Eskom Holdings Limited

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ('NUCLEAR-1') and ASSOCIATED INFRASTRUCTURE

TERRESTRIAL VERTEBRATE FAUNA IMPACT STUDY

J27035

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EXECUTIVE SUMMARY

At Duynefontein, the amount of land that is available for development, and that is not of high faunal sensitivity, is limited but sufficient to allow for Nuclear-1. However, further future expansion of power-generating facilities within the present Eskom property, to the north of KNPS, should not be considered.

Development of Nuclear-1 at Duynefontein would have significant negative impacts, mainly because of the direct impacts on faunal habitats within the footprint areas. Duynefontein would benefit from the no-development option because the land is already managed as part of a private nature reserve. Opportunities for on-site conservation offsets are limited.

At Bantamsklip, the amount of land on the coastal side of the R43, available for development and that is not of high faunal sensitivity, is more than sufficient to allow for Nuclear-1. The portion of the property inland of the R43 is highly sensitive and should not be developed at all.

Development of Nuclear-1 at Bantamsklip would have significant negative impacts, mainly because of the direct impacts on faunal habitats within the footprint areas. However, highly significant potential offsets are possible at Bantamsklip if undeveloped land is declared a nature reserve and is effectively managed as such. This would depend especially on the protection and management of the inland portion, as well as an adequate coastal corridor.

The no-development option at Bantamsklip is not positive because it can be assumed that it will lead to a change of land ownership and probable residential and/or resort development at the coast, and a possible increase in intensity of agricultural exploitation on the inland portion.

The amount of land that is available for development, and that is not of high faunal sensitivity, is severely constrained and not sufficient to allow for Nuclear-1. However, if additional land were purchased adjacent to the pan-handle portion of the property, this deficit could be overcome.

Development of Nuclear-1 at Thyspunt would have significant negative impacts, mainly because of (a) the direct impacts on faunal habitats within the footprint areas, (b) the development of three major new access roads, and (c) the need for a development corridor across a large field of mobile dunes, making this site highly problematic with respect to fauna and faunal habitats. On the other hand, highly significant potential offsets are possible at Thyspunt if undeveloped land is declared a nature reserve and is effectively managed as such. Such offsets could be significantly strengthened by acquisition of additional land.

The no-development option at Thyspunt is not positive because it can be assumed that it will lead to a change of land ownership and probable residential and/or resort development at the coast, and a probable increase in intensity of agricultural exploitation on the inland portion.

An important negative factor is the lack of definitive information on whether adequate engineering solutions are available to avoid serious negative impacts on groundwater flows and sensitive wetlands at Thyspunt. There are similar needs for more information on the dynamics of the mobile-dune field, and better mapping of dune forests and thickets of alien vegetation. It is essential that the necessary studies be carried out as a matter of urgency to inform the EIA process.

From the perspective of faunal conservation, the following overall conclusions are reached:

- Given the present uncertainty around groundwater and wetlands as well as other aspects of the biophysical environment, and the inadequate amount of suitable land

for development, the proposal for development at Thyspunt is currently flawed. This situation must be improved by completion of relevant studies, and acquisition of additional land, if necessary.

- Outstanding issues at Thyspunt should be satisfactorily resolved before final decisions are made and in time for full specification of necessary mitigation measures. This may have the effect of postponement of development at Thyspunt.
- Nuclear-1 could be developed at either Duynefontein or Bantamsklip, without further faunal EIA investigations.

The identified impacts are similar for the three site alternatives, Duynefontein, Bantamsklip and Thyspunt, although the severity of the impacts varies from site to site. The identified impacts are:

i. Destruction of natural habitats and populations
ii. Reduction in populations of Threatened species
iii. Fragmentation of natural habitats and patterns of animal movement
iv. Road mortality
v. Mortality associated with overhead-transmission lines and substations
vi. Disturbance of sensitive breeding populations
vii. Dust pollution beyond the building site
viii. Pollution of soil and water beyond the building site
ix. Light pollution beyond the building site
x. Alteration of surface and groundwater levels and flows, effects on local wetlands
xi. Poaching of local wildlife
xii. Problem-animal scenarios
xiii. Accumulation of radioisotopes in the environment and in the bodies of wild animals
xiv. Cumulative impacts
xv. Improved conservation status of undeveloped land (positive impact).

Recommended mitigation measures are similar for the three site alternatives, Duynefontein, Bantamsklip and Thyspunt, although the details vary from site to site.

i. <u>Mitigation of destruction of natural habitats and populations</u>
- Restrict development to a recommended footprint.
- Restrict the footprint of the development to the smallest area possible.
- Dispose of spoil at sea.
- Create laydown areas in previously disturbed areas.
- Use natural topographical features as boundaries.
- Clear the site in a logical sequence.
- Mark off the affected area.
- Rehabilitate affected areas, where possible.
- Compensate for loss of habitats. (See below.)

ii. <u>Mitigation of reduction in populations of Threatened species</u>
- All of the mitigations listed under (i) (above).
- Facilitate search-and-rescue operations before and during site clearance.
- Facilitate collection of scientific material and information before and during site clearance.

iii. <u>Mitigation of fragmentation of natural habitats and patterns of animal movement</u>
- Most of the mitigations listed under (i) (above).
- Make provision for ecological corridors.
- Construct under- and overpasses across roads.
- Keep roads as far away from wetlands as possible.
- Use recommended types of security fencing.
- Wherever possible, place pipelines and cables underground, and rehabilitate.
- Reduce the number of roads and tracks and place them carefully.

- Make roads off limits for fixed periods every day.

iv. Mitigation of road mortality
- Reduce the number of roads and tracks and place them carefully.
- Keep roads as far away from wetlands as possible.
- Construct under- and overpasses across roads.
- Restrict speed on roads.
- Make roads off limits for fixed periods every day.
- Place warning signage in appropriate places.
- Use appropriate curb designs.

v. Mitigation of mortality associated with overhead-transmission lines and substations
- Fit standard devices on all new routes (e.g., “flappers” or reflectors or “balls”).
- Monitor routes and installations.

vi. Mitigation of disturbance of sensitive breeding populations
- Determine location and extent of sensitive bird and other areas.
- Quarantine sensitive bird and other areas.
- Restrict the timing of blasting.
- Create wide buffer zones.
- Restrict air traffic.
- Restrict water traffic.
- Enforce all restrictions.
- Institute a programme of monitoring.

vii. Mitigation of dust pollution beyond the building site
- Apply standard mitigation measures, e.g., damping down with freshwater, use of cloth or brush barrier fences, covering dumps with plastic sheeting, etc.
- Do not use seawater.

viii. Mitigation of pollution of soil and water beyond the building site
- Apply standard mitigation measures.
- Remove all polluted soil and water from site.
- Dispose of brine from desalination into the sea.
- Dispose of sewage in a sustainable manner.

ix. Mitigation of light pollution beyond the building site
- Reduce exterior lighting.
- Use only long-wavelength lights.
- Use directional fittings.
- Screen interior lighting.

x. Mitigation of alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands
- Avoid sites where major damage to wetlands is inevitable.
- Do not use wetlands or groundwater as sources of freshwater.
- Engineer solutions to the flow of groundwater.
- Carry out additional studies at Thyspunt.

xi. Mitigation of poaching of local wildlife
- Educate workers.
- Patrol the area.
- Control materials.
- Control firearms.
- Control after-hours access.

- Control access to non-construction areas.

xii. Mitigation of problem-animal scenarios

- Do not allow feeding of wild animals.
- Keep attractive resources out of reach.
- Exercise rigorous control of edible refuse.
- Eliminate feral cats and dogs.
- Do not allow pets on site.

xiii. Mitigation of accumulation of radioisotopes in the environment and in bodies of wild animals

- No mitigations, beyond those required by human health and safety regulations, are recommended.

xiv. Mitigation of cumulative impacts

The recommended mitigations that will contribute most are:

- choice of a suitable development footprint
- rehabilitation of degraded areas, post construction
- use of a suitable design for boundary fences
- use of suitable exterior lighting
- avoidance and mitigation of impacts on groundwater
- enforcement of restrictions on disturbance and poaching of wildlife
- monitoring of sensitive populations to aid environmental management
- monitoring of radioisotope pollution to aid environmental management.

xv. Mitigation/offset of impacts through improved conservation of undeveloped land

- Elevation of legal status of undeveloped portions to statutory nature reserves
- Replacement of unsuitable mesh fences with palisade fences
- Increased spending on the removal of invasive alien plants
- Installation of two or three strategically located underpasses to facilitate animal movements across busy roads
- Commissioning of detailed surveys of poorly surveyed animal groups, viz., reptiles, amphibians and small mammals
- Commissioning of a programme to monitor the populations of sensitive species.

Recommended monitoring and evaluation programme

- An appropriate monitoring and auditing programme should be put in place to track the efficacy of the mitigation measures. Most of this monitoring must be built into the auditing procedures of the EMPs for the construction, operational and decommissioning phases, but input during the design phase is also important for the demarcation of sensitive areas. The programme should include monitoring directed specifically at sensitive faunal populations.

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ('NUCLEAR-1') AND ASSOCIATED INFRASTRUCTURE: TERRESTRIAL VERTEBRATE FAUNA

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ABBREVIATIONS

CR	Critically Endangered
DD	Data Deficient
DEAT	Department of Environmental Affairs and Tourism
ECO	Environmental Conservation Officer
EMP	Environmental Management Plan
EN	Endangered
IUCN	International Union for the Conservation of Nature
KNPS	Koeberg Nuclear Power Station
LC	Least Concern
LT	Least Threatened
NPS	nuclear power station
NE	Not Evaluated
NT	Near Threatened
NSIP	Eskom's Nuclear Site Investigation Programme
pT	potentially Threatened
PBMR DPP	Pebble-bed Modular Reactor Demonstration Power Plant
VU	Vulnerable

GLOSSARY

Threatened: Capitalized and used in its formal sense to denote one of the three categories of threat, as defined by the IUCN, viz., Critically Endangered, Endangered and Vulnerable.

Near Threatened (NT): The status of a species that does not satisfy the IUCN criteria for Vulnerable, Endangered or Critically Endangered, but is close to qualifying, or is likely to qualify as Vulnerable in the near future.

potentially Threatened (pT): This status is applied to certain reptiles which are currently undergoing conservation assessment, and whose status is therefore not certain at present.

Data Deficient (DD): The status of a species which lacked sufficient information to apply the IUCN criteria objectively. Such a species may, in fact, be Threatened, Near Threatened, or of Least Concern, but a definitive statement is not possible at this time.

Least Concern (LC): The status of a species which is not Threatened, nor Near Threatened, nor Data Deficient. This designation does *not* imply that the species is not experiencing threats or conservation problems, only that these do not come close to the relevant thresholds for Threatened status.

Least Threatened (LT): Terminology used in Mucina & Rutherford (2006) and roughly equvalent to Least Concern (above).

Critically Endangered (CR): The status of a species that has satisfied the IUCN criteria that indicate that it faces as an extremely high risk of extinction in the wild.

Endangered (EN): The status of a species that has satisfied the IUCN criteria that indicate that it faces as a very high risk of extinction in the wild.

Vulnerable (VU): The status of a species that has satisfied the IUCN criteria that indicate that it faces as a high risk of extinction in the wild.

Ecological corridor: An area of land, often a relatively narrow strip, which is intended to provide a connection between to other areas of ecological importance, and allow for free movement of organisms between these two areas. (See Appendix 4 for more detail.)

Endemic: Of a species whose distribution range is restricted to a particular, specified area or region. Species that are endemic to relatively small areas are generally more vulnerable than species with large distribution ranges.

Fossorial: Of an animal that digs underground and spends much of its time underground.

Trophic levels: Feeding levels, i.e., levels in the food chain.

1. INTRODUCTION

1.1. Background

Eskom proposes to construct Nuclear Power Stations (NPS) on each of three sites, with a power generation capacity of up to 4000 MW at each station. It is estimated that the entire development of each NPS will require in the order of 31 ha, including all auxiliary infrastructure. The proposed NPSs will each include a nuclear reactor, turbine complex, spent fuel and nuclear fuel storage facilities, waste handling facilities, intake and outfall structures, and various auxiliary service infrastructure.

The following additional infrastructure will or could potentially be required, amongst others:

- Internal road network as well as the potential for upgrading of existing roads in or around the proposed site
- Pipelines, for example water and sewage
- Transmission network including substations and power lines
- Village
- Cooling water intake basin and outflow structure
- Sewage treatment facilities
- Desalinisation plant
- Contractors yard for laydown of materials and other equipment
- Water reservoir
- Telecommunication and meteriological mast
- Security infrastructure.

In the event that the proposed projects are authorised, it is estimated that the construction of the first NPS could commence in 2011 with commissioning of the first unit in 2016.

1.1.1. Scope of the study

This study deals with terrestrial vertebrate fauna, namely amphibians, reptiles, mammals and birds. Freshwater fish form part of the study on freshwater ecology and marine mammals and fish form part of the study on marine ecology. This study should be seen as one of a suite of studies dealing with biodiversity issues. The others deal with invertebrate fauna, freshwater ecology, marine ecology and terrestrial flora. It is our view that these studies are of equal importance in understanding the impacts of the proposed development on the natural environment.

Setting aside considerations specific to nuclear fuel as a source of heat, the impacts of a nuclear power station on the natural environment in general, and vertebrate fauna in particular, are similar to that of any other large development. Broadly speaking, these are (a) the physical footprint of the power station and its associated infrastructure on natural habitats and populations, (b) further disturbance of habitats and populations arising from activities during the construction phase, and (c) further disturbance of habitats and populations arising from activities during the operational phase.

With respect to the operational phase, only normal operation is considered. Issues related to accidents and emergencies are the subject of separate specialist studies on safety and are not relevant here. The impacts of accidents, especially nuclear accidents, are primarily relevant to human safety, not the safety of wild animals, and such measures as are taken to protect humans are likely to also protect animals. Accidents of a predictable nature, such as conventional fuel spillages, are understood and there are standard procedures for preventing and mitigating such accidents. This report makes reference to such events and the need to mitigate their impacts.

Impacts on vertebrate fauna are likely, for the most part, to be confined to direct and indirect impacts on their habitats and associated ecosystem processes, and these impacts will be largely determined by the construction of the facility and the processes, external to the plant itself, involved in its normal operation. Processes involved in the commissioning of the plant do not appear to differ from construction and operation with respect to impacts on the surrounding ecosystem and are therefore not specifically addressed in this report.

The process of decommissioning of a plant is discussed. However, in this regard, we wish to have it noted that, in our professional opinion, impacts associated with activities that are far-removed in time, such as the future decommissioning of a plant, should be the subject of a separate EIA process which will be informed by the environmental and other circumstances, as well as technical information, that pertain at that time. For this reason, we do not consider our treatment of the decommissioning process as in any way adequate or definitive.

The scope of this report does not include off-site constructions, activities and processes, such as transmission lines, transport routes, quarries, housing, storage facilities, etc. Our understanding is that all such off-site activities are subject to separate EIA processes.

This report also does not take on any specific assessment of nuclear fuel, nuclear reactors and nuclear waste in relation to other options for the generation of electricity. It is a fact that all forms of electricity generation have their attendant pros and cons, but these are beyond the scope of this study.

1.1.2. The alternatives

For the purposes of this study, the development alternatives are the “no-go” alternative, and the alternative placements of the plant and other elements at each of the three localities, namely Duynefontein, Bantamsklip and Thyspunt. The three localities are not alternatives and each is a potential site for a NPS, in its own right. The possible reactor designs will not be discussed as separate alternatives with respect to their impacts on fauna, because these are believed to be equivalent.

1.1.3 Legislative framework (adapted from Brownlie 2005)

Biodiversity in general, and vegetation/plant life in particular, should form one of the focal points of an EIA where one or more of the following aspects are relevant:

I. ***The presence of important biodiversity pattern,*** such as Critical Biodiversity Areas, protected/threatened ecosystems, protected/threatened species, and/or where there are high levels of endemism.
II. ***Important ecological processes or process areas***, such as Ecological Support Areas, regional or local ecological corridors, important habitat for threatened, protected or commercially valuable species, highly dynamic or unstable systems, or the need to maintain key processes which 'drive' ecosystems (e.g. fire, coastal sediment movement, etc.).
III. ***Important ecosystem goods or services in the area***, which support lives or livelihoods, such as reserves of harvestable goods, wetlands, estuaries or reefs which regulate water supply and coastal protection, natural or living landscapes or species having heritage or other cultural value, and unique opportunities offered by biodiversity to enhance development (e.g. ecotourism).
IV. ***Potential of the proposed activity***, because of its nature, to pose a significant threat either directly or indirectly to biodiversity. Where pollution is an issue, a biodiversity specialist is invariably needed to address effects on valued receiving ecosystems and species.
V. ***Potential of a component of biodiversity or receiving ecosystems*** to pose a threat to the proposed activity (e.g. disease vectors, flooding, waterlogging, sea level rise, sand movement, etc.).

