performed during Spring, when the majority of plant species can be identified. Furthermore, he found that 42% of the surveys failed to specify the timing of the survey and 36% of the specialists performed surveys at suboptimal or inappropriate times. This may lead to an inaccurate representation of actual on-site biodiversity and an incorrect assessment of potential impacts on biodiversity.

2.5.2 Description of projects and sub-processes

Several authors (Byron *et al.*, 2000; Thompson *et al.*, 1997; Treweek, 1996) have found that biodiversity-inclusive EIA fail to adequately describe projects, especially with regards to sub-processes such as waste generation or effluent discharge. Moreover, the assessments fail to describe the activities that are likely to cause biodiversity impacts, and they also neglect to

provide the life-cycle duration of the respective projects. A thorough description of activities and sub-processes is necessary to establish a clear understanding of potential biodiversity impacts that may arise from a development (Slootweg *et al.*, 2006).

2.5.3 Ecosystem approach

Increasingly EIA literature emphasises the importance of shifting biodiversity assessments away from merely assessing impacts on species or habitats. Researchers urge biodiversity specialists to employ an ecosystem approach to evaluate on-site biodiversity and to assess potential impacts on biodiversity. This approach entails the assessment of potential impacts on biodiversity at ecosystem level, including impacts on ecological processes and products (IAIA, 2005; Slootweg, 2005). Although an ecosystem approach is the ideal method of assessing potential impacts on biodiversity, assessments have a tendency to focus on lower levels of biodiversity, including species or habitats, neglecting impacts on ecological processes (Brownlie *et al.*, 2006b; Byron *et al.*, 2000; Rouget *et al.*, 2003; Treweek, 1999).

2.5.4 Thresholds of significance

Environmental or ecological thresholds are points or zones at which human-related activities can cause relatively rapid change in the ecological condition of a specific area. Thresholds are unique to a specific area and certain ecosystems have the capacity to absorb more change than others. Thresholds are important to accurately evaluate the significance of biodiversity impacts, especially in areas with unique biodiversity and associated resilience to absorb or adapt to potential changes (Groffman *et al.*, 2006; Huggett, 2005). Various authors have found that environmental thresholds are generally not incorporated into EIA to assess the significance of impacts on biodiversity (Cooper and Sheate, 2002; De Villiers *et al.*, 2008; Slootweg, 2005; Warnken and Buckley, 1998).

2.5.5 Mitigation measures and monitoring

Mitigation measures are prescribed to avoid, reduce or remedy environmental consequences (Glasson *et al.*, 2005; Treweek, 1999) and environmental legislation, including NEMA, makes provision to include such measures in EIA. Several studies (Byron *et al.*, 2000; Söderman, 2006; Treweek, 1996) have found that mitigation measures are generally prescribed in biodiversity assessments. However, it was identified that such

measures are vague and incomprehensive. Furthermore, Treweek (1999) found that proposed mitigation measures at times do not correlate with the impacts identified, which might lead to serious biodiversity impacts being left unmitigated.

Monitoring is an essential component of biodiversity assessments and performs the following fundamental functions (Byron *et al.*, 2000; Treweek, 1999):

- It provides a scientific basis for impact assessments by establishing the current status of biodiversity and by describing the baseline conditions of the respective study areas.
- Monitoring is also essential for maintaining and improving the effectiveness of BIAs. It is vital to monitor impacts on biodiversity in order to evaluate the validity of impact predictions and also to determine the effectiveness of mitigation measures.

Although monitoring plays a vital role in the success of biodiversity-inclusive EIA (Beanlands and Duinker, 1983; Treweek, 1999), a severe lack of adequate monitoring of biodiversity attributes exists in BIA practice (Byron *et al.*, 2000; Mandelik *et al.*, 2005; Söderman, 2005; Söderman, 2006; Treweek, 1996; Treweek *et al.*, 1993; Warnken and Buckley, 1998).

The above discussion clearly shows that prevalent inadequacies exist, internationally, within biodiversity-inclusive EIA and pose significant threats to biodiversity. Comparing these international trends with the quality of biodiversity input to EIA in the CFR can show the particular strengths and weaknesses of biodiversity-inclusive EIA in an area with high biodiversity value.

2.6 Conclusion

The purpose of this chapter was to provide an overview of the purpose of EIA and the importance of reviewing EIA processes, especially in terms of reviewing biodiversity input to EIA. Generic factors that should be utilised to assess the quality of biodiversity input to EIA were also discussed on an international, national and area (CFR) specific level. The chapter also focused on international trends in the quality of biodiversity input to EIA. This provides a firm basis to evaluate the quality of biodiversity input into EIA in the CFR and also enables the comparison of the results with international trends pertaining to biodiversity input into EIA.

The following conclusion was derived from the literature review: EIA is widely utilised to assess impacts on biodiversity arising from development activities. It aims to minimise potential negative impacts and enhance positive impacts associated with such activities (Rajvanshi *et al.*, 2009). Consequently, inadequate biodiversity input into EIA may lead to a significant loss of biodiversity and contribute to the international decline in biological resources. Assessing the quality of the biodiversity input into EIA is therefore essential to ensure the consistent quality of such input and to avoid adverse impacts on biodiversity due to poor BIA practices (Brownlie, 2005). According to the (UNEP, 2002) important factors that should be considered prior to the assessment of biodiversity input to EIA include legal requirements, Best Practice Guidelines and area-specific biodiversity dynamics. Incorporating these factors into EIA practice could provide a measure of consistency of biodiversity input and ensure the legitimacy of information capture. These factors were, therefore, incorporated as criteria to develop a custom review package (see article manuscript) to evaluate biodiversity input into EIA in the CFR.

Common inadequacies identified in the international EIA literature pertaining to biodiversity input into EIA include poor project descriptions (Byron *et al.*, 2000; Thompson *et al.*, 1997; Treweek, 1996), incorrect seasons in which assessments are conducted (Byron *et al.*, 2000; Mandelik *et al.*, 2005; Thompson *et al.*, 1997; Treweek, 1996), and under-utilisation of environmental thresholds to assess impacts on biodiversity (Cooper and Sheate, 2002; De Villiers *et al.*, 2008; Slootweg, 2005; Warnken and Buckley, 1998). Moreover, specialists tend to focus on lower levels of biodiversity (Brownlie *et al.*, 2006b; Byron *et al.*, 2000; Rouget *et al.*, 2003; Treweek, 1999), neglecting impacts on ecosystem processes, and monitoring is also severely neglected in biodiversity-inclusive EIA (Byron *et al.*, 2000; Mandelik *et al.*, 2005; Söderman, 2005; Söderman, 2006; Treweek, 1996; Treweek *et al.*, 1993; Warnken and Buckley, 1998). The CFR provides an excellent case example to evaluate the quality of biodiversity input to EIA in an area with remarkable biodiversity and tremendous development pressure. Comparing the international trends of biodiversity input into EIA with the quality of such input in the CFR could serve to indicate how prevalent international trends are in an area with high biodiversity value. This comparison will also be conducted in Chapter 3 (article manuscript).

2.7 References

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Chapter 3: Article manuscript

A critical evaluation of the quality of biodiversity inputs to Environmental Impact Assessments in areas with high biodiversity value – experience from the Cape Floristic Region

Journal for publication

It is the intention of the researcher to publish the article in a scientific journal, namely Environmental Impact Assessment Review.

Guide for Authors

Please refer to Appendix C for the guide for authors as prescribed by the Journal Committee

Cover page

Title

A critical evaluation of the quality of biodiversity inputs to Environmental Impact Assessments in areas with high biodiversity value – experience from the Cape Floristic Region

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Title page

A critical evaluation of the quality of biodiversity inputs to Environmental Impact Assessments in areas with high biodiversity value – experience from the Cape Floristic Region

Abstract

BIA could potentially make an essential contribution to EIA, especially in areas with high biodiversity value and development pressure such as the CFR biodiversity hotspot in South Africa. Therefore, measuring the quality of BIA is one method that can be utilised to evaluate the quality of biodiversity input to EIA. A customised review package was designed to evaluate the quality of 26 BIA reports in the CFR in order to gauge the quality of biodiversity input to EIA in an area with high biodiversity value. Lee and Colley's hierarchical approach was applied to determine the degree to which the reports conformed to the criteria of the review package. In addition, the results were compared with international trends. This comparison indicated that international inadequacies related to biodiversity input to EIA generally support the results of the review. Typically, biodiversity specialists neglected to adequately consider alternatives and failed to incorporate public consultation in the BIAs. Specialists also failed to develop adequate monitoring programmes. Furthermore a very pertinent limitation was that, in general, assessments are conducted during inappropriate seasons and over insufficient time periods. On the other hand, deviations from international trends are present in the CFR. This was evident in the incorporation of ecosystem services in the BIAs, not merely focusing on lower levels of biodiversity only. Moreover, the specialists followed a precautionary approach to prevent impacts on biodiversity, contradicting international trends.