With regard to the legal framework within which a botanical study takes place, the following 'bigger picture' aspects are important:

1. South Africa has ratified a number of international conventions, namely the Convention on Biological Diversity, the Ramsar Convention (on wetlands of international importance especially as waterfowl habitat), The Bonn Convention (on conservation of migratory species of wild animals) and the World Heritage Convention.
South Africa thus has an obligation to protect species and ecosystems that warrant national or local protection, including: ecosystems that are threatened, important for maintaining key ecological or evolutionary processes and/or functions, ecosystems that contain rich biodiversity or large numbers of threatened or endemic species, with social, economic, cultural or scientific value; species and communities of species that are threatened, related to domesticated or cultivated species, and/or have medicinal, agricultural or other economic, social, cultural or scientific significance; genotypes with social, scientific or economic significance. In addition, it must use indigenous biological resources sustainably; and share the benefits of biodiversity equitably.
2. South Africa has a number of legal tools at national level aimed at conserving biodiversity and natural systems. In addition, biodiversity plans have been developed at national, provincial and local levels to prioritize conservation efforts. The laws and policies are summarised in Table 1.1.3 below.
3. South Africa has a number of formally protected areas (such as National Parks and Provincial Nature Reserves), as well as World Heritage Sites and the United Nations Educational, Scientific and Cultural

Organisation (UNESCO) Biosphere Reserves that reflect priority areas for biodiversity conservation.

Table 1.1.3: Laws, policies and plans relating to the natural environment.

Constitution of the Republic of South Africa (Act 108, 1996), article 24 (b) – (c)	"*everyone has the right to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable[1] development and use of natural resources while promoting justifiable economic and social development*"
National Environmental Management Act (NEMA) (Act 107 of 1998	The National Environmental Management Act (Act 107, 1998) states in s2(4)(k) that The environment is held in public trust for the people, the beneficial use of resources must serve the public interest and the environment must be protected as the people's common heritage. Section 2(4)(a) specifies that sustainable development requires the consideration of all relevant factors including the following: ▪ that the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied; ▪ that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised; ▪ that a risk-averse and cautious approach is applied, which takes into account the limits of current knowledge about the consequences of decisions and actions ▪ that negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied; ▪ that equitable access to environmental resources, benefits and services be pursued to meet basic human needs and ensure well-being. Special measures may be taken to ensure access by categories of persons disadvantaged by unfair discrimination, ▪ that pollution and degradation of the natural environment be avoided, or, where they cannot altogether be avoided, are minimised and remedied, ▪ that landscapes and sites that constitute the nation's cultural heritage be avoided, or where they cannot be altogether avoided, are minimised and remedied, ▪ that sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and developmental pressure. Section 28 imposes a 'duty of care' obligation for the environment on every person with regard to taking reasonable measures to prevent pollution or degradation of the environment or, where unavoidable, to minimize and rectify such pollution or degradation.
National Environmental	The objectives of this Act are within the framework of the National

[1] The term 'sustainable' in relation to biological resources is defined as 'sustainable in relation to the use of a biological resource in a way and a rate that

a) Would not lead to its long-term decline
b) Would not disrupt the ecological integrity of the ecosystem in which it occurs, and
c) Would ensure its continued use to meet the needs and aspirations of present and future generations of people

Management: Biodiversity Act 10 of 2004	Environmental Management Act, include: ▪ The management and conservation of biological diversity within the Republic of South Africa and the components of such biological diversity ▪ The use of indigenous biological resources in a sustainable[2] manner; and ▪ The fair and equitable sharing among stakeholders of benefits arising from bio prospecting involving indigenous biological resources; and ▪ Giving effect to ratified international agreements relating to biodiversity which are binding on the Republic. The Act, amongst others, provides the framework for biodiversity management and planning. It provides (s52) for the listing of threatened (critically endangered, endangered or vulnerable) and protected ecosystems (of high conservation value or of high national or provincial importance although not listed as threatened) and for activities or processes within those ecosystems to be listed as 'threatening processes', thus triggering the need to comply with the NEMA EIA regulations. Promulgation of such lists is imminent[3]. The Act establishes the South African National Biodiversity Institute (SANBI), with a range of functions and powers (Chapter 2 Part 1). It also provides for the listing, control and eradication of invasive species (currently the responsibility of the Conservation of Agricultural Resources Act, 1983).
National Environmental Management Protected Areas Act 57 of 2003	The objectives of this Act within the framework of the National Environmental Management Act, include the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes in order to: ▪ Protect areas with significant natural features or biodiversity ▪ Protect areas in need of long-term protection for the provision of environmental goods and services ▪ Provide for sustainable flow of natural products and services to meet the needs of a local community; involvement of private landowners. The Act provides for the involvement of parties other than organs of State in the declaration and management of protected areas.
National Environmental Management: Integrated Coastal Management Act (Act 24 of 2008)	The Act's intention, through integrated coastal and estuarine management, is to ensure that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable, amongst others, through appropriate regulation, management, protection, conservation and rehabilitation measures. The Act focuses on regulating (by restricting or controlling) human activities within, or that affect the 'coastal zone'. The 'coastal zone' is defined as the area comprising coastal public properly, the coastal protection zone, coastal access land and coastal protected areas, the seashore, coastal waters and the exclusive economic zone and includes any aspect of the environment on, in, under and above such area. The *coastal protection zone* includes any land situated wholly or partially within 1km of the HWM which, when this Act came into force, (i) was zoned for agricultural or undetermined use; or (ii) was not zoned and was not part of a lawfully established human settlement, and any land within

[2] Until threatened ecosystems and habitats are listed, South Africa's Red Data books and electric datasets of threatened species, and the NBSA list different categories of threatened vegetation types and ecosystems (Critically Endangered, Endangered, Vulnerable)

	100m of the HWM. This coastal protection zone, through regulation, management and/or restrictions, aims (s17) to protect its ecological integrity, natural character and socioeconomic/ aesthetic values, avoid increasing the severity or effect of natural hazards in this zone, protect people, property and economic activities from dynamic coastal processes (including sea level rise), maintain the natural functioning of the littoral active zone, maintain the productive capacity, and make land available to the state or authorized persons for specified purposes. The MEC must establish coastal set-back lines to prohibit or restrict the building, erection, alteration or extension of structures sea-ward of these lines; the lines may be wholly or partially outside the coastal zone. The Act makes the preparation of a provincial and municipal coastal management plans compulsory within a specified time period, and prescribes its contents. It also provides for coastal planning schemes to facilitate its objectives. The Act also regulates the discharge of effluent into coastal waters, incineration or dumping of waste at sea. Development in the coastal zone must take into account both the impacts of the activity on the coastal environment (including cumulative impacts), and the impacts of coastal environmental processes on that activity. Any activity within the coastal protection zone should be consistent with its purpose (s17).
Integrated Coastal Zone Management Bill 2007	The Bill focuses on regulating (by restricting or controlling) human activities within, or that affect the "coastal zone". The coastal zone is defined as the area comprising coastal public property, the coastal buffer zone (an area along the edge of coastal public property), coastal access land (which the public may use to gain access to coastal public property), specially protected coastal areas, and includes any aspect of the environment on, in and above them.
Western Cape Nature Conservation Laws Amendment Act (Act No. 3 of 2000)	This Act and associated Ordinance provides for measures to conserve the province's flora, fauna and protected areas, and deals with the permitting processes to regulate harvest/offtake/ trade in protected or endangered flora and wild animals, as well as to control noxious aquatic growths.
Policies and Plans	
National Spatial Biodiversity Assessment (NSBA) 2004 (Driver et al. 2005)	The NSBA establishes status for terrestrial, inland water, estuarine and marine ecosystems, protection levels and conservation priorities at a 1: 250 000 scale nationally and suggested implementation options for priority areas. It provides the national context for development of biodiversity plans at the sub-national and local scale. For each vegetation type a defensible target has been determined, based on protecting 75% of species occurring in that vegetation type. Ecosystem status is thus based on the percentage of the original area remaining untransformed in relation to the biodiversity target, and a threshold for ecosystem functioning. Conservation priority areas indicate where there is a need for finer scale planning, expansion of the protected area system and integration of biodiversity-compatible development and resource management across the landscape and seascape, including on private and communal land.
National Biodiversity Strategy Action Plan (NBSAP) (DEAT 2005)	Five main strategic objectives have been identified, namely: ▪ Strategic Objective 1: An enabling policy and legislative framework integrates biodiversity management objectives into the economy. ▪ Strategic Objective 2: Enhanced institutional effectiveness and efficiency ensures good governance in the biodiversity sector. ▪ Strategic Objective 3: Integrated terrestrial and aquatic management across the country minimizes the impacts of threatening processes on biodiversity, enhances ecosystem services and improves social and economic security. ▪ Strategic Objective 4: Human development and well-being is

	enhanced through sustainable use of biological resources and equitable sharing of the benefits. ▪ Strategic Objective 5: A network of protected areas conserves a representative sample of biodiversity and maintains key ecological processes across the landscape and seascape.
National Biodiversity Framework (DEAT, 2009)	The NBF provides a framework for conservation and development. It aims to focus attention on the most urgent strategies and actions required for biodiversity management, and assign roles and responsibilities to key stakeholders (including the State). It provides a 5-year strategy, drawing out immediate priorities within each of the 5 Strategic Objectives of the NBSAP.
Draft National Strategy for Sustainable Development (DEAT 2006)	This Strategy stems from Section 24 (b) of the Constitution and particular the phrase "secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development". Although still in development, the final product is set to be used by government and stakeholders to enhance South Africa's long term planning capacity. It would specifically influence national and provincial development strategies, such as the National Spatial Development Perspective, the Provincial Growth and Development Strategies and other cross-sectoral development programmes. The draft National Strategy notes that the nation's biodiversity provides critical ecosystem services on which socioeconomic systems depend. Our ecosystems are the basis of our society and our economy; they provide vital services and are of great use and non-use value to society.
Towards a Sustainable Development Implementation Plan for W. Cape: concept paper on sustainable development. (DEA&DP 2005); and the provincial Sustainable Development Implementation Plan (PSDIP) Final Draft (DEA&DP 2006)	▪ Provides a framework that assists in developing a common understanding of the concept of "sustainable development" and enables decision makers to assess the extent to which their proposed policies, strategies and projects contribute to sustainability. ▪ The PSDIP recognizes the inter-dependencies of economic growth, social equity and ecosystem services, and the need to stay within the ecological limits of the natural resource base. ▪ Four priority areas, including (Priority Area 3) promoting resource efficiency and sustainability, and (Priority Area 4) – safeguarding ecosystem services. ▪ Within Priority Area 4, priority actions include the development of a biodiversity accounting system, implementing programmes that promote biodiversity conservation, and expanding conservation areas and networks of protected areas.
Western Cape Provincial Growth and Development Strategy Green Paper (Department of the Premier 2007)	Economic growth is a prerequisite for boosting job creation, better quality human settlement and improved human well-being. The PGDS notes that: ▪ Environmental integrity is 1 of 4 key pillars of the 'shared growth and integrated development' path to 2014, with growth, equity and empowerment. ▪ Biodiversity embraces the richness in species as well as the wealth in endemic plants and animals. Protecting the natural resource base is essential to any economic and socially sustainable system, even when the full economic value of natural resources has not yet been calculated. ▪ Biodiversity protection and the protection of ecological hot spots are internationally recognized imperatives governed by specific international agreements. Land cover change is the most significant driver or decline in ecosystem health. The Strategy aims for a 50% improvement in environmental condition by 2014 (through urban edge and other guidelines, target is to reduce biodiversity loss and urban/agricultural land encroachment).

Western Cape Spatial Development Framework (2005 and 2009)	The WCSDF has been approved as a formal Structure Plan in terms of the Land Use Planning Ordinance (1985). Its purpose is to guide spatial development in the landscape and investment of public resources to achieve development objectives. The WCSDF draws on bioregional planning principles and applies broad Spatial Planning Categories linked to resource conservation, amongst others, and differentiating between rural development beyond urban edges, and urban/ settlement areas. 'Core' and 'buffer' SPCs relate directly to valued biodiversity or natural resources; they incorporate ecological corridors, e.g. along rivers and coastlines.
Guidelines for development in the Western Cape: biodiversity offsets (2007)	Echoing the intention of national government to develop a national policy for biodiversity offsets, the Western Cape (2007) and KwaZulu-Natal (2009) have developed draft guidelines for biodiversity offsets in these provinces. The guidelines explain where offsets would be required, the quantum of offset that would be appropriate and its location in the landscape.

1.2. Study approach

This section deals with the broad philosophical aspects of the study approach (section 1.2.1) as well as the specific aspects of study methods (section 1.2.2) and limitations of the study (section 1.2.3).

1.2.1. Approach to the study

In preparing reports on faunal surveys, as input into environmental Scoping Reports, Impact Assessments (EIAs) and Management Plans (EMPs), we apply certain values and principles. Here we make those values and principles explicit so that the user of this report is appraised of our approach and assumptions.

Fundamental objectives:

We see EIAs and EMPs encompassing two ultimate purposes:

(A) the maintenance of South Africa's biodiversity, and

(B) the enhancement of the quality of life of South Africa's people.

Unfortunately, these two objectives are frequently perceived to be in conflict. We believe that they are, in fact, inseparably linked and fundamentally compatible. In fact, recent research indicates that the availability of natural, wild areas is essential to the emotional, intellectual and physical well-being of urban residents, especially children (Miller 2005).

To preserve biodiversity, it is necessary to focus on both *pattern* and *process*, that is, the full range of species and habitats (pattern), as well as the ecological and evolutionary processes that allow biodiversity to persist over time (Driver at al. 2003). Animals cannot survive in the absence of their habitats, and neither species nor habitats can survive in the absence of the 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 "ecosystems approach".*

A guiding principle:

In large-scale development projects, i.e., those that involve relatively large areas (e.g., 10 ha or more), we believe that it is necessary to apply the principle that *a development should not result in a net decrease in the biodiversity of the site*, especially if the site contains unaltered, natural habitats. This principle is based on the logical premise that, unless biodiversity conservation is applied at the micro-scale of individual developments, biodiversity conservation at the macro-scale, that is, in the country as a whole, will not succeed.

Important implications of this principle are that, (A) large-scale developments need to set aside portions of land specifically for conservation purposes, and (B) those portions need to be appropriately managed to preserve their ecological and biodiversity value.

Ascribing value and importance:

There is frequently an assumption that certain species, habitats and biotic communities have greater value and importance than others. The factors which affect value and importance are:

- ***Ecological importance:*** The contributions of particular patches of habitat to the overall ecology of an area are not equal. Some habitats have greater importance because of their rarity or because of their role. Wetland habitats, for example, are usually small components of a landscape in terms of area, but play a vital role in sustaining aquatic biota and in providing essential resources to terrestrial animals. Any habitat which is needed to maintain ecological processes has added value.
- ***Connectivity:*** This is a special case of ecological importance (above). A particular patch of habitat, which may have little importance in itself, may acquire considerable, even critical importance and value if it connects two other areas of ecological importance. Such "corridor" areas sustain the process of movement of biota between areas and thereby promote the long-term sustainability of ecosystems. Similarly, if an area is adjacent or connected to other areas of conservation importance, its value is increased because it functions as a part of a larger ecological system.
- ***Sustainability****:* Sustainability is a central concept because conservation aims to preserve species, habitats and ecosystem processes in the long term. In fact, the ideal of conservation is to preserve natural systems at temporal and spatial scales that allow evolutionary processes to continue indefinitely. It is therefore essential that conservation planning take into account the factors that are likely to affect the long-term sustainability of systems. Preservation of isolated patches of habitat, no matter how pristine, will not succeed if the larger processes that sustain that patch are not also preserved. In general, the smaller and more isolated a conserved area is, the more intensive the management of the area needs to be to maintain its character. Sustainability interacts with the allocation of value and importance. If a feature is deemed to have high value, but that value is unsustainable, its value tends to be down-graded. Conversely, a feature of lesser intrinsic value may have its value enhanced by a greater degree of sustainability.

- ***Threatened status:*** If a species has been designated "Threatened", its value is taken to be higher than that of a non-threatened species. Similarly, the higher the level of threat, the greater the ascribed value. Levels of threat for species are usually objectively defined in Red Data books, and the status of veld types is given in the National Spatial Biodiversity Assessment (Rouget et al. 2005). Special attention is devoted to wetland and lowland habitats because, in general, they are more threatened than dryland and montane habitats, respectively.
- ***Intactness:*** This concept applies to habitats, ecosystems and communities. If a system is perceived to be relatively undamaged and functioning normally, it is considered to be "intact". This attribute does not imply long-term sustainability, but merely that, at the present time, the habitat and its biotic community are present and surviving. Intact systems are given greater value because they are generally more functional (with regard to ecological processes), complex, rare and sensitive than damaged, disturbed or transformed habitats.
- ***Aesthetic, recreational and educational value:*** These aspects of value are largely context-dependent, that is, the social and economic context of any particular piece of habitat and its associated biotic community is what largely determines whether it has aesthetic, recreational or educational importance. In general, the more built and densely populated an area, the more relevant these aspects become. As mentioned above, these aspects need to be viewed as important to the maintenance of the quality of life in urban and suburban environments.

The importance of management:

The underlying assumption of development plans tends to be that certain natural features may be destroyed and other natural features must be preserved. This approach is far too simplistic to achieve the fundamental objectives (above). If biodiversity and the quality of life of human inhabitants is to be maintained, the environment has to be *managed*. This principle is readily accepted for the built environment where various environmental management services are routinely provided by landowners and local authorities (e.g., refuse removal, drainage, waste-water treatment, etc.), but the principle of management is frequently ignored for the natural environment. While benign neglect may be a valid aspect of a management policy, it is never a complete solution. *For this reason, we frequently make recommendations for management and we view these as among the most important aspects of any report.*

1.2.2. Methods and materials

TOR, background information, technical reports, maps and other relevant information were provided by ARCUS GIBB.

Some information compiled during previous Eskom NSIP and other studies was available for each of the sites, but was not equally detailed or useful for each site. Reports specifically accessed and used in this study were, for Duynefontein: Eskom undated; Tlukzek & Shippey 1995; Le Roux J. 2002; Simmons et al. 2002; Eskom 2005; Parsons & Underhill 2005. For Bantamsklip: Allan & Hockey 1989; Palmer 1989; De Villiers 1989; Courtney 1993. For Thyspunt: Branch

1986; Martin 1986; Swanepoel 1986; Courtney & Speirs 1994; De Villiers undated.

In compiling this report, site visits and some additional sampling were carried out. Survey work at Duynefontein was carried out mainly in September with some additional observations in November 2007; Bantamsklip was surveyed in mid-July 2008, and Thyspunt was surveyed at the end of July and beginning of August 2008. An additional survey was carried out at Thyspunt during the period 9-15 September 2009.

The methods used at the three sites were not the same. Survey work at Duynefontein was carried out with sampling of the fauna and with a relatively generous time budget of a week in the field, while, initially, only three days each were possible at Bantamsklip and Thyspunt, which allowed for little actual sampling of fauna. These deficiences were compensated for by refering to previous studies, in the case of Bantamsklip, and by carrying out a further survey in 2009, in the case of Thyspunt.

The methods used to survey the various groups are described below. All trapped specimens were released on site.

Amphibians:

Calls of frogs were noted and identified, including surveys done after dark. Funnel traps were set in wetlands to determine whether platannas were present. The presence and likely species identity of tadpoles were noted.

The methods used were not exhaustive and the results cannot be regarded as comprehensive. However, together with a desktop study, the species lists are regarded as reasonably complete and adequate, especially in view of the fact that it should be possible to mitigate the projected impacts on wetlands. However, the results of recommended wetland monitoring (see recommendations, below) will be relevant in this regard.

A previous study at Bantamsklip (De Villiers 1989) and direct communication with A.L. de Villiers and K. Dunn (pers. comm.) were useful in describing the frog fauna for that site. A previous study for Thyspunt (Branch 1986) was apparently a desktop study only, and not especially useful, but a later survey of the dune field (Cunningham & Henderson 2008) did provide some important data.

Figure 1: Checking a funnel trap for tadpoles and platannas at Hagelkraal, Bantamsklip.

Reptiles:

Trap arrays, each comprising drift fences in a Y-formation with four pitfall traps and six funnel traps, were erected in various habitats. The arrays were checked daily for 6 days and all captured specimens noted. In addition, active searches were carried out at a variety of localities.

Coordinates of trap arrays at Duynefontein:

Array 1: 33 39 36 S 18 25 19 E
Array 2: 33 39 34 S 18 25 39 E
Array 3: 33 40 25 S 18 27 32 E
Array 4: 33 41 05 S 18 26 10 E
Array 5: 33 39 56 S 18 26 07 E

Coordinates of trap arrays at Thyspunt:

Array 1: Along seep at coast	34 11 22.5 S	24 42 15.3 E
Array 2: Inland from coast	34 11 16.3 S	24 42 40.1 E
Array 3: In small forest patch	34 11 06.4 S	24 42 27.3 E
Array 4: In Langefonteinvlei	34 10 40.7 S	24 43 59.5 E

Reptiles are generally secretive and cryptic in their behaviour, making it notoriously difficult to obtain comprehensive samples of species richness, let alone measure population densities. However, it was possible to considerably enlarge the list of confirmed species at Duynefontein (cf. Koeberg Private Nature Reserve species list in Appendix 1) and Thyspunt.

Some sampling by active search was carried out at Bantamsklip. A previous study at Bantamsklip (De Villiers 1989) and direct communication with K. Dunn (pers. comm.) were useful in describing the reptile fauna. A previous study for Thyspunt (Branch 1986) was apparently a desktop study only, and not especially useful. However, together with desktop studies, the lists of reptiles presented in this report are believed to be reasonably complete.

Figure 2: A trap array among the dunes at Duynefontein.

Figure 3: Trap array in forest habitat at Thyspunt.

Figure 4: Trap array in dune strandveld at Thyspunt.

Figure 5: Constructing a trap array in the Langefonteinvlei at Thyspunt.

Mammals:

The trap arrays also served to trap small mammals. In addition, transects of Sherman small-mammal traps were set. Each transect comprised 20 traps set at 10-pace intervals. Larger mammals were recorded during active searches from incidental sightings as well as spoor.

Coordinates of Sherman-trap transects:

Transect 1	33 40 25 S	18 27 33 E
Transect 2	33 41 03 S	18 26 12 E
Transect 3	33 39 56 S	18 26 09 E

Sherman-trap transects at Thyspunt were adjacent to the trap arrays (see above for coordinates).

Trapping of small mammals tends to have a very low return on effort, and trapping at Duynefontein and Thyspunt was no exception. Nevertheless, some species not previously recorded were found. Together with a desktop study, the mammal lists in this report are considered to be reasonably complete.

Figure 6: Searching caves for bats on Hagelkraal, Bantamsklip.

Mist-netting of bats (one evening) and active searching of caves were carried out on Hagelkraal, Bantamsklip. Otherwise, sampling was limited to incidental observations of animals and spoor at Bantamsklip. A previous study at Bantamsklip (Palmer 1989) and direct communication with K. Dunn (pers. comm.) were useful in describing the mammal fauna. A previous study for Thyspunt (Swanepoel 1986) was apparently a desktop study only, and was positively misleading, but useful records were obtained from G. Greef (Eskom; pers. comm.) and Mr Papenfus (local resident; pers. comm.), as well as the survey in September 2009.

Birds:

Birds were sampled by active searching throughout the Duynefontein site and Koeberg Private Nature Reserve. A list of sighted species was kept for each of 5 one-hour periods, and a reporting rate for each species calculated from the resultant lists. The reporting rate gives a rough indication of relative abundance. Additional information was obtained from Koeberg Private Nature Reserve (Eskom undated) and the Southern African Bird Atlas Project (Harrison et al. 1997).

At Bantamsklip and Thyspunt, lists of species observed were compiled separately for the inland and coastal portions of the sites. A previous study of Bantamsklip (Allan & Hockey 1989) was useful in expanding the list of confirmed species and in identifying sensitive localities. A previous study of Thyspunt

(Martin 1986) appeared to be a desktop study only and was not especially helpful.

Ecosystem processes:

Ecosystem processes were assessed by observation of habitats and land forms, and by reference to principles of animal ecology. Photography was an important tool in documenting these aspects.

1.2.3. Limitations of the study

Studies such as this generally suffer from defects that must be acknowledged:

- ***Limited time:*** A comprehensive survey requires systematic sampling of all habitats in all seasons, and at different times of day. Such thoroughness is never possible and therefore most records of occurrence are based on the literature and reports of local residents. Follow-up verification of occurrence of important species is often necessary and recommended.
- ***Limited expertise:*** It is not possible to be an expert on all groups of animals and all aspects of ecology. It is expected that this report will identify all issues of likely importance, but the appropriate response to some of these may require the inputs of other specialists.

Shortcomings arising from these limitations are minimized by application of the precautionary approach.

A specific consideration with respect to vertebrate fauna is the availability of recent Red Lists and accurate species distribution maps. In this regard, birds, mammals and amphibians all have relatively up-to-date conservation assessments published (Barnes 2000; Friedmann & Daly 2004, Minter et al. 2004; respectively). Unfortunately, the most recently published work for reptiles (Branch 1988) is badly out of date. A new conservation assessment of South African reptiles is currently underway, but will be published only in 2010. For this reason, reference to threatened reptile species is based on a provisional list of species, obtained from the Southern African Reptile Conservation Assessment (SARCA in litt.).

The methods used at the three alternative sites were not the same. Survey work at Duynefontein and Thyspunt was carried out with sampling of the fauna and with a relatively generous time budget of a week in the field at each site, while only three days were available at Bantamsklip, which allowed for little actual sampling of fauna. However, in the case of Bantamsklip, the disadvantages were reduced by the availability of relatively thorough and comprehensive NSIP studies from the 1980s (Allen & Hockey 1989; De Villiers 1989; Palmer 1989).

2. DESCRIPTION OF AFFECTED ENVIRONMENT

The three sites are discussed in turn. Six subsections under each deal with habitats, amphibians, reptiles, mammals, birds and ecosystem processes. The subsections on the four animal groups must be read in conjunction with the relevant species tables in Appendixes 1, 2 and 3.

2.1. Duynefontein: the affected environment

Figure 7: A view of the affected environment at the Duynefontein site, from the north. Note the dunes and dune slacks parallel to the coast.

The Duynefontein site is just to the north of Melkbosstrand on the west coast. The site currently houses the Koeberg Nuclear Power Station (KNPS), and the Koeberg Private Nature Reserve lies immediately to the north, although all undeveloped parts of the Koeberg site are managed as part of the nature reserve – a positive and laudable aspect of Eskom's management of this land. The site is bisected by the R27, and has numerous buildings and infrastructural features associated with the existing power station.

Koeberg Private Nature Reserve was identified as one of 11 priority conservation sites in a study encompassing the region along the West Coast between Blouberg and Silwerstroomstrand, inland to the N7 National Road (Daines & Low 1993).

Figure 8: A view of the affected environment at the Duynefontein site, from the south. Note the relatively high dunes close to the coast.

2.1.1 Habitats

It should be emphasized that the diversity of habitat types, and their condition, is inextricably linked to the diversity of vertebrate fauna on site, and to conservation management of faunal communities. It is for this reason that considerable space is devoted to describing habitats and ecosystem process (below). (The concept of biodiversity and issues surrounding biodiversity conservation are discussed at some length in Appendix 7, *An introduction to biodiversity*.)

Duynefontein lies within the Cape Floristic Region (CFR) which is largely restricted to the Western Cape and Eastern Cape provinces. This is an exceptionally biodiverse region with very high levels of species endemism. The CFR has been identified as a global Biodiversity Hotspot by Conservation International (CI; www.biodiversityhotspots.org), and is the focus of a South African government-supported initiative, the Cape Action for People and the Environment (C.A.P.E.; www.capeaction.org.za), based at the South African National Biodiversity Institute (SANBI).

Habitats on site are comprised mainly of the following vegetation types: a narrow strip of Cape Seashore Vegetation (Least Threatened) along the coast, Cape Flats Dune Strandveld (Endangered) over most of the site, and some Atlantis Sand Fynbos (Endangered) on inland portions (Mucina & Rutherford 2006).

The substrate on site is uniformly sandy. There appear to be no rocky outcrops that may be affected by the proposed construction site, although calcrete outcrops do occur elsewhere within the Koeberg Private Nature Reserve.

Natural wetlands on site are small and seasonal, and situated mainly in the slacks of vegetated dunes. There are also some semi-natural wetlands near the eastern boundary of Duynefontein (see freshwater specialist report for more detail).

The habitats within the footprint of the proposed Nuclear-1 are generally in fair to good condition because they have been cleared of alien vegetation and rehabilitation of the habitats is well advanced (see Figures 7 & 8). A full complement of expected fauna is believed to occur on site.

2.1.2 Amphibians (see Appendix 1, Table 1)

There are 9 possible species, 8 of which are of probable or confirmed occurrence.

One Threatened species, the Cape Caco *Cacosternum capense* (Vulnerable; Minter et al. 2004), could possibly breed in seasonal wetlands, but it is unlikely to occur within the proposed footprint. However, its possible occurrence is an indication that seasonal wetlands should be protected wherever possible (see specialist report on freshwater ecology for more detail). Rose’s Rain Frog *Breviceps rosei* is a Western Cape endemic species confined to coastal dune habitats. Maintenance of a coastal corridor is important to prevent fragmentation of this species’ distribution range.

2.1.3 Reptiles (see Appendix 1, Table 2)

There are 53 possible species, 40 of which are of probable or confirmed occurrence.

Two provisionally Red Listed species (see section 1.2.3, above), Gronovi's Dwarf Burrowing Skink *Scelotes gronovii* (Near Threatened) and Southern Adder *Bitis armata* (Vulnerable), are of probable occurrence, and one, Blouberg Dwarf Burrowing skink *Scelotes montispectus* (Near Threatened), is of confirmed occurrence. Local impact on these species is likely to occur within the footprint. As with Rose’s Rain Frog, these species are Western Cape endemics confined to coastal habitats. Maintenance of a coastal corridor is important to prevent fragmentation of their distribution ranges.

Figure 9: A specimen of the Blouberg Dwarf Burrowing Skink *Scelotes montispectus,* a recently described and potentially threatened species, found at Duynefontein by active searching. (Photo by M. Burger.)

2.1.4 Mammals (see Appendix 1, Table 3)

There are 56 possible species, 39 of which are of probable or confirmed occurrence.

The only Threatened species which may occur are the Whitetailed Mouse *Mystromys albicaudatus* (Endangered) and Honey Badger *Mellivora capensis* (Near Threatened; Friedmann & Daly 2004). Local research suggests that the mouse is more likely to occur on heavy soils than on sandy soils, so its occurrence at Koeberg may be limited to relatively small patches of suitable habitat, and these are not likely to be situated near to the coast (C. Dorse pers. comm.). The Honey Badger has been recorded at Blaauwberg (C. Dorse pers. comm.), but it is less likely to occur in coastal areas such as Duynefontein. It is a species that should be able to easily escape from the construction site during site clearance. Four species of bat that have the status of Near Threatened, are likely to be only visitors to Duynefontein, with their roosting and breeding sites elsewhere. The Bontebok (Vulnerable), is an introduced species which need not be directly impacted by the proposed developments, unless it is poached.

2.1.5 Birds (see Appendix 1, Table 4)

There are 203 possible species, 158 of which are of probable or confirmed occurrence.

Several Threatened seabird species occur on the coast, e.g., Crowned Cormorant *Phalacrocorax neglectus* (Vulnerable), Bank Cormorant *Phalacrocorax coronatus* (Near Threatened), Caspian Tern *Hydroprogne caspia*

(Near Threatened). However, these are unlikely to be negatively impacted by the proposed Nuclear-1 because, in light of the experience at KNPS, the power station will have a neglible impact on the marine environment (Afrosearch 2002).