Key terms:

Biodiversity-inclusive EIA, Biodiversity Impact Assessment (BIA), BIA review package, Cape Floristic Region (CFR), Environmental Impact Assessment (EIA), EIA review.

3.1 Introduction

EIA is globally utilised to identify, predict and evaluate environmental consequences associated with development activities (Barrow, 2006; Glasson *et al.*, 2005; Morrison-Saunders *et al.*, 2001; Petts, 2009). Biodiversity considerations have long been recognised as a key component of EIA, yet various inconsistencies and inadequacies still linger within biodiversity-inclusive EIA (Bagri *et al.*, 1997; Beanlands and Duinker, 1983; Brownlie *et al.*, 2005; Brownlie *et al.*, 2006; Gontier *et al.*, 2006; Rajvanshi *et al.*, 2009; Treweek, 1999; Wegner *et al.*, 2005). The aim of this paper is to evaluate the quality of biodiversity input to EIA in an area with high biodiversity value, in this instance the CFR of South Africa.

The CFR is a globally recognised Biodiversity Hotspot, which provides habitat for a remarkable array of biodiversity, including 6 200 endemic plant species (Goldblatt and Manning, 2002). However, the Region's biodiversity is threatened by unsustainable agricultural practices, urbanisation and the invasion of alien plants (Rouget *et al.*, 2003). Similarly, current international trends in biodiversity decline are mainly due to habitat loss, over exploitation of biological resources, climate change, invasive alien species and pollution (Butchart *et al.*, 2010; CBD, 2010; Corvalán *et al.*, 2005; Miller and Spoolman, 2011). As a response many countries, including South Africa, have developed tools such as trans-frontier conservation initiatives, new or improved biodiversity related legislation, and different IA mechanisms such as BIA to combat further biodiversity loss (CBD, 2010).

BIA is the process of identifying, quantifying and evaluating the potential impacts of a project on biodiversity (Atkinson *et al.*, 2000; Treweek, 1999). BIA demands an in-depth scientific analysis of potential impacts of development projects on biodiversity and should form an integral component of EIA and not be regarded as a separate, parallel entity (Brooke, 1998). BIA also provides an essential scientific basis for biodiversity input to EIA processes (Treweek, 1999). Consequently, the adequacy and quality of a BIA report is an important measure to gauge the effective consideration of biodiversity in EIA.

An investigation of international EIA literature indicated that various recurring weaknesses are prevalent within biodiversity-inclusive EIA. Typically, baseline studies are conducted over insufficient time periods and in inappropriate seasons, and BIA reports contain inadequate descriptions of projects and their associated activities (Byron *et al.*, 2000; Thompson *et al.*, 1997; Treweek, 1996). Moreover, assessments tend to focus on lower levels of biodiversity, including species or habitats, neglecting the potential impacts on

ecological processes (Brownlie *et al.*, 2006; Byron *et al.*, 2000; Rouget *et al.*, 2003; Treweek, 1999).

Another weakness seems to be that biodiversity impact significance thresholds are generally not incorporated in EIA (Cooper and Sheate, 2002; De Villiers *et al.*, 2008; Slootweg, 2005; Warnken and Buckley, 1998). Although mitigation measures are generally included in biodiversity assessments, they are framed too vaguely (Byron *et al.*, 2000; Söderman, 2006; Treweek, 1996). Monitoring is another vital aspect of BIA (Beanlands and Duinker, 1983; Treweek, 1999), but indications are that there is a severe lack of monitoring of biodiversity attributes in EIA (Byron *et al.*, 2000; Mandelik *et al.*, 2005; Söderman, 2005; Söderman, 2006; Treweek, 1996; Treweek *et al.*, 1993; Warnken and Buckley, 1998).

In order to provide the reader with a context-specific understanding of the particular study area, the next section provides a brief overview of biodiversity inputs into EIA specifically within the CFR of the Western Cape, South Africa. This is followed by a description of the methodology of the research, after which the results are presented. The paper concludes with a discussion of overall trends and recommendations for improving the quality of biodiversity inputs into EIA.

3.2 Biodiversity input to EIA in the Cape Floristic Region

Various international guidelines have been developed to enhance biodiversity input into EIA, which include guidelines published by the Council on Environmental Quality (CEQ) and Environmental Protection Agency (EPA) in the USA, the Canadian Environmental Assessment Agency (CEAA) and the World Bank Commission for Environmental Assessment etc. (Rajvanshi *et al.*, 2009). However, in areas such as the CFR with biodiversity value of international significance a range of regulatory policy and legislative measures typically applies, which varies from international conventions to national policy and even regional (or provincial) and/or locally specific guideline requirements.

South Africa is a signatory of the Convention of Biological Diversity of which Article 14 (CBD, 1993) binds signatory parties to enhance the incorporation of biodiversity considerations into EIA, especially for projects with the potential to cause significant impacts on biodiversity. As a response, South Africa has developed a National Biodiversity Framework (South Africa, 2009) and the National Biodiversity Strategy and Action Plan (DEAT, 2005), which make

specific provision for the inclusion of biodiversity considerations into EIA. Other international conventions such as the Convention on Migratory Species and the Ramsar (Wetlands) Convention also make provision to include biodiversity as part of EIA (Rajvanshi *et al.*, 2009). Furthermore, the NEMA (South Africa, 1998) makes extensive provision for the involvement of specialists, including biodiversity specialists, in the EIA process. Regulation 31 of GN R. 543 (South Africa, 2010), published under Section 24 of NEMA, stipulates specific requirements for specialist studies and may be used as ToR for biodiversity specialist studies. The extent to which these requirements have been incorporated into BIAs gives a measure of legal compliance and consistency within biodiversity assessment practice.

The CFR covers a large area of the Western Cape Province (Figure 2). In terms of Section 4 of The National Environmental Management: Biodiversity Act, No. 10 of 2004 (South Africa, 2004), the duty to implement measures for the management and conservation of biodiversity within the region is therefore imposed on the Province. Guidelines developed by the Western Cape Province for Involving Biodiversity Specialists in EIA Processes (hereinafter - Biodiversity Inclusive EIA Guidelines) (Brownlie, 2005), and the Review of Specialist Input in the EIA process (hereinafter - Specialist Review Guidelines) (Keatimilwe and Ashton, 2005) provide a more refined basis to evaluate the quality of BIA reports. In accordance with the policy and legislative context, this research has used the Biodiversity Inclusive EIA Guidelines specifically designed for the Western Cape as a basis for the design of the review criteria. The next section describes the methodology followed.

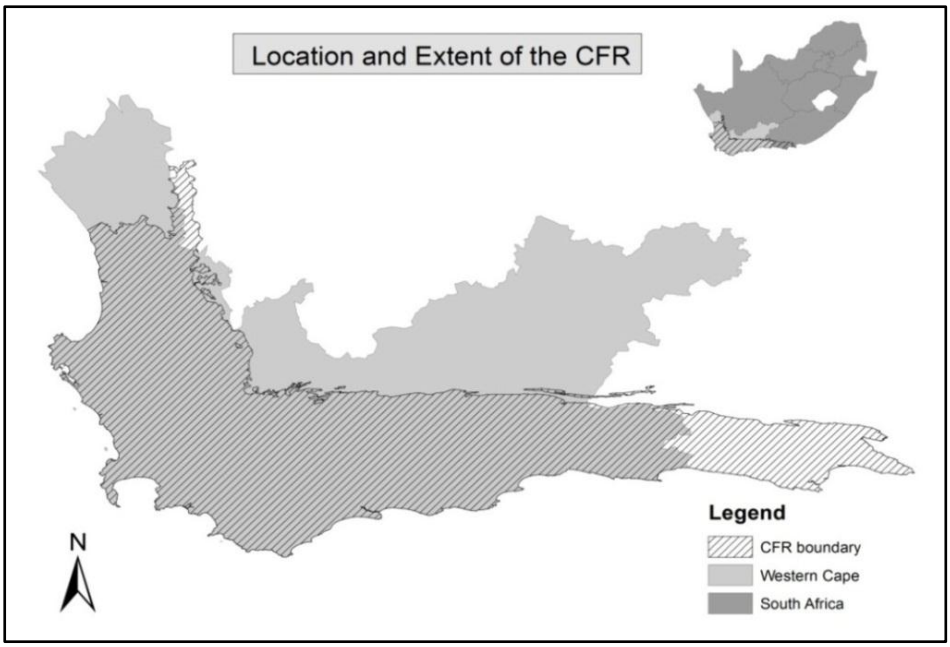

Figure 2: Location and extent of the CFR in South Africa (SANBI, 2000)

3.3 Methodology

The methodology described in this section was used to determine the quality of biodiversity input into the EIA process in the CFR – by evaluating the content of BIA reports. The review of the quality of the reports was conducted on the basis of a quality review package. The criteria were designed within the context of the Western Cape Best Practice Guidelines and general South African legal requirements. The application of purposefully designed review criteria is widely accepted as an appropriate and effective method for quality review (Lee *et al.*, 1999; Peterson, 2010; Sandham *et al.*, 2013).

3.3.1 Selection of the study area

In order to achieve the outcome of this paper, the research required a study area high in biodiversity value. In this regard, the CFR is a globally recognised Biodiversity Hotspot and a designated World Heritage Site, which provides habitat for a remarkable array of biodiversity (UNESCO, 2004). The CFR contains an estimated 9030 plant species, of which 68.7% are endemic to the region (Goldblatt and Manning, 2002), and is known as one of the globe's "*hottest*" floral hotspots (Myers *et al.*, 2000). According to Cowling *et al.* (2003), the region is a centre of endemism for various faunal species, including mammals, freshwater fish and many invertebrate groups. Recent studies have shown that new species are continuously being discovered and greater faunal diversity exists within the CFR, than previously thought (Turner, 2012). The 2011 South African National Biodiversity Assessment (Driver *et al.*, 2011) rated the Fynbos biome, which covers a large portion of the CFR, as the most threatened biome in South Africa. Approximately 30% (26 367.6 km^2) of the CFR has been completely transformed by unsustainable agricultural practices, urbanisation and the invasion of alien plants (Rouget *et al.*, 2003). It is essential to develop and implement sound biodiversity management practices to prevent further degradation.

The CFR was chosen as the study area due to its conservation status and the consequent urgency to implement sound biodiversity management practices in the region. As already stated, Western Cape Best Practice Guidelines (Brownlie, 2005; Keatimilwe and Ashton, 2005) for specialist input into EIA processes also provide a comprehensive basis for evaluating the quality of BIA reports in the region. The CFR provides a good case example to indicate how biodiversity considerations are incorporated into the EIA process in an area with remarkable biodiversity and severe development pressure.

3.3.2 Report selection

A total of 26 BIA reports was randomly selected from seven EIA consultancies operating within the CFR. The sample included diverse types of biodiversity assessments such as avifaunal, bats, botanical, ecological, faunal, fresh water and wetlands as well as different types of development activities such as agricultural, commercial, industrial, recreational, energy and residential. Table 1 provides a summary of the sample selected against the types of assessment and developments. The selection of reports from a range of consultancies, dealing with different types of assessment and for different types of development, strengthened external validity by reducing any bias towards a specific consultancy and/or specific types of assessment or developments.

Table 1: Sample of BIA reports against types of assessment and development

Types and quantities of development activities		**Types of Biodiversity Assessments**						
Development type	**Quantity**	**Avifaunal**	**Bats**	**Botanical**	**Ecological**	**Faunal**	**Fresh water**	**Wetlands**
Agricultural	1						1	
Commercial	1							2
Infrastructure	3	1		2			1	1
Light industrial	1			1				
Recreational	2			1				1
Renewable energy	5	4	4	2	2			
Residential	3			2		1	2	
Total	26	5	4	6	2	1	4	4

3.3.3 Development of the BIA Review Package

Internationally, review packages are commonly used to evaluate the quality of EIRs, employing a set of criteria to evaluate the adequacy of such reports (Canelas *et al.*, 2005; Cashmore *et al.*, 2002; McGrath and Bond, 1997; Peterson, 2010; Sandham *et al.*, 2013). The most commonly applied of these packages is the so-called Lee and Colley EIA review package (Lee *et al.*, 1999), or adapted versions thereof (Badr *et al.*, 2011; Canelas *et al.*, 2005; Peterson, 2010; Sandham *et al.*, 2008a; Sandham and Pretorius, 2008). However, our literature review suggests that although the Lee Colley review package methodology is widely applicable, specifically designed criteria to evaluate the quality of BIA reports have

not yet been developed internationally or for South Africa specifically. For this reason this research applied the Lee Colley review methodology, but had to develop from scratch criteria applicable to BIA. In order to ensure context-specific relevance for South Africa and the CFR the criteria were based on the Specialist Review Guideline (Keatimilwe and Ashton, 2005) and the BIA reporting requirements of the Biodiversity-Inclusive EIA Guideline (Brownlie, 2005) for the Western Cape. The criteria therefore gave an indication of the extent to which local best practice had been incorporated by the particular specialist. At this point it needs to be stated that the context-specific guidelines do include consideration of international best practice and therefore the results of the review do also provide an opportunity to reflect against international standards.

As highlighted in the previous sections, there is also a need to incorporate regulatory compliance in the BIA review criteria. Therefore, legal requirements for specialist studies, as stipulated in GN. R 543 (South Africa, 2010), were also integrated in the review package. Of note is that all of the biodiversity assessments were conducted after the promulgation of the legislative requirements and relevant guidelines.

For the purpose of this research, it was decided to use the qualitative rating scale proposed by the Lee and Colley package, which is used to measure the extent to which report content conforms to the review criteria. The rating scale includes symbols, ranging from A (well done) to F (poorly performed). Detailed descriptions of each symbol are provided in Table 2. Letters are used, instead of numeric values, to discourage crude mathematical evaluation of the content of the report and to enable intuitive assessments of higher levels in the assessment hierarchy (Sandham *et al.*, 2008b).

Table 2: Assessment symbols and descriptions

Symbol	Explanation
A	Generally well performed, no important tasks left incomplete.
B	Generally satisfactory and complete, only minor omissions and inadequacies.
C	Can be considered just satisfactory, despite omissions and/or inadequacies.
D	Parts are satisfactorily; attempted but must, as a whole, be considered just unsatisfactory because of omissions or inadequacies.
E	Not satisfactory, significant omissions or inadequacies.
F	Very unsatisfactory, important task(s) poorly done or not attempted.
N/A	Not applicable. The review topic is not applicable or it is irrelevant in the context of this BIA.

Lee and Colley employ a hierarchical pyramid to evaluate the quality of EIRs. The structure consists of 4 levels, or tiers, of review topics, including overall report assessment, review areas, review categories and sub-categories. The original review checklist structure, extracted from the Specialist Review Guidelines, was comprised of 2 review fields (review areas), 9 review categories and 54 sub-categories. This structure was used similar to that of Lee and Colley. The proposed BIA review structure is comprised of 3 tiers of assessment (see Figure 3), including overall report assessment, 9 review areas and 51 review criteria. A summary of the BIA review areas and criteria is presented in Appendix B.

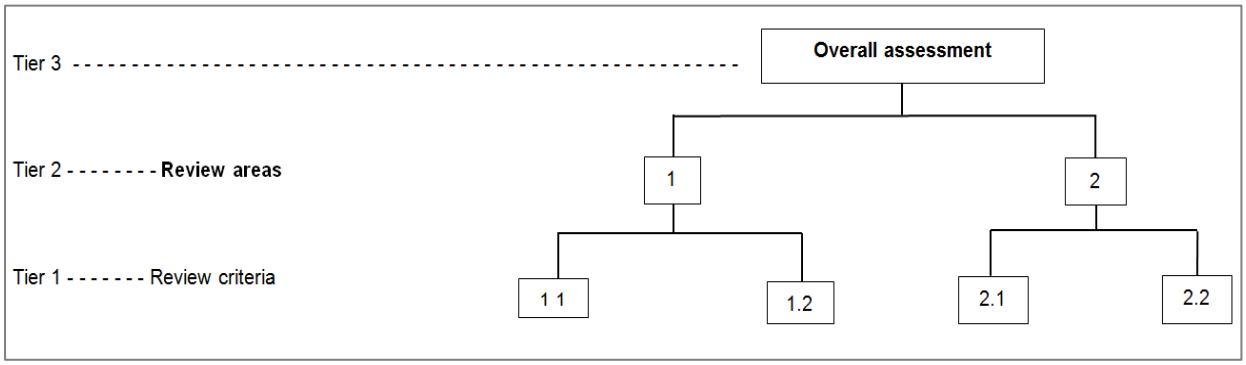

Figure 3: Hierarchical pyramid approach incorporated in BIA review package

The review aimed to determine the degree to which the content of the sample BIA reports conforms to the set of review criteria, indicating how well each task was performed. Each criterion was rated according to a standard set of symbols, ranging from A-F. The assessment results of each of the 3 tiers show, cumulatively, the overall grading of the next tier (see Figure 3). The results derived from the application of the review criteria were used to evaluate the next tier above, namely the review areas, which were then used to rate the overall assessment score of the respective BIA report.

3.4 Results

The results discussed in this section were obtained during the review of the sample BIA reports according to the methodology described in the previous section. Table 3 provides a summary of the results. The results obtained during the review will also be compared in this section with international trends, showing similarities and dissimilarities.