The relatively protected environment in and around Koeberg harbour provides excellent habitat for seabirds and shorebirds to roost and even breed. Swift Terns *Sterna bergii* and African Black Oystercatchers *Haematopus moquini* (Near Threatened), in particular, have been recorded breeding in numbers and these represent regionally important breeding colonies (Le Roux 2002; Parsons & Underhill 2005). It is essential that disturbance of these colonies is kept to an absolute minimum. Nuclear-1 will not be using or affecting Koeberg harbour directly, but construction activities in the vicinity have the potential to cause damaging disturbance.

Several Threatened species of raptor occur on site. The Black Harrier *Circus maurus* (Near Threatened) is known to breed at Duynefontein, and the Marsh Harrier *C. ranivorus* (Vulnerable) may breed in the large coastal wetland area in the northern part of Duynefontein (Barnes 2000; Simmons et al. 2002). It is unlikely that either of these species breed on the proposed footprint.

Several species of raptor, some of which are Threatened, and waterbirds, are among the species which could be problematic in terms of interactions with electrical installations.

2.1.6 Ecosystem processes

Continuity between inland habitats and the coast is generally good at Duynefontein, but is locally disrupted by KNPS and its associated buildings and security fences. The erection of a second nuclear power station immediately north of KNPS, and the addition of PBMR DPP immediately to the south of KNPS, presents the prospect of a long, solid barrier between the coast and the inland portions of Duynefontein. Every effort must be made to maintain ecological corridors linking the coast to the interior so that animals can move freely between these habitat types and exploit a variety of food resources.

There is extensive and severe invasion by alien vegetation, mainly Rooikrans *Acacia cyclops*, in large parts of Koeberg Private Nature Reserve. Alien vegetation not only degrades natural habitats, but also tends to create drier soil conditions, to the detriment of seasonal wetlands and their fauna, and also creates the conditions for hot, damaging wildfires. There is clear evidence of an aggressive programme by Eskom to remove these invader plants, and this is to be praised and encouraged.

The sandy dunes, especially the sparsely vegetated, high dunes near the coast, are vulnerable to mechanical disturbance and to obstruction of wind-borne sand. It is important to allow mobile dunes to remain mobile, without artificial barriers to the movement of sand, and to avoid causing vegetated dunes to become mobile through disturbance. Natural, dynamic dune systems create a complex of ecotonal habitats and habitat edges that are attractive to a variety of vertebrate fauna.

On the western side of the R27, natural habitats are being maintained with as little disturbance as possible. For example, there has been no bush clearance under the transmission lines. From a conservation viewpoint this is a positive management practice as breaks, especially wide breaks, in habitats can be almost as disruptive as physical barriers to the movements of certain species that need to remain within their preferred habitat types at all times.

The ecosystem at Duynefontein has characteristically few large, permanent wetlands, and relatively many small, seasonal wetlands. Although seasonal wetlands may appear to be insignificant, they play an important ecological role as breeding habitats for semi-aquatic fauna, such as frogs, and a variety of birds, such as weavers, bishops, reed warblers, etc. They supply shelter for a variety of fauna, as well as seasonal food resources and fresh drinking water, at least for the winter months. For these reasons, seasonal wetlands should be regarded as important and sensitive habitats that are essential to the maitenance of a healthy ecosystem and a full complement of biodiversity (see specialist report on freshwater ecology for more detail).

2.1.7 Sensitivity map

The mapping of faunal sensitivity was based primarily on (a) scarce habitats important to the maintenance of faunal diversity, (b) areas important for ecological corridors, and (c) areas occupied by particularly sensitive species. In the case of Duynefontein, the areas identified as having high faunal sensitivity were:

- All wetlands, with a 100-m buffer. Wetlands have a central role in maintaining faunal diversity and faunal populations. Buffers are essential to provide semi-aquatic species with terrestrial habitat and corridors of access for terrestrial species.
- The coastal corridor (200 m above the projected 2075 100-year high-water line; Prestedge et al. 2009). A coastal corridor provides fauna with access to coastal resources and allows movement along the coast. The width of the corridor needs to take future sea-level rise into account.
- A 100-m corridor between KNPS and the Nuclear-1 development corridor. This corridor prevents an unbroken wall of development separating inland habitats from coastal habitats.
- The mobile-dune field. The ecology of the dune field is highly dynamic and easily disrupted by alteration of patterns of sand movement, therefore obstructions – especially at the coastal point of origin – need to be avoided. Such disruption has already occurred with the construction of KNPS, but the balance of the dune field needs to be protected as far as possible.
- Areas to the north have greater conservation value because their long-term prospects of protection are better, and the Koeberg Private Nature Reserve could, potentially, be expanded to the north.
- All other areas are of medium sensitivity.
- No areas are of low sensitivity because all are in relatively natural condition.

Figure 10: Faunal sensitivity map for Duynefontein.

2.2 Bantamsklip: the affected environments

In the discussions that follow, it should be noted that it is the coastal portion of the Bantamsklip site, south of the R43, that contains the entirety of the proposed development footprint. It is, therefore, the fauna of this portion, and the likely impacts on this portion, that receive the most attention in this section.

Figure 11: View of eastern portion of the affected environment at Bantamsklip. Note the limestone ridge, with the remains of a dry-stone wall (foreground) angling away from the coast, and the complex of dune ridges and slacks on the seaward side of the ridge.

Figure 12: A view of the western portion of the affected environment at Bantamsklip. Note the limestone ridge that angles in close to the coast in this area. Also note the relatively level area (top right) inland of the ridge.

2.2.1 Habitats

It should be emphasized that the diversity of habitat types, and their condition, is inextricably linked to the diversity of vertebrate fauna on site, and to conservation management of faunal communities. It is for this reason that considerable space is devoted to describing habitats and ecosystem process (below). (The concept of biodiversity and issues surrounding biodiversity conservation are discussed at some length in Appendix 7, *An introduction to biodiversity*.)

The Bantamsklip site lies within the Cape Floristic Region Cape Floristic Region (CFR) which is largely restricted to the Western Cape and Eastern Cape provinces. This is an exceptionally biodiverse region with very high levels of species endemism. The CFR has been identified as a global Biodiversity Hotspot by Conservation International (CI; www.biodiversityhotspots.org), and is the focus of a South African government-supported initiative, the Cape Action for People and the Environment (C.A.P.E.; www.capeaction.org.za), based at the South African National Biodiversity Institute (SANBI).

The site lies roughly equidistant between the town of Pearly Beach to the north-west and Quoin Point to the south-east. It is bisected by the R43, creating a coastal and an inland portion (the latter on the farm Hagelkraal), which are distinct from each other in terms of dominant habitats and biotic communities. The farm Hagelkraal is registered with DEAT as a Natural Heritage Site.

Habitats on site are comprised mainly of the following vegetation types: a narrow coastal strip of Cape Seashore Vegetation (Least Threatened), Overberg Dune Strandveld (Least Threatened) covering almost all of the coastal portion, Agulhas Limestone Fynbos (Least Threatened) covering the majority of the inland portion, an extensive area of Overberg Sandstone Fynbos (Least Threatened) on the inland portion, a small area of Agulhas Sand Fynbos (Vulnerable) on the inland portion, a very small area of Southern Coastal Forest (Least Threatened) on the hillsides of the inland portion. In addition, there are significant areas of wetland and drainage lines on the inland portion.

The coastal portion is characterized by an undulating topography created by a series of vegetated dunes. The inland portion is a broken landscape with hills – including rocky, limestone hills with numerous caves – and marshy lowlands.

Figure 13: A typical landscape on Hagelkraal. Note the limestone hills and marshy fynbos.

Figure 14: Typical landscape on the coastal portion of Bantamsklip. This view is in the dune field on the western half of the site. Note the undulating vegetated dunes and dune slacks.

Both portions of the Bantamsklip site are in good condition with only limited disturbance and invasive alien vegetation. There is, however, evidence of abelone-poaching activities at the coast. The site, as a whole, is exceptionally varied in its habitats and can be expected to contain a rich diversity of fauna. The inland portion, in particular, includes some Threatened habitat types which are important to some equally sensitive species. The site has impressive scenic qualities, especially on the inland portion.

2.2.2 Amphibians (see Appendix 2, Table 1)

On the coastal portion of Bantamsklip, there are 14 possible species, 4 of which are of probable or confirmed occurrence.

While several Threatened species are known to occur and breed on the farm Hagelkraal (inland portion), including the Micro Frog *Microbatrachella capensis* (Critically Endangered), Cape Platanna *Xenopus gilli* (Endangered) and Western Leopard Toad *Amietophrynus pantherinus* (Endangered; De Villiers 1989; Minter et al. 2004), these species are only of possible to unlikely occurrence on the coastal portion, and then only at the western extreme, close to the Hagelkraal River. The area covered by the proposed footprint is occupied by Rose's Rain Frog *Breviceps rosei* which is a Western Cape endemic species confined to coastal dune habitats. Maintenance of a coastal corridor is important to prevent fragmentation of this species' distribution range.

Figure 15: A highly sensitive wetland on Hagelkraal. This wetland is home to important populations of Threatened species, viz., Micro Frog and Cape Platanna.

Figure 16: A Critically Endangered Micro Frog found on Hagelkraal.

2.2.3 Reptiles (see Appendix 2, Table 2)

On the coastal portion of Bantamsklip, there are 42 possible species, 34 of which are of probable or confirmed occurrence.

One provisonally Red Listed species is likely to occur, namely the Southern Adder *Bitis armata* (Vulnerable), which is also a Western Cape endemic species. This species occupies coastal thicket and lowland fynbos. Ecological corridors will help to prevent its coastal distribution from being fragmented. A number of other endemic species, such as the Silvery Dwarf Burrowing Skink *Scelotes bipes*, will similarly benefit from the provision of corridors.

Figure 17: Cape Girdled Lizards and Ocellated Geckos, as found under a rock on the limestone ridge, near the coast at Bantamsklip.

2.2.4 Mammals (see Appendix 2, Table 3)

On the coastal portion of Bantamsklip, there are 60 possible species, 37 of which are of probable or confirmed occurrence.

Red Listed species of probable occurrence include Fynbos Golden Mole *Amblysomus corriae* (Near Threatened), White-tailed Mouse *Mystromys albicaudatus* (Endangered), four species of Near Threatened bat (non-breeding individuals only), and Honey Badger *Mellivora capensis* (Near Threatened; Friedmann & Daly 2004). The proposed developments are not likely to affect important breeding populations of any of these species, and the provision of ecological corridors will help to ensure their continued presence on site.

2.2.5 Birds (see Appendix 2, Table 4)

On the coastal portion of Bantamsklip, there are 187 possible species, 72 of which are of confirmed occurrence.

A sensitive group of birds occurring on and near to the site comprises Threatened and Near Threatened seabirds which roost and forage at the coast: Cape Cormorant *Phalacrocorax capensis* (Near Threatened), Bank Cormorant *P. neglectus* (Endangered), Crowned Cormorant *P. coronatus* (Near Threatened), African Black Oystercatcher *Haematopus moquini* (Near Threatened), and Damara Tern *Sterna balaenarum* (Endangered; Barnes 2000). Allan & Hockey (1989) identified the following sensitive seabird sites near to the development site: a gull and tern roost at the mouth of the Hagelkraal River, six potential Damara Tern foraging sites along the coast between the Hagelkraal River mouth and Buffeljagt Bay, a tern roost at Plaatjieskraal Bay, and a cormorant breeding colony on Voëleiland (Bird Island), immediately east of Buffeljagt Bay. Many other parts of the rocky coastline are also used by cormorants, gulls and terns for roosting. Most of the coastline can be considered sensitive for breeding pairs of oystercatchers (pers. obs.).

An important wetland with numerous breeding waterbirds is situated on the Hagelkraal River, near to its mouth. Blue Cranes have been recorded breeding in unusual habitat in the dunes at the western end of the Bantamsklip site (Allan & Hockey 1989).

Collectively, these facts indicate that it is necessary to view the whole of the coastline as sensitive habitat where construction impacts and disturbance need to be kept to an absolute minimum. The maintenance of a wide coastal corridor is an essential mitigation in this regard.

Sensitive terrestrial species include Black Harrier *Circus maurus* (Near Threatened), Denham's Bustard *Neotis denhami* (Vulnerable) and Blue Crane *Anthropoides paradiseus* (Vulnerable), all of which are likely to breed on site. Denham's Bustard and Blue Crane are also vulnerable to fatal collisions with overhead transmission cables, and Denham's Bustard is notoriously sensitive to disturbance while breeding (Barnes 2000). Allan & Hockey (1989) identified Denham's Bustard breeding areas at the eastern end of Bantamsklip and beyond its eastern boundary; at least some of this breeding habitat falls within the development corridor.

2.2.6 Ecosystem processes

The fragmentation of the site by the R43 is an unfortunate feature which partially disrupts ecosystem processes, but otherwise the site is well connected to neighbouring properties and local ecosystems appear to be largely intact and functioning normally.

The variety of habitats means that there are extensive ecotones which are important in ecological and evolutionary processes. The inland, fynbos areas have fire as an important ecological driver, and this holds important implications for environmental management. There are a number of watercourses and wetlands, as well as numerous rocky hills and caves, all of ecological importance and potentially vulnerable to disturbance.

The coastal portion is sandy, undulating and sensitive to mechanical disturbance. However, except for the coast itself and areas immediately adjacent to the coast, the portion of the site to the south of the R43 can be considered generally less ecologically sensitive and less irreplaceable to conservation than the portion to the north of the R43. Within this coastal portion, however, the eastern half can be considered less sensitive than the western half, because an extensive, undulating dune field is present in the western half. The undulating topography of the dune field creates a greater complexity of micro-habitats and niches for fauna. The dunes are also more sensitive to disturbance.

2.2.7 Sensitivity map

The mapping of faunal sensitivity was based primarily on (a) scarce habitats important to the maintenance of faunal diversity, (b) areas important for ecological corridors, and (c) areas occupied by particularly sensitive species. In the case of Bantamsklip, the areas identified as having high faunal sensitivity were:

- All wetlands, with a 100-m buffer. Wetlands have a central role in maintaining faunal diversity and faunal populations. Buffers are essential to provide semi-aquatic species with terrestrial habitat and corridors of access for terrestrial species. The wetlands on the inland portion hold several Threatened species of amphibian.
- The coastal corridor (200 m above the projected 2075 100-year high-water line; Prestedge et al. 2009). A coastal corridor provides access to coastal resources and allows movement along the coast. The width of the corridor needs to take future sea-level rise into account.
- The western dune field. This dune field provides a relative diversity of microhabitats and is sensitive to mechanical disturbance and destabilization.
- The whole of the inland portion (above the R43). This area is highly sensitive because of wetlands, rare habitat types and broken topography.
- All other areas are of medium sensitivity.
- No areas are of low sensitivity because all are in relatively natural, unspoilt condition.