Table 3: Overview of the review results

Summary of review area grades											
Review areas	**Number of symbol scores**						**Percentage of symbol scores**				
	A	B	C	D	E	F	%A-B	%A-C	%C-D	%D-F	%E-F
1. Expertise and professional conduct	12	9	3	2	0	0	81	92	19	8	0
2. Adequacy and sufficiency of information	1	9	13	3	0	0	38	88	62	12	0
3. Clarity and inclusiveness of report	0	14	11	1	0	0	54	96	46	4	0
4. Description of project	1	7	7	10	1	0	31	58	65	42	4
5. Description of baseline environment	12	11	3	0	0	0	88	100	12	0	0
6. Consideration of alternatives	2	5	6	5	4	4	27	50	42	50	31
7. Inclusion of legal aspects	0	1	8	7	6	4	4	35	58	65	38
8. Stakeholder consultation	0	2	1	3	10	10	8	12	15	88	77
9 Prediction and assessment of impacts	0	5	17	3	1	0	19	85	77	15	4
10. Recommended management actions	8	10	1	6	1	0	69	73	27	27	4
11. Monitoring	2	7	7	1	5	4	35	54	31	46	35

3.4.1 Results for the overall quality of the BIA reports

The analysis of the sample BIA reports, as indicated in Table 3 and illustrated in Figure 4, showed that 73% of the reports were graded as satisfactory (A-C), while 27% were graded as not satisfactory (D-F). The analysis also showed that 23% of the reports were graded as well-done (A-B) and none were poorly done (E-F). However, 77% of the reports were boundary cases (C-D), indicating that a significant portion of the sample was just satisfactory or unsatisfactory. The most common grade was C, i.e. just satisfactory, despite omissions and/or inadequacies, followed by D, just unsatisfactory because of omissions or inadequacies. However, the overall quality scores do not tell us much in terms of the specific areas of weakness or strengths. For this we need to consider the scores per review area described in the next section.

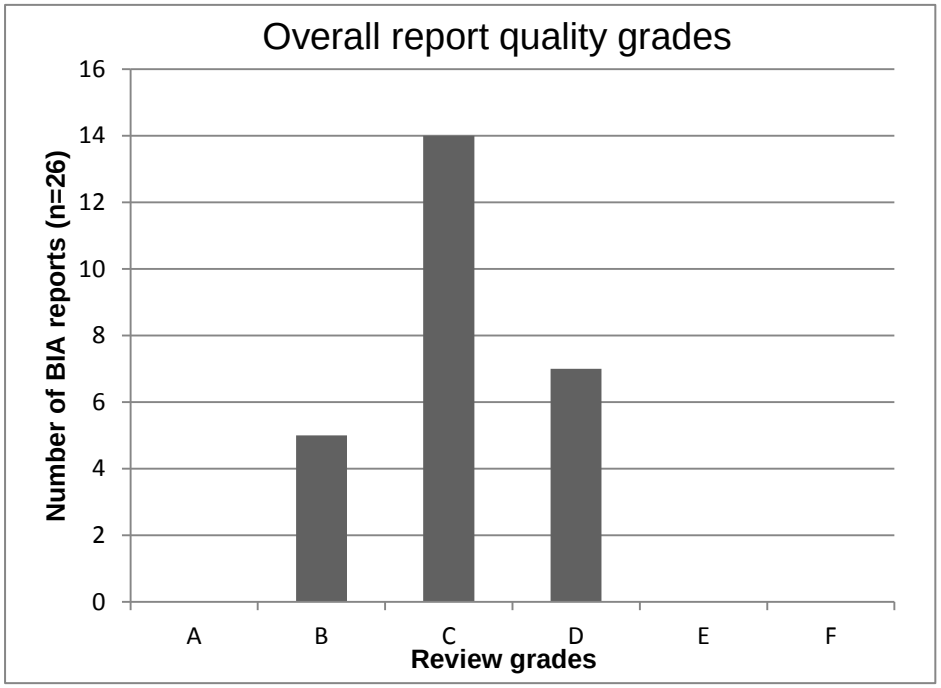

Figure 4: Overall report grades (A - well performed, B – generally satisfactory, C – just satisfactory, D – unsatisfactory, E – poorly attempted and F – did not attempt)

3.4.2 Results for the review areas

A significant portion, more than 80%, of the BIA reports addressed five of the review areas to a satisfactory degree (Table 3), which included review area 1 (expertise and professional conduct), review area 2 (adequacy of information), review area 3 (clarity and inclusiveness), review area 5 (description of baseline environment) and review area 9 (prediction and

assessment of impacts). Between 50% and 70% of the reports were graded as satisfactory for review area 4 (description of the project), review area 6 (consideration of alternatives), review area 10 (recommended management actions) and review area 11 (monitoring). Less than 50% of the reports were graded as satisfactory for review area 7 (inclusion of legal aspects) and review area 8 (public participation).

The discussion below shows the general trend of results pertaining to the review areas. Furthermore, it highlights certain important review criteria under each review area, in which the reports performed well or poorly.

- *Review area 1: Expertise and professional conduct*

The analysis indicated that 81% of the reports performed well in this review area, while 19% were boundary cases and none were poorly done. Most of the BIA reports included comprehensive descriptions of the specialists' qualifications, expertise and experience. Although it is necessary for an ecologist to have a holistic perspective on the natural environment and its components, it is also essential to possess knowledge pertaining to certain biodiversity attributes when conducting a specialised study, i.e. bat impact assessments (Brownlie, 2005). Most of the specialists had significant postgraduate qualifications and applicable experience, indicating that a substantial biodiversity-related knowledge pool exists among people who work within the CFR.

The independence of specialists is considered important to ensure the objectivity of the information captured (Münster, 2005). The requirement of independence is even included in South African law. In this regard most of the studies contained a declaration of independence.

- *Review area 2: Adequacy and sufficiency of information*

The review results indicated that 38% of the reports performed well in this review area, while 68% were boundary cases and none were poorly performed. The inclusion of comprehensive ToR in specialist studies is important to evaluate the degree to which a study has achieved specific objectives (Keatimilwe and Ashton, 2005). Certain studies included a comprehensive ToR, but other studies had vague ToRs or did not include one at all. This

inconsistency concurs with the general notion that poor or non-existent specialist ToRs are a potential weakness in EIA practice (DEAT, 2002; Keatimilwe and Ashton, 2005).

Various authors (Barrow, 2006; Sallenave, 1994; Slootweg, 2009; Stevenson, 1996) have emphasised the importance of incorporating indigenous knowledge in environmental assessments. Only 2 of the biodiversity studies included indigenous knowledge in their assessment techniques, suggesting a particular weakness.

The most frequent gaps in information identified by the specialists were that there was insufficient provision of time to conduct the studies and that they had been conducted at the incorrect time of year to optimally assess the potential impacts. Statements such as "*Early winter is not the ideal time for surveying the vegetation in the designated study area"* (McDonald, 2011: 8) and *"Analysis of the freshwater ecosystems was undertaken at a rapid level and did not involve detailed habitat and biota assessments"* (Belcher, 2012: 4) were common. Due to the legal timeframes set for EIA within the South African context, it is difficult to see any way around this particular weakness.

These patterns strongly correspond with those to be found in international review studies (Byron *et al.*, 2000; Thompson *et al.*, 1997; Treweek, 1996). The researchers revealed that commercial pressure (timing and financial constraints) and the specifications of contractual agreements contribute significantly to inappropriate time allocation for biodiversity assessment.

DEAT (2002: 14) states that "*a prediction of change can only be as effective as the baseline information from which it is derived*". Furthermore, according to Slootweg (2005); Treweek (1999), sufficient time should be allocated for assessments to take seasonal biodiversity features into consideration. An adequate description of baseline conditions is essential for accurate impact prediction and for the consideration of the no-go development option. It should be taken into account that biodiversity and ecosystem processes are dynamic and fluctuations occur continuously. Therefore, once-off surveys are only superficial "*snapshots*" of the reality, generating baseline information only for a specific timeframe (Treweek, 1999). Biodiversity baseline studies should be conducted over longer periods and within appropriate seasons to optimally describe and include average on-site biodiversity baseline conditions.

- *Review area 3: Clarity and inclusiveness of report*

Generally, the sample BIAs performed well in this review area, with 54% of the reports graded as well done (A-B), 46% as boundary cases (C-D), and none performing poorly. Most of the reports contained an adequate non-technical summary of the results. According to Keatimilwe Ashton (2005), the inclusion of a concise non-technical summary enables stakeholders, including decision makers, to fully comprehend specialist studies, and thus enhances environmental decision making. Overall, adequate descriptions of methodologies and sources of information were included in the studies. The specialists frequently utilised government biodiversity databases and guidelines in their methodologies, including i.e. the National Wetlands Inventory (SANBI, 2008), the List of Threatened Terrestrial Ecosystems (South Africa, 2011), the South African National Biodiversity Assessment 2011 (Driver *et al.*, 2011), and the Western Cape Guideline for Involving Biodiversity Specialists in the EIA Processes (Brownlie, 2005). This finding is in contradiction of a study conducted by Mandelik *et al.* (2005) in Israel, which showed a lack of proper referencing in biodiversity-inclusive EIA.

Opinions and statements were adequately justified by most of the specialists. However, there were notable instances where conclusions were not consistent with the discussion in the main body of the report. For example one report states that" *The facility will be spread over an area of about 6 km^2*", "*Sixty-five bird species were seen during the site visit*" and "*Twelve priority species are recognized as key in the assessment of avian impacts*",while the conclusion states "*This is a small facility, proposed for a site with limited intrinsic avian biodiversity value*". It does, therefore, seem that sometimes the conclusions go beyond the reasonable outcomes of the specialist study. This is possibly due to the fact that specialists are required to provide answers to questions that they do not have the data for.

- *Review area 4: Description of the project*

The results showed that 31% of the reports were graded as well done in this review area, while 65% were boundary cases and 4% performed poorly. Most specialists did not provide comprehensive descriptions of the respective projects and associated alternatives. This pattern was especially evident in the lack of a description of project lifecycles and sub-processes, including waste generation, vehicular movement, on-site staff facilities etc. Various international studies (Byron *et al.*, 2000; Thompson *et al.*, 1997; Treweek, 1996; Treweek *et al.*, 1993) have found similar patterns and judge this to be a significant anomaly

in biodiversity-inclusive EIA. This weakness may be ascribed to the fact that EIRs generally provide adequate descriptions of the proposed projects and alternatives. The specialist therefore regards this as duplication.

Slootweg *et al.* (2006) express the need to describe the project itself in biodiversity assessments to enhance the understanding of the potential impacts arising from its development and the related activities. Not providing a description of the project would mean that the reader of the specialist report would need to cross reference the main EIR, which might be a cumbersome task. Another, more important, reason for including the project description is for the specialist to confirm which version of the project s/he used in the study, because the project description has a way of changing over time. Without a clear understanding of the proposed development activities and sub-activities, the potential impacts cannot be accurately predicted.

- *Review area 5: Description of the baseline environment*

The reports performed exceptionally well in this review area, with 88% well done, 12% boundary cases, and none poorly performed. The specialists generally provided comprehensive descriptions of the baseline environment. As previously stated, various specialists indicated that limiting seasonal and time factors can have an influence on the accuracy of the information gathered. Therefore, although the baseline descriptions are comprehensive their accuracy is questionable. Take note that the legitimacy of baseline conditions was not included as a criterion to evaluate this review area, and the timeframes and seasons in which assessments were conducted have therefore not been considered.

- *Review area 6: Consideration of alternatives*

The analysis showed that the reports did not give adequate consideration to this review area, with 27% of the reports performing well, 42% being boundary cases, and 31% poorly attempted. Similar results were obtained by some international studies, which found that inadequate consideration is given to biodiversity attributes in the evaluation and selection of alternatives (Söderman, 2006; Treweek, 1996), whereas another review study, conducted by Mandelik *et al.* (2005), indicated that consideration had been given to biodiversity in the determination of alternatives. Nonetheless, it was not possible for the researchers to

establish whether the final choice of an alternative had been based on biodiversity considerations.

Steinemann (2001: 4) describes alternatives as the "*heart*" of EIA and the quality of decisions depend on the robustness of selection of alternatives to choose from. The consideration of alternatives also ensures that all reasonable approaches to a project have been taken into account and can contribute to preventing harm to the environment (Glasson *et al.*, 2005). Biodiversity studies play an essential role in the consideration of alternatives and should assist in identifying new alternatives suitable to achieving development objectives, whilst promoting sound biodiversity management (Brownlie, 2005). The stand-alone nature of specialist studies might be a contributing factor to the poor performance in this area. The point is that if BIA does not influence thinking about alternatives, especially location, the effect on decision making and ultimately on the production of better outcomes for the EIA is severely limited.

- *Review area 7: Inclusion of legal aspects*

The reports performed poorly in this review area. Only 4% of the reports performed well, receiving A-B ratings, 58% were boundary cases (C-D) and 38% of the reports performed poorly (E-F). These results show that most of the biodiversity specialists did not consider legal provisions in their assessment techniques. Environmental laws, regulations and policies reflect current scientific thinking as well as pertinent environmental issues (Brownlie, 2005). A study conducted by Wegner *et al.* (2005) showed that policies and laws guiding biodiversity in impact assessment are perceived by EAPs to be of the utmost importance for effective EIA practice. South Africa has comprehensive legislation pertaining to biodiversity management (King *et al.*, 2009; Olivier *et al.*, 2009; Rumsey, 2009) and this legal framework should be utilised as a basis to conduct biodiversity assessments. For example, some legislation, including the NEM: BA, makes extensive provision for the management of alien and invasive species and therefore needs to be incorporated in BIA.

- *Review area 8: Public participation*

The analysis showed that this review area was neglected by the specialists, with only 8% of the reports performing well, 15% being boundary cases and 77% performing poorly. This finding concurs with international trends that show a poor consideration of biodiversity

attributes during EIA public participation processes (Söderman, 2006; Thompson et al., 1997).

Social entities are interconnected with biodiversity and the associated ecological processes (De Villiers et al., 2008; Dietz and Stern, 2008; Miller and Spoolman, 2011; Slootweg, 2005). The only way in which biodiversity can be effectively managed is through proper consultation with local communities (Treweek, 1999). The lack of direct reference to community inputs in the BIA reports may be ascribed to specialists that regard public consultation, performed during the EIA process, as sufficient and duplication unnecessary. However, the lack of inputs from the community into the BIA is potentially problematic. This lack of consultation is again a reflection of the perception that the BIA report is separate and parallel to the EIA. Also see discussion around the alternatives in review area 6.

- *Review area 9: Prediction and assessment of impacts*

Most of the reports were graded as boundary cases (C-D) for this review area, indicating that 77% of the sample performed just satisfactorily or not satisfactorily for the prediction and assessment of impacts. Most of the specialists utilised criteria prescribed by GNR 543 (South Africa, 2010) to evaluate the significance of biodiversity impacts. Criteria commonly used included the magnitude, extent, duration and probability of the respective impacts. However, several BIAs neglected to include "*the degree to which impacts can be reversed*" or "*the extent to which the activity can cause irreplaceable loss of biodiversity*" as criteria in the assessment of impact significance.

Another important omission found during the review was a neglect of the inclusion of environmental thresholds in the assessment of impact significance. This corresponds with the findings of international studies, which indicated that environmental thresholds are generally not incorporated in EIA to assess the impacts of development on biodiversity (Cooper and Sheate, 2002; De Villiers *et al.*, 2008; Slootweg, 2005; Warnken and Buckley, 1998). Environmental or ecological thresholds are "*points or zones at which relatively rapid change occurs from one ecological condition to another*" (Huggett, 2005: 302). Thresholds are important to accurately evaluating the significance of environmental impacts.

Internationally, environmental assessments and conservation practices focus on lower levels of biodiversity, including species or habitats, neglecting impacts on ecological processes

(Byron *et al.*, 2000; Rajvanshi *et al.*, 2009; Rouget *et al.*, 2003; Treweek, 1999). This research showed that a trend is emerging in the CFR where biodiversity specialists are increasingly incorporating ecological processes into BIA practice. Most of the specialists not only described such processes but also assessed the potential impacts that could affect ecological processes on- and off-site. Some BIAs also referred to habitat fragmentation as a severe impact on ecological corridors and associated processes, in contrast to the findings of international review studies (Mandelik *et al.*, 2005; Söderman, 2006; Thompson *et al.*, 1997; Treweek *et al.*, 1993), which indicated that a lack of consideration had been given to impacts associated with habitat fragmentation.