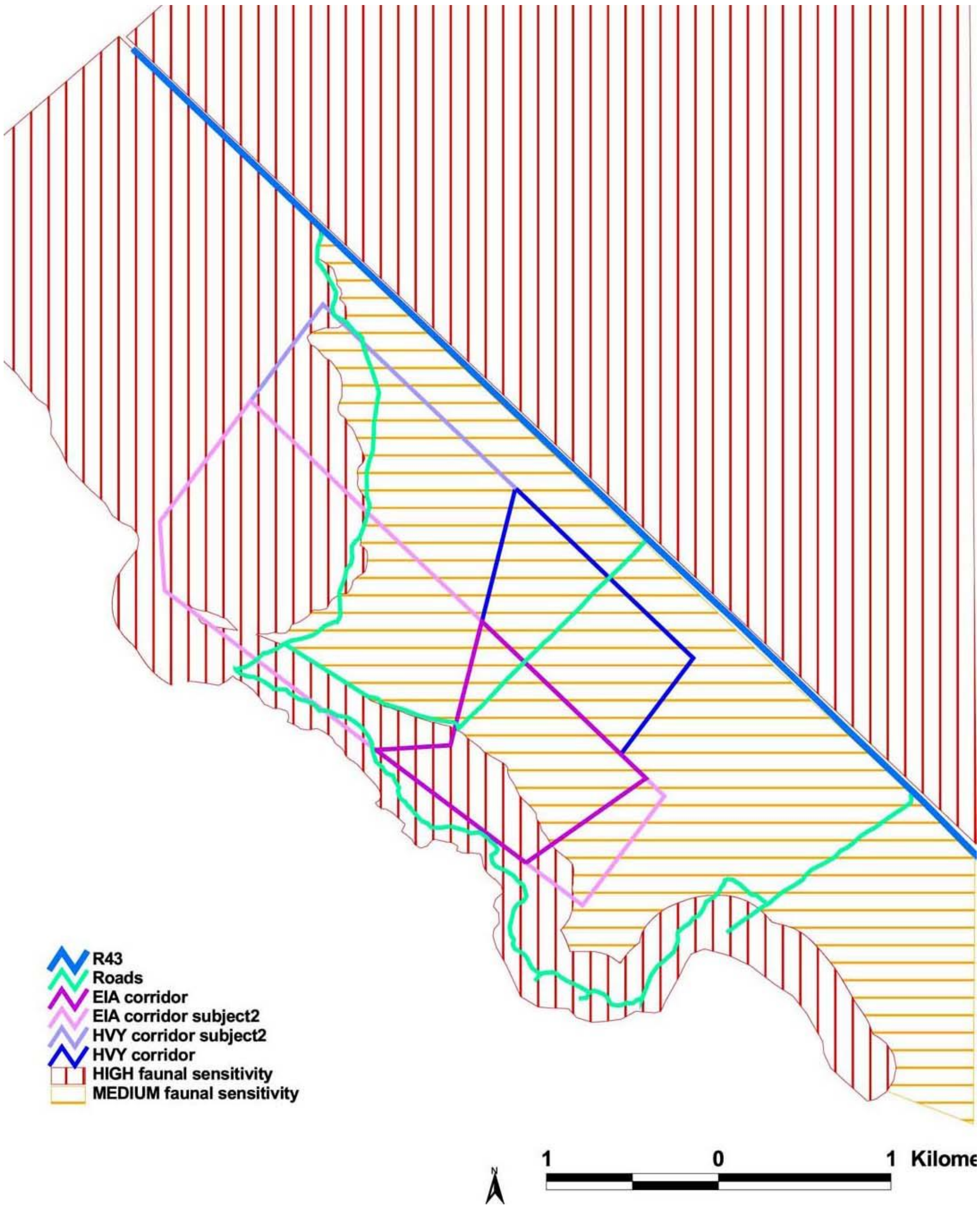

Figure 18: Faunal senstivity map for Bantamsklip.

2.3 Thyspunt: the affected environments

Figure 19: A view of the coastal portion of the affected environment at Thyspunt, from the west. Note the densely vegetated dunes and dune slacks and the great height of some dunes.

Figure 20: View of the inland portion of the affected environment at Thyspunt, from near the northern boundary. Note the natural grassy fynbos on a rocky substrate in the foreground, the agricultural lands (pale green) in the middle distance, and the mobile dunes (white) in the far distance.

2.3.1 Habitats

It should be emphasized that the diversity of habitat types, and their condition, is inextricably linked to the diversity of vertebrate fauna on site, and to conservation management of faunal communities. It is for this reason that considerable space is devoted to describing habitats and ecosystem process (below). (The concept of biodiversity and issues surrounding biodiversity conservation are discussed at some length in Appendix 7, *An introduction to biodiversity*.)

The site lies close to Cape St Francis, to the west. It lies within the CFR which is largely restricted to the Western Cape and Eastern Cape provinces. This is an exceptionally biodiverse region with very high levels of species endemism. The CFR has been identified as a global Biodiversity Hotspot by Conservation International (CI; www.biodiversityhotspots.org), and is the focus of a South African government-supported initiative, the Cape Action for People and the Environment (C.A.P.E.; www.capeaction.org.za), based at the South African National Biodiversity Institute (SANBI).

The site is registered with DEAT as a Natural Heritage Site.

Habitats on site are largely comprised of the following veld types: Algoa Dune Strandveld (Least Threatened) covering the majority of the area, Southern Cape Dune Fynbos (Least Threatened) on a relatively large area, a narrow coastal strip of Cape Seashore Vegetation (Least Threatened), and a relatively small area of Tsitsikamma Sandstone Fynbos (Vulnerable) on an inland extension of the site. The latter inland portion has been largely transformed by agriculture. In addition there are small patches of thicket which have matured into low forest; also thickets of invasive alien vegetation, mainly Rooikrans *Acacia cyclops* and Port Jackson Willow *A. saligna*. Between the coastal and inland portions of the site lies and extensive transverse mobile-dune field with interspersed vegetated areas and and seasonal wetlands.

Figure 21: Tsitsikamma Sandstone Fynbos (Vulnerable) on rocky substrate in the northern parts of the inland portion of Thyspunt. This is one of the sensitive areas on the inland portion. Note dune field in the background.

Figure 22: An example of thicket that has matured into low forest at Thyspunt.

The site has many complex wetland systems. These comprise (1) seasonal and perennial springs and wetlands in dune slacks, (2) many seeps along the rocky shores at the coast, (3) seasonal wetlands in flat areas between dunes in the mobile-dune field, (4) wetlands associated with drainage from rocky uplands on the inland portion of the site, and (5) a large perennial wetland which appears to actually be a dam on the Slang River, just to the north of the mobile-dune field.

The largest of the dune-slack wetlands is the Langefontein wetland which lies between vegetated dunes, with most of its length within the Eskom property. At least some of the coastal seeps are perennial sources of freshwater. There are also at least two streams, one with a small estuary at the eastern end of the central sandy beach. The richness of freshwater systems contributes greatly to the ecological and biodiversity richness of the Thyspunt site.

Figure 23: A drainage line and wetlands on the inland portion of Thyspunt. Note transformed habitats with invasive Kikiyu Grass.

Figure 24: The dam on the Slang River, Thyspunt.

Figure 25: The Langefontein wetland, most of which is on the Thyspunt site and situated close to the proposed footprint. Note the dense wetland vegetation between vegetated dunes.

The site slopes quite steeply from its inland reaches, down to the coast. In addition, the larger coastal portion of the site undulates as a result of vegetated transverse (east-west) dune ridges. The intervening mobile-dune field is one of the largest along the south coast. The coastal areas are rocky in the western parts, with relatively small, sandy beaches in places, while at the eastern end of the site there is a long, sandy beach.

Figure 26: A view of the inland dune field at Thyspunt. Note the seasonal wetland and the complexity of transitional habitats in the dune field.

Figure 27: Coastal wetlands and seeps on the rocky shore at Thyspunt.

Figure 28: A view of the Thyspunt coast where the reeds indicate how extensive the freshwater systems are along this stretch of rocky coastline.

Figure 29: A stream emerging from the dunes onto a beach at Thyspunt.

Figure 30: An example of freshwater habitat and organisms penetrating deep into the splash zone of the rocky coast at Thyspunt.

Figure 31: An example of estuarine habitat on a sandy shore at Thyspunt. Note vegetation typical of lagoons here occurring on a beach on an open shore as a result of freshwater seepage.

It is clear from the description above that the site is environmentally varied and complex, with several distinctly different habitat types, a complex topography with complex drainage, and a varied coastline. Despite the proximity of the towns of Cape St Francis in the east and Oyster Bay in the west, the site is remarkably wild, unspoilt, and strikingly beautiful.

See ecosystem processes (section 2.3.6, below) for discussion of relevance of habitats to fauna.

2.3.2 Amphibians (see Appendix 3, Table 1)

There are 15 possible species, all of which are of probable or confirmed occurrence. None of the species is Threatened, but there are nevertheless some important conservation issues around amphibians on site.

The wetlands in the dune field are occupied by a number of species and these have been the subject of special surveys by Van Teylingen et al. (1993) and Cunningham & Henderson (2008). A population of Cape Sand Toad *Vandijkophrynus angusticeps* is of special interest because it is at the eastern extremity of its range here. The population is probably isolated from all others populations of this species and may, therefore, be genetically and even taxonomically distinct. The population needs to be studied further, but, in the interim, it should be regarded as a rare, important and sensitive population requiring the highest levels of protection.

Figure 32: An example of a well-vegetated seasonal wetland in the dune field. Habitats like these are important for wildlife and may be home to scientifically important populations of frogs.

Also of considerable interest are the frogs that occupy the coastal wetlands and seeps above the rocky shoreline. Six species (Common Platanna *Xenopus laevis,* Common River Frog *Amietia angolensis,* Bronze Caco *Cacosternum nanum*, Striped Stream Frog *Strongylopus fasciatus*, Clicking Stream Frog *Strongylopus grayii*, Cape Sand Frog *Tomopterna delalandii*) were observed in these habitats which is an unusual species richness for localities so close to the sea. It can be assumed that these species are also all breeding here. Along with the occurrence of other types of freshwater-associated species (see below), this community of amphibians is of special scientific and conservation interest and needs to be protected.

Penther's Rain Frog *Breviceps adspersus pentheri,* a fossorial terrestrial frog, is a range-restricted taxon endemic to the Eastern Cape province and therefore of special conservation significance. It is of probable occurrence on the inland "pan-handle" part of the site.

Figure 33: Eastern Leopard Toad *Amietiophrynus pardalis* found at the Langefontein wetland, Thyspunt.

2.3.3 Reptiles (see Appendix 3, Table 2)

There are 62 possible species, 50 of which are of probable or confirmed occurrence.

Probably occurring species that are provisionally Red Listed (SARCA in litt.) are FitzSimons' Long-tailed Seps *Tetradactylus fitzsimonsi* (Vulnerable) and Tasman's Girdled Lizard *Cordylus tasmani* (Vulnerable). In addition, Péringuey's Coastal Leaf-toed Gecko *Cryptactites peringueyi* (Critically Endangered) is of possible occurrence. This extremely range-restricted Eastern Cape endemic species is known from only two localities, one of which is the Krom River estuary, situated only a few kilometers to the east of the site. If it does occur, it is likely to be associated with vegetation in the splash zone along the coast.

Herald Snake *Crotaphopeltis hotamboeia* and Cape Girdled Lizard *Cordylus cordylus* were found very near to the sea, in association with the coastal wetlands. The Herald Snake is a specialist predator of frogs. These findings strengthen the impression that a community of wetland-associated species exists immediately adjacent to the marine environment – an unusual and rare ecosystem which should be protected.


Figure 34: Two Herald Snakes found very near to the coast at Thyspunt.

None of the anticipated Threatened species was confirmed during the field survey (September 2009), but this does not necessarily mean that they are not present. A short survey in one season is insufficient to confirm absence of a species. However, one provisionally Red Listed species that was not anticipated was found, namely Elandsberg Dwarf Chameleon *Bradypodion taeniabronchum* (Endangered; Fig. 35). This animal was found to inhabit the vegetation in the Langefontein wetland, and was not found at any other locality on site (Fig. 36). (Nor was any other chameleon found on site.) This is a new locality for this species, and it is well removed from other known localities. Its DNA is undergoing analysis because it may be genetically distinct from other populations of the species. If this is found to be the case, it would further underline the population's conservation importance, and that of the Langefontein wetland.

Figure 35: Elandsberg Dwarf Chameleon *Bradypodion taeniabronchum* (Endangered) found in the Langefontein wetland, Thyspunt.

Figure 36: Langefontein wetland (pale area in the centre, just below the horizon), where Elandsberg Dwarf Chameleons were found. Note the elevation of the wetland relative to the surrounding landscape.

2.3.4 Mammals (see Appendix 3, Table 3)

There are 58 possible species, 44 of which are of probable or confirmed occurrence.

Only three species are Red Listed as Threatened or Near Threatened, namely Fynbos Golden Mole *Amblysomus corriae* (Near Threatened), Honey Badger *Mellivora capensis* (Near Threatened) and Blue Duiker *Philantomba monticola* (Vulnerable). The Blue Duiker and Honey Badger are almost certain to occur. The duiker depends on protection of the patches of dense coastal thicket and forest that occur on site.

Figure 37: A Woodland Dormouse *Graphiurus murinus* which was caught in a small-mammal trap at Thyspunt.

At the coast, especially at or near to coastal wetlands, there was abundant spoor of Cape Clawless Otter *Aonyx capensis* and Marsh Mongoose *Atilax paludinosus,* as well as antelope, probably Bushbuck *Tragelaphus scriptus* and Common Duiker *Sylvicapra grimmia*. These provided further evidence of the ecological importance, as well as the richness and sensitivity of the coastal wetlands. To our knowledge, the largest number of Cape Clawless Otters ever filmed together in the wild – six adults and juveniles – were filmed at Thyspunt for the TV programme “Groen” (2009; Fig. 41).

Figure 38: Cape Clawless Otter spoor on a beach at Thyspunt, in association with a freshwater coastal seep.

There have been reliable reports of Leopards *Panthera pardus* occurring and possibly breeding on site (Gert Greeff pers. comm.). While the Leopard is not a Threatened species, its occurrence in coastal environments has become rare. This species is symbolic of the wild, unspoilt nature of the site, and of an ecosystem that is intact and functioning in, or quite close to, its original condition. Leopards can survive, and possibly thrive, in this environment because a number of suitable prey species still occur in good numbers (confirmed), e.g., Bushpig, Vervet Monkey, Common Duiker, Bushbuck and Red Necked Spurfowl. It is this intactness of the ecosystem which makes Thyspunt a site of substantial conservation importance for fauna, especially as it is located at the coast where most ecosystems have been radically altered.

Figure 39: Vervet Monkeys in coastal thicket at Thyspunt.

2.3.5 Birds (see Appendix 3, Table 4)

There are 206 species of possible occurrence, 61 of which were confirmed during the site visit.

Several Threatened and Near Threatened species are of likely or confirmed occurrence on site: Blue Crane *Anthropoides paradiseus* (Vulnerable), Black-winged Lapwing *Vanellus melanopterus* (Near Threatened), African Black Oystercatcher *Haematopus moquini* (Near Threatened), African Marsh Harrier *Circus ranivorus* (Vulnerable), Black Harrier *Circus maurus* (Near Threatened), Secretarybird *Sagittarius serpentarius (*Near Threatened), White-bellied Korhaan *Eupodotis senegalensis* (Vulnerable), Denham's Bustard *Neotis denhami* (Vulnerable), Knysna Woodpecker *Campethera notata* (Near Threatened) and Knysna Warbler *Bradypterus sylvaticus* (Vulnerable). Threatened seabirds are likely to roost and/or forage at the coast, viz., Roseate Tern *Sterna dougalli* (Endangered) and Damara Tern *Sterna balaenarum* (Endangered).

Threatened birds likely to occur on the inland portion of the Thyspunt site, and be particularly affected by transmission lines there, are Blue Crane, Denham's Bustard, White-bellied Korhaan and Secretarybird.

Figure 40: Terns and gulls roosting in a sheltered bay on Thyspunt's rocky coast.

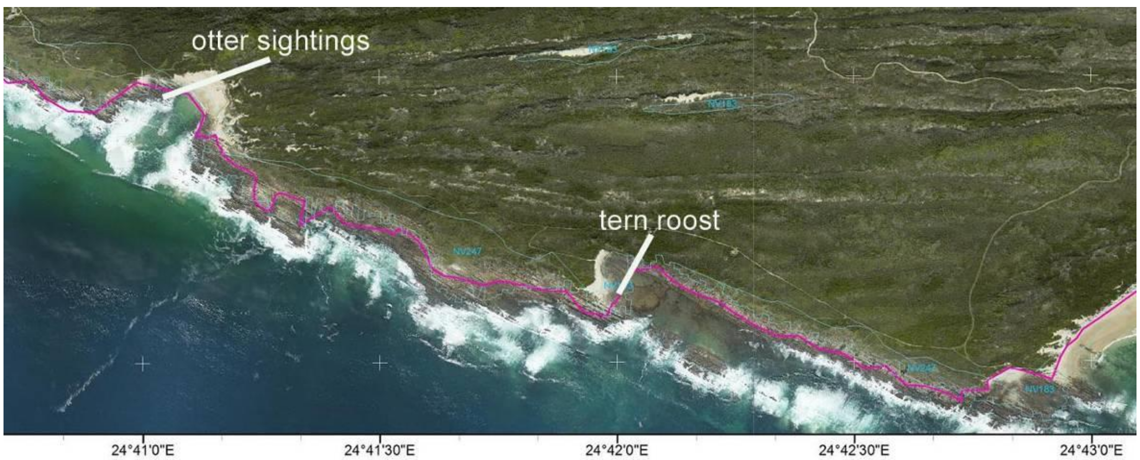

Figure 41: Location of tern roost and otter sightings. This stretch of rocky coast is also where most of the coastal seeps are located.

There is a coastal locality which appears to be important as a roost site for terns of a variety of species (Fig. 40). This is at the head of the sheltered bay just to the west of Thyspunt itself (Fig. 41). It is also along the shoreline of this bay that the greatest concentration of coastal seeps occurs. The proximity of marine and freshwater ecosystems in this area (see above) is believed to be the result, in part, of the sheltered nature of the bay which protects the coastal seeps from saltwater invasion by wave action. The sheltered nature of the bay also creates a suitable roost site for seabirds. This bay should be viewed as a sensitive locality requiring the highest level of protection.

2.3.6 Ecosystem processes

In the preceding section on habitats (2.3.1, above), the text and illustrations highlight the variety of habitats found at Thyspunt. Under an ecosystems approach (see section 1.2, above), the species richness of fauna needs to be understood in terms of the bio-physical features of the ecosystem and, in particular, the diversity of habitats contained within that system. This implies that it is not merely the species on site themselves, but also the environmental context in which they are found, that is relevant to biodiversity conservation. Thus, for example, the fact that many common terrestrial species are found at the very edge of the marine environment along the rocky coastline of Thyspunt, is a direct result of the freshwater coastal seeps that occur in this area. This has given rise to an ecosystem with a pattern of resource utilization that is atypical and unusual. These ecological patterns, quite apart from the species themselves, are rare, of scientific interest and ecologically important, and therefore should be viewed as conservation worthy and of high significance. The same logic applies to aquatic and semi-aquatic communities in the dune field.

Because the diversity of habitats and their use by animals is an important determinant of the biodiversity of the site, it follows that threats to those habitats are also a threat to the vertebrate animals that use them, and to the ecological relationships between animals and their resources, which include vegetation, wetlands and coastline. For example, the spread of Kikuyu Grass *Pennisetum clandestinum* into wetlands (Fig. 23) is a threat not only to the indigenous vegetation of the wetlands, but to the fauna, such as frogs, for which the wetlands are a vital resource.

Space and available information do not permit one to outline every relevant ecological relationship between vertebrate species and their habitats in order to justify an emphasis on habitat preservation and management, but this should not be necessary because the importance of habitats and ecological relationships is axiomatic to conservation theory. (The concept of biodiversity and issues surrounding biodiversity conservation are discussed at some length in Appendix 7, *An introduction to biodiversity*.)

The presence of several different habitat types means that there are also extensive ecotonal areas where habitats intergrade. Such areas are important in promoting adaptability and resilience of ecosystems. The inter-connectedness of habitats means that a wide variety of resources is available to fauna, thus helping to ensure the sustainability of populations. Fragmentation and isolation of habitats should be avoided.

The presence of perennial water on site is an important feature in sustaining aquatic and semi-aquatic species in particular, and animal life in general. These include the Langefontein wetland, the riparian habitats in the northern parts of the site, the seasonal wetlands in the dune field, and the many coastal wetlands, seeps and streams that are created by seepage of groundwater. Seepage and drainage are processes that need to be protected from disturbance caused by construction of buildings.

Large areas of mobile dunes, and vegetated dunes, are vulnerable to disturbance and resultant habitat degradation, especially given that the dunes are steeply sloped in many places. Where dune systems are crossed by infrastructural development, environmental management and maintenance of installations is often problematic. The transverse field of mobile dunes is especially problematic for all forms of development because the dunes are mobile and sand will inevitably encroach on any development within this zone. The dynamic nature of the dune field is important in the maintence of its particular suite of habitats.

2.3.7 Sensitivity map

The mapping of faunal sensitivity was based primarily on (a) scarce habitats important to the maintenance of faunal diversity, (b) areas important for ecological corridors, and (c) areas occupied by particularly sensitive species (Fig. 42). In the case of Thyspunt, the areas identified as having high faunal sensitivity were:

- All wetlands, with a 100-m buffer. Wetlands have a central role in maintaining faunal diversity and faunal populations. Buffers are essential to provide semi-aquatic species with terrestrial habitat and corridors of access for terrestrial species. The Langefontein wetland is home to the Elandsberg Dwarf Chameleon (Endangered). The coastal seeps represent a rare and unusual ecosystem.
- The coastal corridor (200 m above the projected 2075 100-year high-water line; Prestedge et al. 2009). A coastal corridor provides access to coastal resources and allows movement along the coast.
- Most of the central mobile-dune field. The ecology of the dune field is highly dynamic and easily disrupted by alteration of patterns of sand movement, therefore obstructions need to be avoided. Areas containing wetlands have been indicated as having high sensitivity, otherwise medium.
- All areas containing forest (defined mostly as “thicket” by Low 2008). Many species are obligate residents of thicket and forest, and many more regularly use the resources found in these habitats, therefore they are essential in the maintenance of faunal diversity on site. The resolution of types of thicket (viz., strandveld thicket, dune forest, alien thickets) was not possible (Barrie Low pers. comm.), so parts of the thicket areas would, in fact, be of medium sensitivity.
- The inland area covered by Tsitsikamma Sandstone Fynbos. This is classified as a Vulnerable vegetation type (Mucina & Rutherford 2006) and, together with its rocky substrate, was found to be a rich habitat for reptiles and a probable breeding habitat for Denham’s Bustard (Vulnerable) and Blue Crane (Vulnerable) and foraging habitat for Secretarybird (Near Threatened).
- All other natural areas are of medium sensitivity.
- Areas transformed by agriculture (on the inland portion) are of low sensitivity.

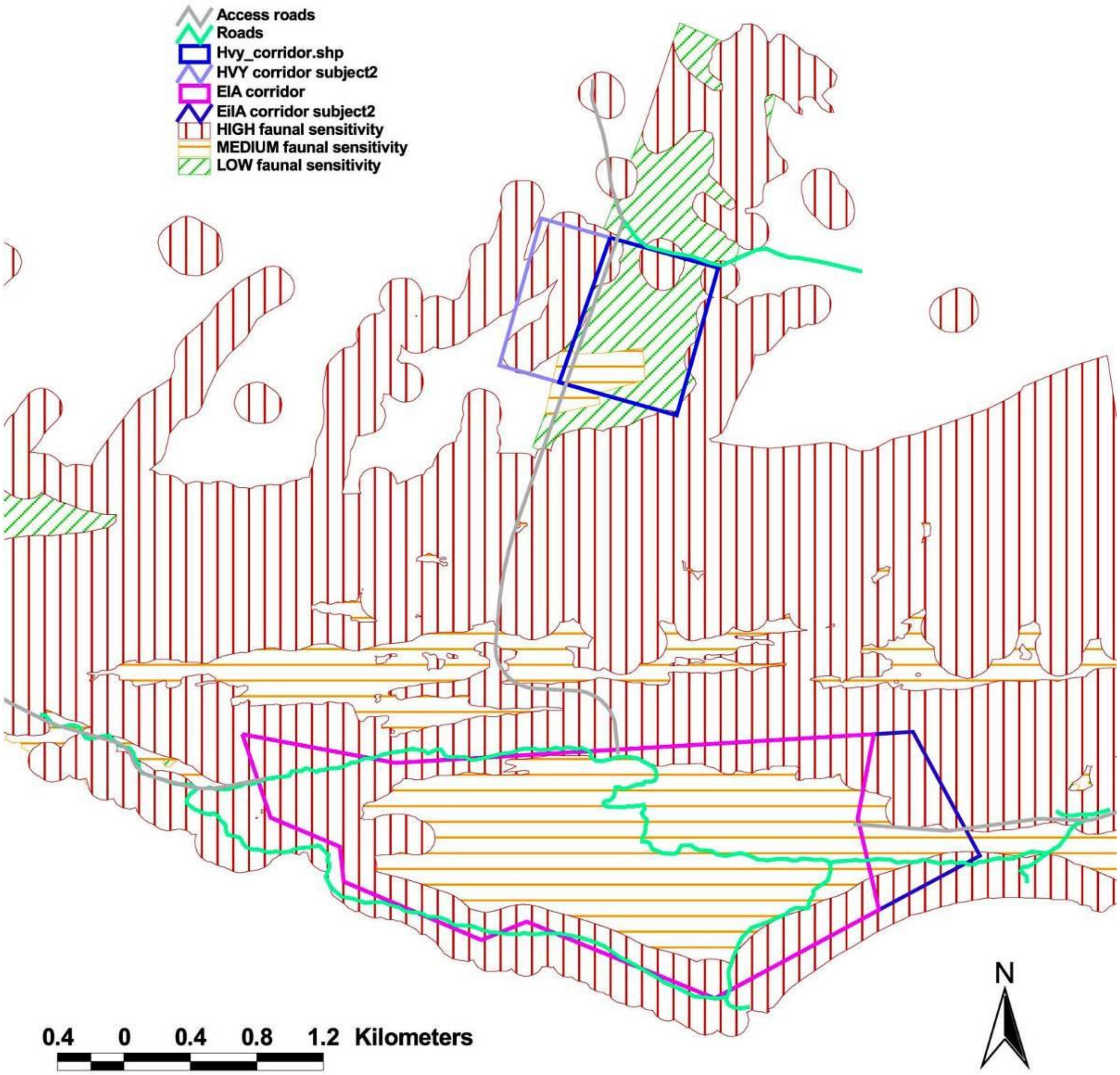

Figure 42: Faunal sensitivity map for Thyspunt.

3 IMPACT IDENTIFICATION

The impacts of the proposed nuclear power station development, Nuclear-1, are identified separately for each of the three sites, namely Duynefontein, Bantamsklip and Thyspunt (below). The term “development corridor” refers to the area on each site, identified by Eskom, within which it is proposed that the plant and most associated buildings will be constructed. Additional footprints are provided for substations near to the development corridor (HV yards).

Note that most of the predicted impacts are common to all three sites, although the severity and significance of those impacts may differ between sites.

3.1 Duynefontein: identified impacts

The development corridor is situated on the coast, immediately to the north of the existing Koeberg Nuclear Power Station (KNPS; Fig. 42).

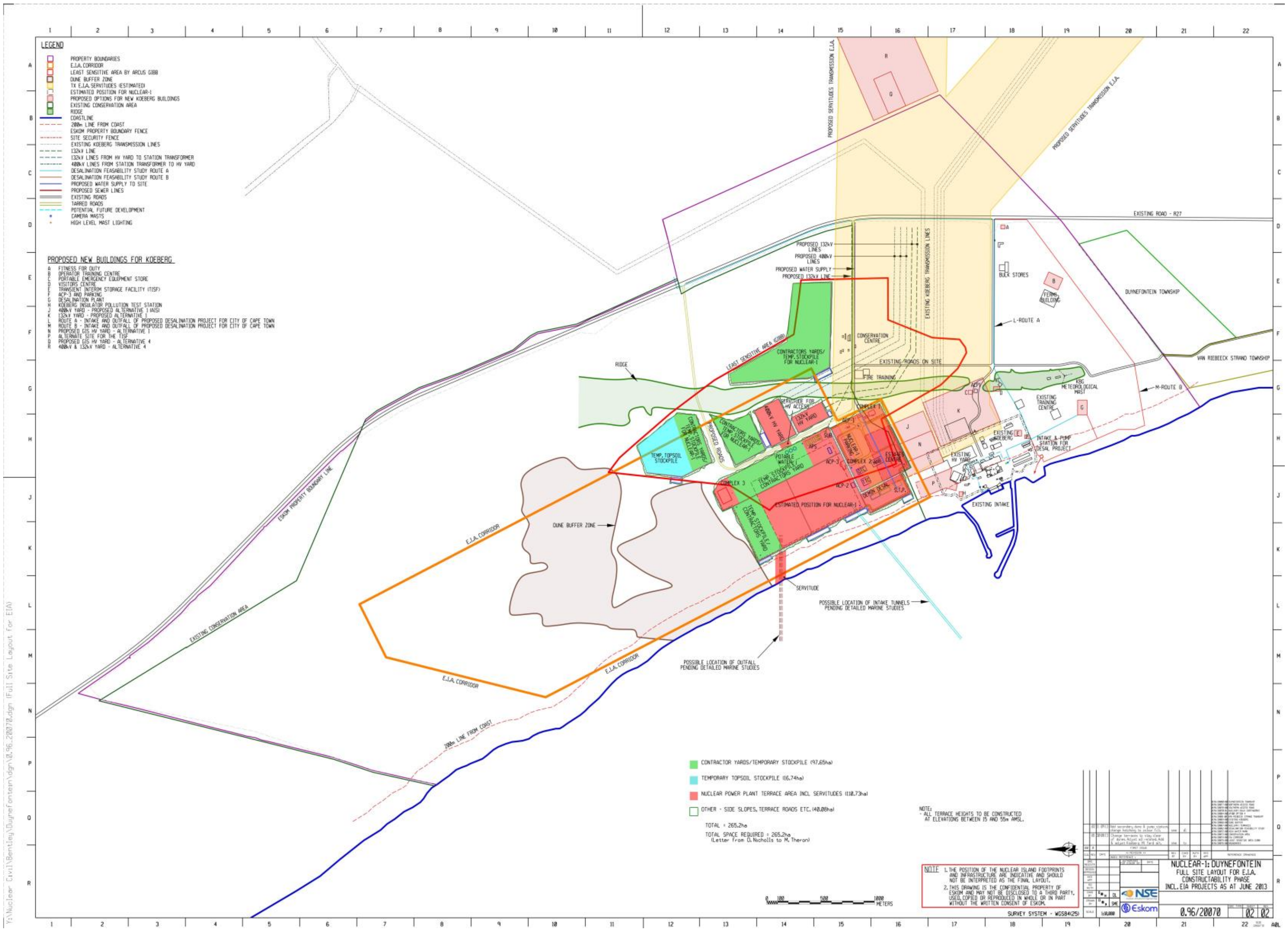

Figure 43: Development corridor and infrastructure for the Duynefontein site. Note close proximity to existing Koeberg plant to the south (dark grey area on the coast). The development corridor is delineated in yellow.

3.1.1 Destruction of natural habitats and populations

Wherever buildings and infrastructure are constructed, natural habitats will be destroyed. In addition, lay-down areas for machinery, materials and soil will be heavily impacted, albeit not permanently. Many of the animals associated with affected habitats will be killed at the time of site clearance. Some of those animals that are able to escape will establish themselves in similar habitats nearby, but their long-term prospects for survival will be poor because those habitats will most likely already be at carrying capacity for the relevant species. These impacts will be locally intense and mainly of a permanent nature. Lay-down areas can be rehabilitated over time. Mitigation should take the form of avoidance of the most sensitive areas (Fig. 42).

3.1.2 Reduction in populations of Threatened species

Species which have Threatened or Near Threatened status (see Appendix 1 and discussion under section 2.1, above) may experience a reduction of their national or global populations and an exacerbation of their poor conservation status. Species relevant to Duynefontein are: Gronovi's Dwarf Burrowing Skink *Scelotes gronovii* (Near Threatened), Southern Adder *Bitis armata* (Vulnerable), Blouberg Dwarf Burrowing Skink *Scelotes montispectus* (Near Threatened), Whitetailed Mouse *Mystromys albicaudatus* (Endangered), Honey Badger *Mellivora capensis* (Near Threatened), African Black Oystercatcher *Haematopus moquini* (Near Threatened) and Black Harrier *Circus maurus* (Near Threatened). Other relevant bird species will be less directly impacted. The fact that habitats occupied by these species will be permanently destroyed means that the negative impacts on the species are likely also to be permanent.

3.1.3 Fragmentation of natural habitats and patterns of animal movement

The construction of buildings and infrastructure, including fencing, will break up blocks of continuous or intergrading habitats into relatively isolated fragments. Roads have an especially damaging impact because they encourage further developments and human activity adjacent to the road; in other words, they begin an ongoing process of human encroachment. The disturbance associated with roads causes some animals to avoid roads, thus inhibiting their ecological need to move across the landscape. The impact of such fragmentation will vary from species to species, depending on the degree of mobility of the species and its tolerance of sub-optimal habitat types. Many species, with limited mobility and low tolerance of habitats other than their preferred habitat, will become ecologically isolated within fragments and thereby become more vulnerable to local extinction. This impact is likely to be permanent, but with the greatest impact on species with restricted movements, such as fossorial reptiles, and the least impact on volant species, such as birds. Ecological corridors are key to the mitigation of fragmentation.

3.1.4 Road mortality

In addition to the fragmentation effect of roads (above), local populations of animals will be negatively impacted by mortality on the roads. Areas close to roads are likely to become population “sinks” in which the rate of increase from reproduction and immigration is less than the rate of decrease owing to deaths on the road. For some species, especially nocturnal species, such impacts may be intense, especially if the road separates two different habitats which are both essential to the species, e.g., dryland and wetland habitats, or inland and coastal habitats.