"*Animals cannot survive in the absence of ecological processes which sustain them. For this reason, this report may devote as much, or more, attention to habitats and ecological processes as to species of fauna. This can be termed an ecosystem approach*" (Harrison, 2012: 6) and "*The streams as a whole are also regarded as having conservation value from the perspective of their capacity to provide a continual ecological corridor, linking adjacent terrestrial areas of concern" (Day, 2011: 9).*

International studies (Byron *et al.*, 2000; Mandelik *et al.*, 2005) have found that the development of guidelines can significantly improve biodiversity practices in EIA. Mandelik *et al.* (2005: 1260) state that "*improving the standards of ecological guidelines might be the most potent tool in upgrading the quality of ecological impact assessment*". The emerging trend of increasingly including ecological processes in BIA practice can therefore be ascribed to the Western Cape Guidelines developed by De Villiers *et al.* (2005) and Brownlie (2005), which makes extensive provision for the inclusion of such processes in biodiversity studies and EIA in general. This review indicated that 14 of the 26 BIAs made direct reference to the guidelines developed by De Villiers *et al.* (2005) and 9 BIAs made reference to guidelines published by Brownlie (2005). The following statements, amongst several others, were extracted from the sample: "*The methodology follows published guidelines for evaluating potential impacts on the natural vegetation in an area earmarked for some form of development (Brownlie 2005, De Villiers et al., 2005)*" (McDonald, 2011: 4), and "*This report takes cognizance of guidelines in Brownlie (2005) and De Villiers (2005)*" *(Harrison, 2012: 6).*

- *Review area 10: Recommended management actions*

Generally this review area was adequately addressed in the BIA reports, with 69% of the reports performing well (A-B) and 27% being boundary cases (C-D).

Mitigation measures were found by various researchers to have been included in biodiversity assessment practices, but only vague descriptions are provided for such measures (Byron *et al.*, 2000; Söderman, 2006; Treweek, 1999). Some studies also indicated that the proposed mitigation included only management actions such as landscaping, merely addressing cosmetic impacts (Mandelik *et al.*, 2005; Treweek *et al.*, 1993). The comprehensive provision and description of mitigation measures were noted during the review of the samples, however.

A hierarchical approach was not extensively proposed by the specialists for the management of biodiversity impacts. However, most of the specialists did incorporate the precautionary principle as the preferred mitigation option. According to NEMA Section 2, the precautionary principle entails "*that the disturbance of ecosystems and loss of biological diversity are avoided*" and is widely recognised as the best form of mitigation (Tanaka, 2001; Treweek, 1999). In situations where baseline knowledge is limited, this approach can be utilised to compensate for impacts pertaining to potential biodiversity loss as a result of uncertainty (Cooney, 2004; Dickson and Cooney, 2005).

As seen in the following statements, the precautionary principle was generally integrated in assessment techniques:

"*As a precautionary step, it is important that all wetland areas are retained*" (Colloty, 2012: 25), "*The precautionary principle has been applied throughout this investigation*", "*Areas where machinery and vehicles are stored and used must be bunded to prevent pollutants from accidentally entering conservation areas*" (Harrison, 2012: 29), and "*Measures and actions to address negative impacts will favour avoidance and prevention over minimization, mitigation or compensation*" (Kruger, 2012: 19).

- *Review area 11: Monitoring*

The analysis showed that this review area performed poorly, with 34% performing well, 31% being boundary cases and 35% performing poorly. Certain BIAs included comprehensive monitoring programmes, but the general pattern showed that the sample did not adequately address monitoring.

Although the monitoring of biodiversity attributes is a vital aspect of BIA (Beanlands and Duinker, 1983; Treweek, 1999), most of the BIA reports excluded adequate provisions for monitoring. This finding is overwhelmingly evident in the international EIA literature, where studies have indicated a severe lack of monitoring in biodiversity assessments (Byron *et al.*, 2000; Söderman, 2006; Treweek, 1996; Treweek *et al.*, 1993; Warnken and Buckley, 1998).

3.5 Concluding remarks

Biodiversity input to EIA is regarded as key to the success of EIA (Gontier *et al.*, 2006; Rajvanshi *et al.*, 2009), especially in regions with high biodiversity value and development pressure such as the CFR. Several patterns were identified during the research and showed that biodiversity input into EIA in the CFR reflects the inadequacies identified in the international EIA literature. Typically, this research showed that biodiversity assessments are regarded as separate, parallel processes to EIA. This was especially evident in the lack of public consultation and consideration of alternatives. Moreover, in developing countries such as South Africa a lack of institutional capacity exists to properly process EIA applications, especially applications with input from highly technical specialised fields such as the study of biodiversity (Duthie, 2001; El-Fadl and El-Fadel, 2004). Consequently, biodiversity considerations may be neglected in EIA decision making. Another prevailing flaw was that biodiversity assessments are conducted in inappropriate seasons and within inadequate timeframes. This may lead to an inaccurate representation of on-site biodiversity dynamics and poor assessment of potential impacts on biodiversity. Inadequate monitoring of biodiversity has also been identified internationally as a prevailing occurrence in biodiversity inclusive EIA. Similarly, this research showed that comprehensive monitoring is generally not incorporated in biodiversity-inclusive EIA in the CFR.

However, a promising pattern is emerging that biodiversity studies in the CFR are increasingly incorporating ecosystem processes in the description of baseline conditions and

assessment techniques. The increasing application of an ecosystem approach in the CFR may be ascribed to the utilisation of the Best Practice Guidelines developed for the Western Cape Province (Brownlie, 2005; De Villiers *et al.*, 2005). The ecosystem approach is highly recommended internationally and should be regarded as a cornerstone of BIA practice (IAIA, 2005: 56; Rajvanshi *et al.*, 2009; Slootweg, 2005), especially in areas with exceptional ecosystem value such as the CFR.

Furthermore, the analysis indicated that a precautionary approach is widely followed in the CFR for the prescription of mitigation measures. This shows that biodiversity-inclusive EIA in the Region does not merely focus on superficial or cosmetic measures to manage biodiversity impacts, in contradiction of international trends. These findings indicate that biodiversity-inclusive EIA in the CFR has moved beyond the international norms of negligence in terms of addressing ecological processes and adopting a precautionary approach in EIA processes.

This research identified promising patterns with regards to biodiversity input to EIA in the CFR. However, prevalent international inadequacies still linger within the Region and poses significant challenges for the management of biodiversity. To overcome these challenges, it is proposed that mechanisms such as Best Practice Guidelines and improved biodiversity related legislation should be incorporated in biodiversity-inclusive EIA. Other provinces in South Africa could also adopt guidelines similar to those developed for the Western Cape and Gauteng (GDARD, 2012). This study focused on the quality of biodiversity input to the assessment, reporting and quality review stages of EIA. However, to fully comprehend the adequacy of biodiversity input to EIA, such input could also be evaluated in the other stages of EIA.

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Chapter 4: Conclusions and recommendations

The main focus of this dissertation was to analyse the quality of biodiversity input into EIA in an area with high biodiversity value such as the CFR. Furthermore, it aimed to reveal the degree to which international trends of biodiversity input to EIA are evident in such areas. The first aim was achieved by employing a customised review package to evaluate the quality of biodiversity input to EIA in the CFR. The results were compared with prevalent international quality trends of biodiversity-inclusive EIA, therefore, achieving the second aim of this dissertation. This chapter summarises the main findings of the research and provide recommendations to improve the quality of biodiversity input into EIA. Additionally, prospects for further research are also highlighted.

4.1 Concluding remarks

Biodiversity plays a key role in EIA (Gontier *et al.*, 2006; Rajvanshi *et al.*, 2009), especially in areas with high biodiversity value and development pressure such as the CFR. This dissertation showed that prevalent international inadequacies pertaining to biodiversity-inclusive EIA are clearly evident in the CFR. This indicates that inadequacies prevalent internationally are present in an area with high biodiversity value. Some of these weaknesses include a lack of public participation and inadequate consideration of alternatives in BIA practice, indicating that biodiversity assessments are regarded as separate, parallel processes to EIA. From the data analysis, it was also evident that biodiversity studies are conducted in inappropriate seasons and over insufficient time periods, a practice which could negatively affect the accuracy and effectiveness of impact assessment and mitigation practices. This inadequacy may be ascribed to time constraints presented by the EIA process and commercial pressure to fast-track BIAs. Another prevalent inadequacy identified was the comprehensive lack of effective monitoring in biodiversity-inclusive EIA, which could negatively influence the ability to evaluate the success of mitigation measures.

On the other hand, the research indicated that positive patterns are emerging in the CFR, where ecological processes are incorporated in biodiversity-inclusive EIA, in contradiction of international trends. Biodiversity specialists not only described on-site ecological products and services but also assessed associated impacts. This emerging pattern may be ascribed to guidelines developed by Brownlie (2005) and De Villiers *et al.* (2005) to enhance the

incorporation of biodiversity, including ecological processes, into EIA. Moreover, biodiversity-inclusive EIA in the CFR seems to be focused on the prevention of impacts on biodiversity, and not on addressing cosmetic impacts only. The NEMA and the abovementioned guidelines endorse the incorporation of a precautionary approach to mitigation, and may be the reason for biodiversity specialists focusing on the prevention of impacts rather than on their rectification.

Although prevalent international inadequacies related to biodiversity-inclusive EIA are evident in the CFR, a promising pattern seems to be emerging in the Region that contradicts international trends. Nevertheless, the identified inadequacies pose significant challenges for the management and conservation of biodiversity. These challenges could be overcome by incorporating mechanisms such as Best Practice Guidelines for biodiversity-inclusive EIA and improved biodiversity related legislation in EIA processes.