3.1.5 Mortality associated with overhead-transmission lines and substations

Overhead cables are obstacles to birds in flight and collisions can occur, especially under conditions of poor visibility. Such conditions frequently prevail on the west coast when fog rolls in from the sea. The danger applies particularly to larger birds which are less manoeuvrable in flight. If transmission lines cross regularly used flight paths, the impact of the lines on local or even regional populations can be severe. Large birds that perch on pylons can also be at risk of electrocution. Substations (e.g., the proposed HV yard) present what appear to be good nesting sites for some birds, but such nesting attempts are inherently dangerous. The interaction of birds and electrical installations is not only potentially deleterious to birds, but can also result in costly breaks in transmission. Happily, Eskom has extensive experience and technological expertise in mitigating problems of this kind (e.g., van Rooyen & Ledger 1997). Note that the transmission lines are the subject of a separate EIA and these issues will presumably be highlighted in that process.

3.1.6 Disturbance of sensitive breeding populations

Noise, visual disturbance, and especially an increased presence of human beings, all have the potential to disturb wild animals and possibly disrupt their normal behaviour patterns. This becomes particularly problematic when breeding of rare and sensitive species is disrupted. Impacts tend to be more intense during the construction phase when human activity is more intense and less routine. Extraordinary disturbances, such as blasting, are also associated with the construction phase. Depending on the nature and timing of disturbances, their impacts can vary from local and moderate to regional and intense. Species likely to be affected are, especially, seabirds roosting and breeding in the relatively protected environment in and around Koeberg harbour, including Swift Terns *Sterna bergii*, African Black Oystercatchers *Haematopus moquini* (Near Threatened), Cape Cormorants *Phalacrocorax capensis*, Crowned Cormorants *P. neglectus* (Vulnerable), and Bank Cormorants *P. coronatus* (Near Threatened). Nuclear-1 will not be using or affecting Koeberg harbour directly, but construction activities in the vicinity have the potential to cause damaging disturbance.

3.1.7 Dust pollution beyond the building site

During the construction phase, dust generated by construction activities, especially trucks on dirt roads, will drift onto neighbouring vegetation and cause degradation of habitats with negative effects on the animals using those habitats. This impact is temporary and localized.

3.1.8 Pollution of soil and water beyond the building site

The use of heavy machinery and vehicles will inevitably lead to fuel and chemical spills with some chemical pollution of soil and groundwater, especially during the construction phase when the use of machinery is more intense. The danger is that polluted water can move, either on the surface or underground, to areas beyond the building site and, in particular, may reach wetlands. Pollution of soil can also be damaging if such pollution occurs in areas that are intended for later rehabilitation to a natural state. Depending on the severity of the pollution, the resultant degradation of habitats can extend into the medium and long term, especially if polluting events continue during the operational phase. Pollution arising from the disposal of sewage is especially relevant in this regard. Some types of pollution can also be cumulative (e.g., heavy-metal pollution and organic eutrophication).

3.1.9 Light pollution beyond the building site

Outdoor lighting, especially of the short-wavelength type (white and blue), attracts night-flying insects from considerable distances, and this leads to unacceptably high levels of mortality among these insects, many of which are critically important to normal ecosystem functioning (see report by invertebrate specialist). In addition, an abundance of insects under lights tends to attract predators such as owls, bats and toads, thus disrupting the normal behaviour patterns of these species. Long-term use of external lighting has an accumulative negative impact on ecosystems (Longcore & Rich 2004).

3.1.10 Alteration of surface and groundwater levels and flows; knock-on effects on local wetlands

The fact that the nuclear reactor itself must be constructed on bedrock (Integration Meeting, pers. comm.) means that, of necessity, there will be local disruption of groundwater flow, and this is likely to lead to altered water supply and/or drainage at local wetlands. The hard surfaces of buildings and roads cause increased run-off which is often contaminated with pollutants. Such impacts may be minor and negligible, or may be major with important ecological consequences for wetland-dependent fauna. This specialist is not able to judge, in advance, the severity of such impacts, but the opinion of relevant specialists (Integration Meeting; pers. comm.) is that such impacts will be insignificant at the Duynefontein site.

3.1.11 Poaching of local wildlife

The area around the Duynefontein site comprises the Koeberg Private Nature Reserve, which is home to many antelope, game birds and other wildlife that is likely to tempt people who would like to hunt for sport or for the pot. With large numbers of workers temporarily on site during the construction phase, the negative impact of poaching could be locally intense. However, with the conservation personnel of Koeberg Private Nature Reserve already deployed on site, this impact will presumably be kept under reasonable control.

3.1.12 Problem-animal scenarios

Of concern are animals that have the potential to become problematic, especially during the operational phase when some animals become accustomed to the presence and activities of humans. The Chacma Baboon *Papio ursinus* is often a good example, but this species does not occur at Duynefontein. However, even small and relatively harmless species, such as Small Grey Mongoose *Galerella pulverulenta*, Small-spotted Genet *Genetta genetta*, Cape Porcupine *Hystrix africaeaustralis,* and various rodents can become problem animals if they are tempted to exploit resources provided by humans. People, in their eagerness to interact with wildlife, will often try to feed mammals and birds. The feeding of birds, although traditional, can cause certain species to become a nuisance, and leftover food attracts other species, such as rodents. If rodent populations build up in an area as a result of artificially elevated food supplies, predators of rodents will also be attracted, including venomous snakes, such as the Puff Adder *Bitis arietans* and Cape Cobra *Naja nivea*. The development site is close enough to residential areas for domestic animals to also pose a potential problem. Stray animals have the potential to become feral and prey on wild fauna.

3.1.13 Accumulation of radioisotopes in the environment and bodies of wild animals

Accumulation of radioisotopes in the environment and in the bodies of wild animals was considered as a possible negative impact. However, available literature (e.g., Saint-Pierre & RPWG 2008) and expert opinion within the EIA team (W. Van Niekerk in lit.) indicate that the radiological protection specified by health and safety standards, and required for licensing of a nuclear facility, are such that a nuclear power station will pose no significant risk to wildlife in this regard.

3.1.14 Cumulative impacts

Several of the impacts listed above will potentially continue during the operational phase of the nuclear power station (e.g., road mortality, light pollution, disturbance of sensitive populations, etc) and will thereby exert a cumulative impact, over time. Given the fact that there is already one nuclear power station at Duynefontein, namely KNPS, and that a Pebble-bed Modular Reactor (PBMR) is proposed for a site just to the south of KNPS, the addition of another nuclear power station just to the north of KNPS will clearly lead to cumulative impacts. Virtually all of the impacts listed above will be cumulative relative to similar impacts brought about by KNPS and PBMR. One of the most serious cumulative impacts is the increasing isolation of coastal and inland habitats from each other. Many of the more mobile species, especially among mammals and birds, rely on a diversity of habitats to sustain them at different times and under varying conditions. For this reason it is ecologically important that animals be able to move freely and unhindered between coastal and inland habitat types. An increasingly long string of buildings and fences at the coast make such movements difficult or impossible and thereby have a cumulative negative impact on local populations. Another potentially serious cumulative impact is the disruption of dune systems. The mobile sands of the sand plume to the north of the site create a mosaic of habitat types with ecologically valuable edges. If the continuous addition of mobile sand from the south is further disrupted – it has already been partially disrupted by KNPS – the existing dunes are likely to stabilize and become permanently vegetated, causing a cumulative negative impact on the diversity of the local ecology.

3.1.15 Improvement of the conservation status of undeveloped land

Given that the site of the proposed new nuclear power station, and the land surrounding it, are currently managed by Eskom as an extension of the Koeberg Private Nature Reserve, it is clear that there will be no improvement of conservation status of Eskom-owned lands. On the contrary, the area under conservation management will shrink substantially. Nevertheless, conservation status can also be enhanced through elevation of the legal status of the reserve, and through improved conservation management, and there is potential to achieve these at Duynefontein.

3.2 Bantamsklip: identified impacts

Figure 44: Development corridor and associated infrastructure at Bantamsklip. Note that the inland portion of the site is not affected, except by a short stretch of transmission lines.

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The proposed development corridor and HV yard are situated on the coastal portion of the site (Fig. 44). Only a short stretch of transmission lines is likely to affect the inland portion (above the R43).

3.2.1 Destruction of natural habitats and populations

Wherever buildings and infrastructure are constructed, natural habitats will be destroyed. In addition, lay-down areas for machinery, materials and soil will be heavily impacted, albeit not permanently. Many of the animals associated with affected habitats will be killed at the time of site clearance. Some of those animals that are able to escape will establish themselves in similar habitats nearby, but their long-term prospects for survival will be poor because those habitats will most likely already be at carrying capacity for the relevant species. These impacts will be locally intense and mainly of a permanent nature, although lay-downs can be rehabilitated over time.

3.2.2 Reduction in populations of Threatened species

Species which have Threatened or Near Threatened status (see Appendix 2 and discussion under section 2.2, above) may experience a reduction of their national or global populations and an exacerbation of their poor conservation status. Species relevant to the coastal portion of Bantamsklip are: Southern Adder *Bitis armata* (Vulnerable), Fynbos Golden Mole *Amblysomus corriae* (Near Threatened), Whitetailed Mouse *Mystromys albicaudatus* (Endangered), Honey Badger *Mellivora capensis* (Near Threatened), African Black Oystercatcher *Haematopus moquini* (Near Threatened), Black Harrier *Circus maurus* (Near Threatened), and Denham's Bustard *Neotis denhami* (Vulnerable). The fact that habitats occupied by these species will be permanently destroyed means that the negative impacts on the species are likely also to be permanent. Other relevant bird species, i.e., various Threatened seabirds, would be less directly impacted, if at all because impacts on marine habitats would be minor. Roosting seabirds at the coast can be adequately protected by a wide coastal corridor, as recommended. The concerns, expressed by some I&APs about possible impacts on seabirds breeding on Dyer Island, are misplaced. The only manner in which these birds could be affected is if the NPS somehow affected their food supply, namely the abundance of shoaling fish such as sardines, pilchards and anchovies. There is no danger of such a negative impact (Tamara Robinson, marine ecology specialist, pers. comm.).

3.2.3 Fragmentation of natural habitats and patterns of animal movement

The construction of buildings and infrastructure, including fencing, will break up blocks of continuous or intergrading habitats into relatively isolated fragments. Roads have an especially damaging impact because they encourage further developments and human activity adjacent to the road; in other words, they begin an ongoing process of human encroachment. The disturbance associated with roads causes some animals to avoid roads, thus inhibiting their ecological need to move across the landscape. The impact of such fragmentation will vary from species to species, depending on the degree of mobility of the species and its tolerance of sub-optimal habitat types. Many species, with limited mobility and low tolerance of habitats other than their preferred habitat, will become ecologically isolated within fragments and thereby become more vulnerable to local extinction. This impact is likely to be permanent, but with the greatest impact on species with restricted movements, such as fossorial reptiles, and the least impact on volant species, such as birds. Creation of ecological corridors is a key mitigation measure.

3.2.4 Road mortality

In addition to the fragmentation effect of roads (above), local populations of animals will be negatively impacted by mortality on the roads. Areas close to roads are likely to become population “sinks” in which the rate of increase from reproduction and immigration is less than the rate of decrease owing to deaths on the road. For some species, especially nocturnal species, such impacts may be intense, especially if the road separates two different habitats which are both essential to the species, e.g., dryland and wetland habitats, or inland and coastal habitats.

3.2.5 Mortality associated with overhead-transmission lines and substations

Overhead cables are obstacles to birds in flight and collisions can occur, especially under conditions of poor visibility, for example, when there is fog or mist. The danger applies particularly to larger birds which are less manoeuvrable in flight. If transmission lines cross regularly used flight paths, the impact of the lines on local or even regional populations can be severe. Large birds that perch on pylons can also be at risk of electrocution. Substations (e.g., the proposed HV yard) present what appear to be good nesting sites for some birds, but such nesting attempts are inherently dangerous. The interaction of birds and electrical installations is not only potentially deleterious to birds, but can also result in costly breaks in transmission. Happily, Eskom has extensive experience and technological expertise in mitigating problems of this kind (e.g., van Rooyen & Ledger 1997). Threatened birds likely to be particularly affected at Bantamsklip are Blue Crane (Vulnerable), Denham’s Bustard (Vulnerable), and Secretarybird (Near Threatened). Note that the transmission lines are the subject of a separate EIA and these issues will presumably be highlighted in that process.

3.2.6 Disturbance of sensitive breeding populations

Noise, visual disturbance, and especially an increased presence of human beings, all have the potential to disturb wild animals and possibly disrupt their normal behaviour patterns. This becomes particularly problematic when breeding of rare and sensitive species is disrupted. Impacts tend to be more intense during the construction phase when human activity is more intense and less routine. Extraordinary disturbances, such as blasting, are also associated with the construction phase. Depending on the nature and timing of disturbances, their impacts can vary from local and moderate to regional and intense. Species likely to be affected include, among others, Cape Cormorant (Near Threatened), Bank Cormorant (Endangered), Crowned Cormorant (Near Threatened), African Black Oystercatcher (Near Threatened), Damara Tern *Sterna balaenarum* (Endangered), Black Harrier (Near Threatened), Denham’s Bustard (Vulnerable) and Blue Crane (Vulnerable).

3.2.7 Dust pollution beyond the building site

During the construction phase, dust generated by construction activities, especially trucks on dirt roads, will drift onto neighbouring vegetation and cause degradation of habitats with negative effects on the animals using those habitats. This impact is temporary and localized.

3.2.8 Pollution of soil and water beyond the building site

The use of heavy machinery and vehicles will inevitably lead to some fuel spills and chemical pollution of soil and groundwater, especially during the construction phase when the use of machinery is more intense. The danger is that polluted water can move, either on the surface or underground, to areas beyond the building site and, in particular, may reach wetlands. Pollution of soil can also be damaging if such pollution occurs in areas that are intended for later rehabilitation to a natural state. Depending on the severity of the pollution, the resultant degradation of habitats can extend into the medium and long term, especially if polluting events continue during the operational phase. Pollution arising from the disposal of sewage is especially relevant in this regard. Some types of pollution can also be cumulative (e.g., heavy-metal pollution and organic eutrophication). The apparent absence of wetlands on or near to the proposed Bantamsklip footprint suggests that this impact is of relatively minor importance at this site.

3.2.9 Light pollution beyond the building site

Outdoor lighting, especially of the short-wavelength type (white and blue), attracts night-flying insects from considerable distances, and this leads to unacceptably high levels of mortality among these insects, many of which are critically important to normal ecosystem functioning (see report by invertebrate specialist). In addition, an abundance of insects under lights tends to attract predators such as owls, bats and toads, thus disrupting the normal behaviour patterns of these species. Long-term use of external lighting has a cumulative negative impact on ecosystems (Longcore & Rich 2004).

3.2.10 Alteration of surface and groundwater levels and flows; knock-on effects on local wetlands

The fact that the nuclear reactor itself must be constructed on bedrock (Integration Meeting, pers. comm.) means that, of necessity, there will be local disruption of groundwater flow, and this is likely to lead to altered water supply and/or drainage at local wetlands. The hard surfaces of buildings and roads cause increased run-off which is often contaminated with pollutants. Such impacts may be minor and negligible, or may be major with important ecological consequences for wetland-dependent fauna. This specialist is not able to judge, in advance, the severity of such impacts, but the opinion of relevant specialists (Integration Meeting; pers. comm.) is that such impacts would be insignificant at the Bantamsklip site.

3.2.11 Poaching of local wildlife

The area around the proposed Bantamsklip footprint is relatively wild and natural and home to antelope, game birds and other wildlife that is likely to tempt people who would like to hunt for sport or for the pot. With large numbers of workers temporarily on site during the construction phase, the negative impact of poaching could be locally intense. This negative scenario is exacerbated by the fact that abalone poachers are already active in the area. Numbers of antelope on site were noticeably low, which suggests that poaching of terrestrial fauna may already be happening in the area, adding to the need for strict control.