4.2 Recommendations for the improvement of biodiversity-inclusive EIA

The following recommendations are proposed to address the limitations/inadequacies highlighted in the data analysis to improve the overall quality of biodiversity input into EIA:

4.2.1 Adoption of Best Practice Guidelines

The development and adoption of Best Practice Guidelines pertaining to BIA practice is essential to establish a basis for consistent and effective biodiversity management. This dissertation indicated that policy guidelines (Brownlie *et al.*, 2005; De Villiers *et al.*, 2005) developed by the Western Cape Province seems to have the potential to improve biodiversity assessment practice. The South African Biodiversity Management Framework (South Africa, 2009) urges other provinces also to develop such guidelines to enhance biodiversity practice across the country. Similar guidelines have been developed by the Gauteng Province (GDARD, 2012), but other provinces have not yet ventured on such initiatives. Biodiversity specialists can adopt Best Practices Guidelines in order to ensure consistent and effective assessment practices.

4.2.2 Ecosystem approach

BIA practice should be directed towards an ecosystem approach where the ecological as well as the social values of biodiversity are entrenched in assessment techniques (IAIA, 2005; Rajvanshi *et al.*, 2009; Slootweg, 2005). The focus of assessments should be shifted from impacts on protected or aesthetically pleasing biodiversity towards impacts on ecological processes, which hold significant value for human well-being and natural processes. Region-specific guidelines, such as the guidelines developed by De Villiers *et al.* (2005), can assist specialists in focusing assessment techniques on ecosystems and the associated ecological processes within a particular area.

4.2.3 Adequacy and appropriateness of biodiversity studies

BIAs should be conducted in appropriate seasons and adequate time should be allocated for surveys to ensure that seasonal fluctuations are taken into account in order to establish an accurate biodiversity profile for particular study areas (Treweek, 1999). Indigenous knowledge pertaining to biodiversity is invaluable to BIA (Barrow, 2006; Sallenave, 1994; Slootweg, 2009; Stevenson, 1996) and the incorporation thereof in BIA practice can enhance the integrity of the information captured. Comprehensive descriptions of proposed activities in BIAs would allow specialists to effectively determine the extent of the potential impacts associated with activities and sub-activities.

4.2.4 Improvement of mitigation measures and monitoring programmes

Mitigation measures are prescribed by specialists to manage the potential impacts on biodiversity and should be integrated in the EIR and Environmental Management Programme (EMP). A hierarchical approach is recommended during the development of mitigation measures (Tanaka, 2001), first seeking measures to enhance or avoid impacts and then to reduce impacts (Glasson *et al.*, 2005; IAIA, 2005; Slootweg, 2005). Additionally, mitigation measures must be practicable to ensure that the proponent will be able to thoroughly implement the management actions. The specialist may provide guidance on the implementation of the mitigation measures.

Monitoring programmes should form part of the initial study design and strategy of BIA studies. Baseline studies and impact predictions can be conclusive only when monitoring

results have been achieved (Beanlands and Duinker, 1983). Monitoring should therefore form an integral part of BIA practice in order to ascertain that the results achieved are accurate.

4.3 Further research

This dissertation has focused on the quality of biodiversity input to EIA as reflected in the BIA reports, with specific reference to the assessment, reporting and quality review stages of EIA. However, biodiversity should be incorporated into all stages of EIA (Brownlie *et al.*, 2006). Biodiversity input into other stages, including screening, scoping and public participation, should therefore be evaluated to truly comprehend the quality and adequacy of biodiversity considerations in the entire EIA process.

Furthermore, this dissertation has shown that guidelines (Brownlie *et al.*, 2005; De Villiers *et al.*, 2005) developed for the Western Cape seem to have enhanced biodiversity considerations in the CFR. This was especially evident in the fact that biodiversity specialists are increasingly incorporating ecosystem processes in assessment techniques, which is a pertinent factor endorsed in the guidelines. Further research could be conducted into the potential of guidelines to improve biodiversity input into EIA. This may be accomplished by comparing the quality of biodiversity considerations pre and post the development of such guidelines.

A comparative analysis could also be performed to determine the difference between the quality of biodiversity input into EIA in the CFR (determined during this dissertation) and that of another region with high biodiversity value but less comprehensive environmental legislation and should not have Best Practice Guidelines for biodiversity-inclusive EIA.

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Appendices

Appendix A: BIA Review criteria

Review Topic	Comments from reviewer	A	B	C	D	E	F	N/A
Overall report quality								
Review area 1: Expertise and professional conduct of specialist								
1.1 Is a clear indication given of relevant qualifications, expertise and experience of the specialist who conducted the study?								
1.2 Does the BIA contain the details of the person who prepared the report?								
1.3 Has a declaration of independence been provided?								
1.4 Has the specialist confirmed the validity of the information included in the report?								
Review area 2: adequacy and sufficiency of information								
2.1 Has the specialist provided sufficient information for decision-making purposes in terms of the level of detail and reliability of findings?								
2.2 Does the specialist report contain the Terms of Reference (ToR) and to what extent has the specialist met all the requirements of the ToR for the specialist input?								
2.3 Where appropriate, has traditional or indigenous knowledge, pertaining to biodiversity, been incorporated into the study?								
2.4 Are there any uncertainties, gaps in knowledge or low levels of confidence in the assessment or evaluation? Are these uncertainties and confidence levels clearly stated?								
2.5 Is the degree of confidence in the impact assessment prediction clearly specified and								

Review Topic	Comments from reviewer	A	B	C	D	E	F	N/A
explained?								
Review area 3: clarity of the report								
3.1 Has a clear, non-technical summary been provided?								
3.2 Are the time and space boundaries of the study appropriate and adequately motivated?								
3.3 Are the sources of information clear and explicit, and has the specialist included a list of references?								
3.4 Has a description of the methodology adopted in preparing the report or carrying out the specialised process been given?								
3.5 To what extent does the specialist explain the purpose and scope of the study undertaken?								
3.6 Are opinions or statements justified and adequately motivated?								
3.7 Are conclusions derived from findings of study logically consistent?								
3.8 Is a summary impact assessment table included, using the defined impact assessment and significance rating criteria to evaluate different alternatives both with and without management actions?								
3.9 Is a description given of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment?								
Review area 4: description of the project								
4.1 Has the purpose and need for the proposed project been clearly stated?								
4.2 Is there adequate description of the proposed project and alternatives to allow effective identification and assessment of potential direct, indirect and cumulative impacts (e.g. location, siting, routing, scheduling, activities, inputs and outputs,								

Review Topic	Comments from reviewer	A	B	C	D	E	F	N/A
labour, buildings and structures, infrastructure and operating scenarios)?								
Review area 5: description of the baseline environment								
5.1 Is there adequate description of the key characteristics of the affected socio-economic and biophysical environment (as relevant to the specialist domain) including baseline conditions, sensitive receptors or resources, uses/users, anticipated trends and pressures, and future scenarios?								
5.2 Are off-site as well as on-site characteristics adequately described to provide the broader context within which the development is proposed, where it is clear that impacts of the proposed project would extend beyond the immediate site?								
5.3 Are clear and accurate maps, plans and possibly photographs, of the project and affected environment provided?								
Review area 6: consideration of alternatives								
6.1 Has adequate consideration been given to the identification of reasonable alternatives to minimise the impact of the activity? (see full description)								
6.2 Have alternatives been addressed at a scale and level of detail that enables adequate comparison with the proposed project?								
6.3 Has the specialist identified the alternative that is the best environmental option from a biodiversity perspective?								
Review area 7: inclusion of legal aspects								
7.1 Is the legal context of the study, in terms of biodiversity, been described and are legal requirements, including those arising from international agreements, clearly considered?								
7.2 Is the policy and planning context of the proposal described, and clearly considered (taking into								

Review Topic	Comments from reviewer	A	B	C	D	E	F	N/A
consideration international, national, provincial and local policies and plans)?								
7.3 Have accepted standards and guidelines with regards to biodiversity been identified and clearly taken into consideration (e.g. National Spatial Biodiversity Assessment, DWA wetland delineation)?								
7.4 Have opportunities for the proposed project to support or contribute to the implementation of policy, plans or programmes been identified?								
7.5 Have inconsistencies, potential areas of conflict and or likely non-compliance between the proposed project and the legal, policy and planning context been clearly identified and the implications described?								
Review area 8: stakeholder consultation								
8.1 Has a description of any consultation process that was undertaken during the course of carrying out the study been provided, and has a summary of the comments been included?								
8.2 Within the specialist's area of expertise, have key I&APs input to the EIA process, where the proposed project could have a direct and/or potentially significant effect on their particular or mandated area of responsibility or interest, been incorporated in the study?								
8.3 Where the EIA process has missed key stakeholders, and/or where additional stakeholder involvement is clearly needed to refine, or better define issues or impacts, has the specialist made adequate provision for such involvement?								
Review area 9: prediction and assessment of impacts								
9.1 Have plausible environmental and operating scenarios been considered in the assessment?								
9.2 Has a clear description been given of the								

Review Topic	Comments from reviewer	A	B	C	D	E	F	N/A
approach and methodology that have been used by the specialist to assess the impacts and has this been clearly motivated?								
9.3 Have linkages to other specialist inputs been identified and taken into account where relevant?								
9.4 Are clear, sufficient and explicit criteria used to assess positive and negatives impacts of different alternatives, taking into account the planned mitigation and management?								
9.5 Have potential direct, indirect and cumulative impacts on important pattern, important ecological processes and associated areas (e.g. corridors), and on ecosystem goods and services (as relevant to the proposed project) on and beyond the site, been described assessed and evaluated?								
9.6 Is there adequate attention to indirect or cumulative effects on significant or sensitive resources? Where potentially significant cumulative effects are possible, but cannot be addressed at the EIA level, has the need for higher order studies been clearly stated?								
5.1.7 Are there systematic, explicit and rational links from identification of key issues, through assessment to evaluation of significance?								
9.8 Are consequences of the predicted impacts made explicit?								
9.9 Is there a clear indication of whether impacts are irreversible or result in an irreplaceable loss of biodiversity or ecosystem services to the ecosystem and/or society?								
9.10 Have impacts been assessed and communicated in terms of the extent to which they support or conflict with the desired future state/vision of the area and sustainable development objectives (as described in relevant policies, plans and								

Review Topic	Comments from reviewer	A	B	C	D	E	F	N/A
legislation)?								
9.11 Are the beneficiaries, and those who stand to lose from the proposed development, clearly identified where there are clear dependencies on ecosystem goods and/or services, highlighting vulnerable and risk-prone parties?								
Review area 10: recommendations for management								
10.1 Is a summary of key management actions that would fundamentally affect the significance of impacts on biodiversity if implemented?								
10.2 Has the management of the potential positive and negative impacts been systematically and adequately addressed (i.e. has the specialist considered measures for the avoidance, mitigation, restoration, rehabilitation or compensation of negative impacts in a hierarchical fashion; and have measures for enhancing positive impacts been considered)?								
10.3 Has the precautionary principle been applied to the recommendations for management and monitoring measures where there is uncertainty or high risk associated with impacts?								
10.4 Are recommended management actions practical, viable and in line with best practice? Are these clearly described and motivated?								
Review area 11: monitoring								
11.1 Does the recommended monitoring programm(es) include: the specific questions to be asked by monitoring; the frequency, season and timing for monitoring; responsibility for monitoring, analysis and implementation of responsive management actions; targets and indicators for monitoring; significance thresholds; and auditing and reporting requirements?								
11.2 Is the proposed monitoring programm(es)								

Review Topic	Comments from reviewer	A	B	C	D	E	F	N/A
practical, viable and in line with best practice? Has it been clearly described and motivated?								

Appendix B: Abbreviated BIA report review areas and criteria

Review area 1: Expertise and professional conduct

1.1 Qualifications, expertise and experience
1.2 Details of specialist
1.3 Declaration of independence
1.4 Validity of information

Review area 2: Adequacy and sufficiency of information

2.1 Information for decision making purposes
2.2 Terms of reference
2.3 Traditional or indigenous information
2.4 Uncertainties and gaps in information
2.5 Degree of confidence

Review area 3: Clarity and inclusiveness of report

3.1 Non-technical summary
3.2 Time and space boundaries
3.3 Sources of information
3.4 Description of specialised methodologies
3.5 Purpose and scope of study
3.6 Justification of opinions or statements
3.7 Adequacy of conclusions
3.8 Summary impact assessment table
3.9 Potential implications of findings

Review area 4: Description of project

4.1 Purpose and need for project
4.2 Description of project and alternatives

Review area 5: Baseline description of affected environment

5.1 Characteristics of affected environment
5.2 Description of surrounding environment
5.3 Maps, plans and photographs

Review area 6: Consideration of alternatives

6.1 Inclusion of reasonable alternatives
6.2 Comparison of alternatives
6.3 Identification of best environmental option

Review area 7: Inclusion of legal aspects

7.1 Description of legal context
7.2 Policy and planning context of project
7.3 Inclusion of standards and guidelines
7.4 Support of policy, plans and programmes
7.5 Likely non-compliance with legislation

Review area 8: Stakeholder consultation

8.1 Description of consultation processes
8.2 Key I&AP input to the EIA process
8.3 Provision for stakeholder involvement

Review area 9: Prediction and assessment of impacts

9.1Environmental operation scenarios
9.2 Assessment approach and methodology
9.3 Linkages to other specialist studies
9.4 Criteria used to assess impacts
9.5 Impacts on ecological processes
9.6 Indirect or cumulative impacts
9.7 Linkages from identification to evaluation
9.8 Explicitness of consequences
9.9 Irreversibility and irreplaceability of impacts
9.10 Assessment i.t.o. desired state
9.11 Identification of beneficiaries

Review area 10: Recommended management actions

10.1 Summary of key management actions
10.2 Mitigation of positive and negative impacts
10.3 Precautionary principle
10.4 Viability and practicability of mitigation

Review area 11: Monitoring

11.1 Monitoring programmes
11.2 Viability and practicability monitoring

Appendix C: Journal for Environmental Impact Assessment Review - guide for authors

1. Ethics in publishing

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

2. Conflict of interest

All authors are requested to disclose any actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations within three years of beginning the submitted work that could inappropriately influence, or be perceived to influence, their work. See also http://www.elsevier.com/conflictsofinterest. Further information and an example of a conflict of interest form can be found at: http://help.elsevier.com/app/answers/detail/a_id/286/p/7923.

3. Submission declaration

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8. Referees

Authors are welcome to suggest suitable referees.

9. Preparation

9.1 Use of word processing software

It is important that the file be saved in the native format of the word processor used. The text should be in single-column format. Keep the layout of the text as simple as possible. Most formatting codes will be removed and replaced on processing the article. In particular, do not use the word processor's options to justify text or to hyphenate words. However, do use bold face, italics, subscripts, superscripts etc. Do not embed "graphically designed" equations or tables, but prepare these using the word processor's facility. When preparing tables, if you are using a table grid, use only one grid for each individual table and not a grid for each row. If no grid is used, use tabs, not spaces, to align columns. The electronic text should be prepared in a way very similar to that of conventional manuscripts. Do not import the figures into the text file but, instead, indicate their approximate locations directly in the electronic text and on the manuscript. See also the section on Electronic illustrations. To avoid unnecessary errors you are strongly advised to use the "spell-check" and "grammar-check" functions of your word-processor.

9.2 Presentation of manuscript

The manuscript must be double spaced with wide (3 cm) margins. (Avoid full justification, i.e. a constant right-hand margin.) If possible, consult a recent issue of the journal to become familiar with layout and conventions. Make sure all pages are numbered, and numbered consecutively.

First, a separate cover page with:

- The article's title.
- Author name(s), affiliations, addresses and emails.
- Corresponding author, with email, telephone and postal address.

Second, a separate biographical page with:

- Author name(s), affiliations and brief (5-10 lines) biography for each.

Third, a separate title page with:

- The article's title.
- Abstracts are ideally about one-third of a page. Start the purpose of the research, the principal results and major conclusions.
- Keywords
- Immediately after the abstract, list up to six keywords.
- Acknowledgements

Fourth, separate pages with the manuscript • Make sure that headers or footers do not reveal the author(s) identity.

9.3 Article structure

Subdivision - numbered sections

Divide your article into clearly defined and numbered sections. Subsections should be numbered 1.1 (then 1.1.1, 1.1.2...), 1.2, etc. (the abstract is not included in section numbering). Use this numbering also for internal cross-referencing: do not just refer to 'the text'. Any subsection may be given a brief heading. Each heading should appear on its own separate line.

- Introduction

State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

- Material and methods

Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

- Theory/calculation

A Theory section should extend, not repeat, the background to the article already dealt with in the introduction and laid the foundation for further work. In contrast, a Calculation section represents a practical development from a theoretical basis.

- Results

Results should be clear and concise.

- Discussion

This should explore the significance of the results of the work, not repeat them. A combined results and discussion section is often appropriate. Avoid extensive citations and discussion of published literature.

- Conclusions

The main conclusions of the study may be presented in a short Conclusions section, which may stand alone or form a subsection of a Discussion or Results and Discussion section.

- Vitae

Include in the manuscript a short (maximum 100 words) biography of each author, along with a passport-type photograph accompanying the other figures.