3.2.12 Problem-animal scenarios

Of concern are animals that have the potential to become problematic. Chief among these is the Chacma Baboon *Papio ursinus*. As human habitation steadily encroaches on their territories, these primates become bolder in exploiting the opportunities presented. At such times, wild animals can become a threatening and hazardous presence. Other potentially problematic and dangerous species include Leopard *Panthera pardus* and Bushbuck *Tragelaphus scriptus*. Even small and relatively harmless species, such as Small Grey Mongoose *Galerella pulverulenta*, Small-spotted Genet *Genetta genetta*, Cape Porcupine *Hystrix africaeaustralis,* Rock Hyrax *Procavia capensis* and various rodents can become problem animals if they are tempted to exploit resources provided by humans. People, in their eagerness to interact with wildlife, will often try to feed mammals and birds. The feeding of birds, although traditional, can cause certain species to become a nuisance, and leftover food attracts other species, such as rodents. If rodent populations build up in an area as a result of artificially elevated food supplies, predators of rodents will also be attracted, including venomous snakes, such as the Puff Adder *Bitis arietans* and Cape Cobra *Naja nivea*. The development site is close enough to residential areas for domestic animals to also pose a potential problem. Stray animals have the potential to become feral and prey on wild fauna.

3.2.13 Accumulation of radioisotopes in the environment and in the bodies of wild animals

Accumulation of radioisotopes in the environment and in the bodies of wild animals was considered as a possible negative impact. However, available literature (e.g., Saint-Pierre & RPWG 2008) and expert opinion within the EIA team (W. Van Niekerk in lit.) indicate that the radiological protection specified by health and safety standards, and required for licensing of a nuclear facility, are such that a nuclear power station will pose no significant risk to wildlife in this regard.

3.2.14 Cumulative impacts

Several of the impacts listed above will potentially continue during the operational phase of the nuclear power station (e.g., road mortality, light pollution, disturbance of sensitive populations, etc) and will thereby exert a cumulative impact, over time. One of the most serious cumulative impacts is the increasing isolation of coastal and inland habitats from each other which is a general consequence of development at the coast. Many of the more mobile species, especially among mammals and birds, rely on a diversity of habitats to sustain them at different times and under varying conditions. For this reason it is ecologically important that animals be able to move freely and unhindered between coastal and inland habitat types. An increasingly long string of buildings and fences at the coast make such movements difficult or impossible and thereby have a cumulative negative impact on local populations.

3.2.15 Improvement of the conservation status of undeveloped land

Most of the development corridor, and the land surrounding it, are currently owned by Eskom but have no particular conservation status. If Eskom retains ownership of the land and manages the natural, undisturbed parts as a private nature reserve, as is presently the case at Duynefontein and Koeberg Private Nature Reserve, it is clear that there will be a significant improvement in the conservation status of the undeveloped parts of the Bantamsklip site. This would be of especial significance to the populations of Threatened frogs on Hagelkraal farm, and other Threatened species. In addition, conservation status could be enhanced through improved conservation management, for example, removal of invasive alien vegetation. Such conservation actions would contribute to national conservation targets as defined, for example, in Rouget et al. (2005), and could represent significant offsets for the loss of habitats and individuals at the development footprint.

3.3 Thyspunt: identified impacts

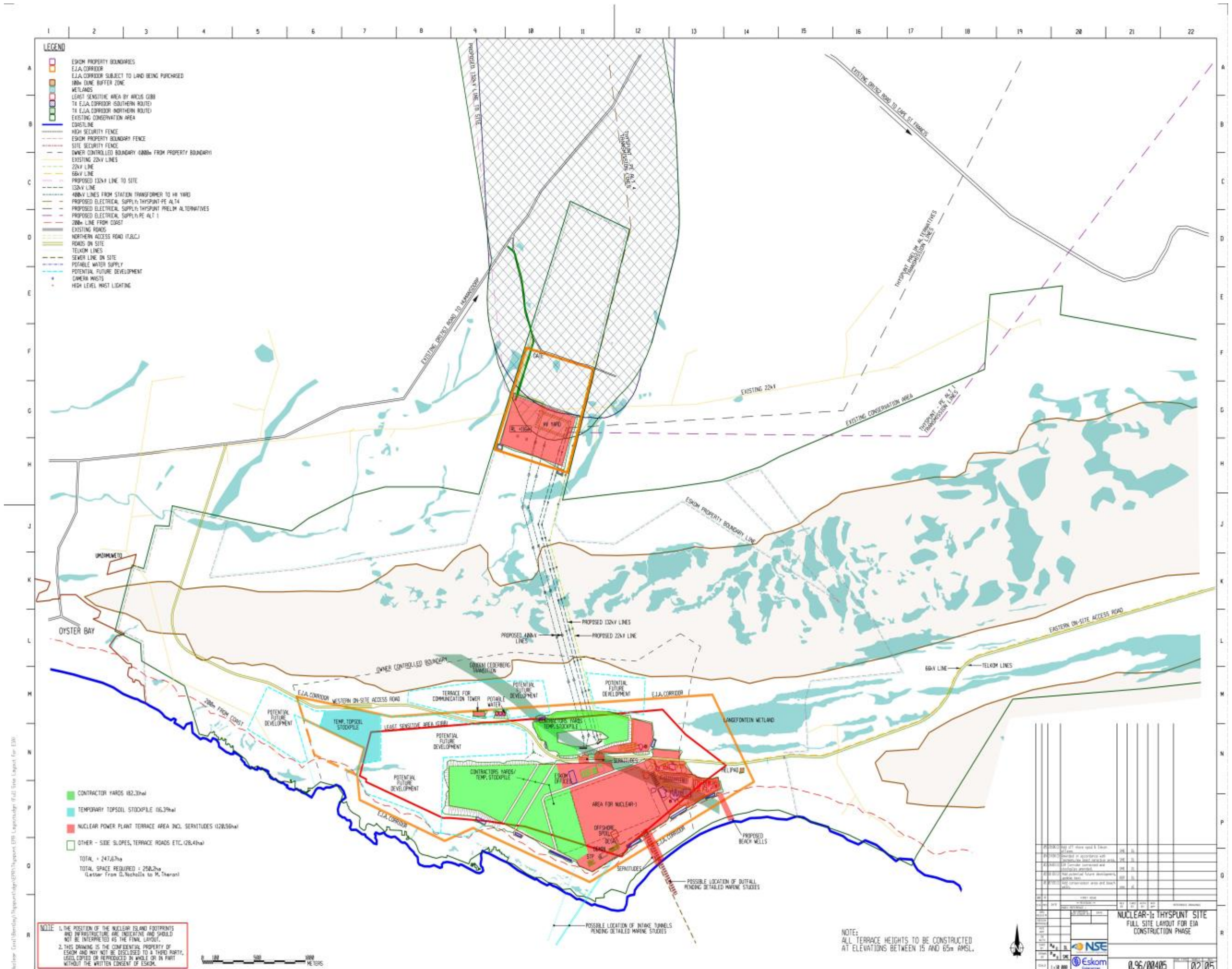

Figure 45: Site boundaries and development corridor, and associated infrastructure at Thyspunt. Note that the HV yard is situated on the inland portion, some distance from the development corridor for the plant.

The proposed Thyspunt plant footprint is situated on the coast with the HV yard on the inland "pan-handle" portion (Fig. 45). Transmission lines are planned to connect the power station to the substation, across an intervening mobile dune system.

3.3.1 Destruction of natural habitats and populations

Wherever buildings and infrastructure are constructed, natural habitats will be destroyed. In addition, lay-down areas for machinery and materials will be heavily impacted, albeit not permanently. Many of the animals associated with affected habitats will be killed at the time of site clearance. Some of those animals that are able to escape will establish themselves in similar habitats nearby, but their long-term prospects for survival will be poor because those habitats will most likely already be at carrying capacity for the relevant species. These impacts will be locally intense and mainly of a permanent nature.

3.3.2 Reduction in populations of Threatened species

Species which have Threatened or Near Threatened status (see Appendix 3 and discussion under section 2.3, above) may experience a reduction of their national or global populations and an exacerbation of their poor conservation status. Species relevant to Thyspunt are: FitzSimons' Long-tailed Seps (Vulnerable) and Tasman's Girdled Lizard (Vulnerable), Elandsberg Dwarf Chameleon (Endangered), Fynbos Golden Mole (Near Threatened), Honey Badger (Near Threatened), Blue Duiker (Vulnerable), African Black Oystercatcher (Near Threatened), African Marsh Harrier (Vulnerable), Black Harrier (Near Threatened), White-bellied Korhaan (Vulnerable), Denham's Bustard (Vulnerable), Knysna Woodpecker (Near Threatened) and Knysna Warbler (Vulnerable). Other relevant bird species will be less directly impacted. The fact that habitats occupied by these species may be permanently destroyed means that the negative impacts on the species are likely also to be permanent.

3.3.3 Fragmentation of natural habitats and patterns of animal movement

The construction of buildings and infrastructure, including roads and fencing, will break up blocks of continuous or intergrading habitats into relatively isolated fragments. Roads have an especially damaging impact because they encourage further developments and human activity adjacent to the road; in other words, they begin an ongoing process of human encroachment. The disturbance associated with roads causes some animals to avoid roads, thus inhibiting their ecological need to move across the landscape. The impact of such fragmentation will vary from species to species, depending on the degree of mobility of the species and its tolerance of sub-optimal habitat types. Many species, with limited mobility and low tolerance of habitats other than their preferred habitat, will become ecologically isolated within fragments and thereby become more vulnerable to local extinction. This impact is likely to be permanent, but with the greatest impact on species with restricted movements, such as fossorial reptiles, and the least impact on volant species, such as birds. At Thyspunt, the impact of roads is expected to be intense because three major new roads onto the site are planned, from the east, west and north.

3.3.4 Road mortality

In addition to the fragmentation effect of roads (above), local populations of animals will be negatively impacted by mortality on the roads. Areas close to roads are likely to become population "sinks" in which the rate of increase from reproduction and immigration is less than the rate of decrease owing to deaths on the road. For some species, especially nocturnal species, such impacts may be intense, especially if the road separates two different habitats which are both essential to the species, e.g., dryland and wetland habitats, or inland and coastal habitats.

3.3.5 Mortality associated with overhead-transmission lines and substations

Overhead cables are obstacles to birds in flight and collisions can occur, especially under conditions of poor visibility, for example, when there is fog or mist. The danger applies particularly to larger birds which are less manoeuvrable in flight. If transmission lines cross regularly used flight paths, the impact of the lines on local or even regional populations can be severe. Large birds that perch on pylons can also be at risk of electrocution. Substations (e.g., the proposed HV yard) present what appear to be good nesting sites for some birds, but such nesting attempts are inherently dangerous. The interaction of birds and electrical installations is not only potentially deleterious to birds, but can also result in costly breaks in transmission. Happily, Eskom has extensive experience and technological expertise in mitigating problems of this kind (e.g., van Rooyen & Ledger 1997). Threatened birds likely to be particularly affected at Thyspunt are Blue Crane (Vulnerable), Denham's Bustard (Vulnerable), White-bellied Korhaan (Vulnerable) and Secretarybird (Near Threatened). Note that the transmission lines are the subject of a separate EIA and these issues will presumably be highlighted in that process.

3.3.6 Disturbance of sensitive breeding populations

Noise, visual disturbance, and especially an increased presence of human beings, all have the potential to disturb wild animals and possibly disrupt their normal behaviour patterns. This becomes particularly problematic when breeding of rare and sensitive species is disrupted. Impacts tend to be more intense during the construction phase when human activity is more intense and less routine. Extraordinary disturbances, such as blasting, are also associated with the construction phase. Depending on the nature and timing of disturbances, their impacts can vary from local and moderate to regional and intense. Threatened species likely to be affected include, among others, Blue Duiker (Vulnerable), African Black Oystercatcher (Near Threatened), African Marsh Harrier (Vulnerable), Black Harrier (Near Threatened), Black-winged Lapwing (Near Threatened), Denham's Bustard (Vulnerable), White-bellied Korhaan (Vulnerable), Blue Crane (Vulnerable); Knysna Woodpecker (Near Threatened) and Knysna Warbler (Vulnerable).

3.3.7 Dust pollution beyond the building site

During the construction phase, dust generated by construction activities, especially trucks on dirt roads, will drift onto neighbouring vegetation and cause degradation of habitats with negative effects on the animals using those habitats. This impact is temporary and localized.

3.3.8 Pollution of soil and water beyond the building site

The use of heavy machinery and vehicles will inevitably lead to some chemical pollution of soil and groundwater, especially during the construction phase when the use of machinery is more intense. The danger is that polluted water can move, either on the surface or underground, to areas beyond the building site and, in particular, may reach wetlands. Pollution of soil can also be damaging if such pollution occurs in areas that are intended for later rehabilitation to a natural state. Depending on the severity of the pollution, the resultant degradation of habitats can extend into the medium and long term, especially if polluting events continue during the operational phase. Pollution arising from the disposal of sewage is especially relevant in this regard. Some types of pollution can also be cumulative (e.g., heavy-metal pollution and organic eutrophication). The presence of a large number of wetlands on or near to the proposed Thyspunt footprint suggests that this impact is of major importance at this site.

3.3.9 Light pollution beyond the building site

Outdoor lighting, especially of the short-wavelength type, attracts night-flying insects from considerable distances, and this leads to unacceptably high levels of mortality among these insects, many of which are critically important to normal ecosystem functioning (see report by invertebrate specialist). In addition, an abundance of insects under lights tends to attract predators such as owls, bats and toads, thus disrupting the normal behaviour patterns of these species. Long-term use of external lighting has a cumulative negative impact on ecosystems (Longcore & Rich 2004).

3.3.10 Alteration of surface and groundwater levels and flows; knock-on effects on local wetlands

The fact that the nuclear reactor itself must be constructed on bedrock (Integration Meeting, pers. comm.) means that, of necessity, there will be local disruption of groundwater flow, and this is likely to lead to altered water supply and/or drainage at local wetlands. The hard surfaces of buildings and roads cause increased run-off which is often contaminated with pollutants. Such impacts may be minor and negligible, or may be major with important ecological consequences for wetland-dependent fauna. This specialist is not able to judge, in advance, the severity of such impacts, but the opinion of relevant specialists (Integration Meeting; pers. comm.) is that such impacts will be potentially major and highly significant at the Thyspunt site.

3.3.11 Poaching of local wildlife

The area around the proposed Thyspunt footprint is relatively wild and natural and home to antelope, bushpigs, game birds and other wildlife that are likely to tempt people who would like to hunt for sport or for the pot. With large numbers of workers temporarily on site during the construction phase, the negative impact of poaching could be locally intense.

3.3.12 Problem-animal scenarios

Of concern are animals that have the potential to become problematic. Chief among these are Chacma Baboon *Papio ursinus* and Vervet Monkey *Cercopithecus pygerythrus*. As human habitation steadily encroaches on their territories, these primates become bolder in exploiting the opportunities presented. At such times, wild animals can become a threatening and hazardous presence. Other potentially problematic and dangerous species include Leopard *Panthera pardus,* Bushpig *Potamochoerus larvatus* and Bushbuck *Tragelaphus scriptus*. Even small and relatively harmless species, such as Small Grey Mongoose *Galerella pulverulenta*, Small-spotted Genet *Genetta genetta*, Cape Porcupine *Hystrix africaeaustralis,* Rock Hyrax *Procavia capensis* and various rodents can become problem animals if they are tempted to exploit resources provided by humans. People, in their eagerness to interact with wildlife, will often try to feed mammals and birds. The feeding of birds, although traditional, can cause certain species to become a nuisance, and leftover food attracts other species, such as rodents. If rodent populations build up in an area as a result of artificially elevated food supplies, predators of rodents will also be attracted, including venomous snakes, such as the Puff Adder *Bitis arietans* and Cape Cobra *Naja nivea*. The development site is close enough to residential areas for domestic animals to also pose a potential problem. Stray animals can become feral and prey on wild fauna.

3.3.13 Accumulation of radioisotopes in the environment and in the bodies of wild animals

Accumulation of radioisotopes in the environment and in the bodies of wild animals was considered as a possible negative impact. However, available literature (e.g., Saint-Pierre & RPWG 2008) and expert opinion within the EIA team (W. Van Niekerk in lit.) indicate that the radiological protection specified by health and safety standards, and required for licensing of a nuclear facility, are such that a nuclear power station will pose no significant risk to wildlife in this regard.

3.3.14 Cumulative impacts

Several of the impacts listed above will potentially continue during the operational phase of the nuclear power station (e.g., road mortality, light pollution, disturbance of sensitive populations, etc) and will thereby exert a cumulative impact, over time. One of the most serious cumulative impacts is the increasing isolation of coastal and inland habitats from each other. Many of the more mobile species, especially among mammals and birds, rely on a diversity of habitats to sustain them at different times and under varying conditions. For this reason it is ecologically important that animals be able to move freely and unhindered between coastal and inland habitat types. An increasingly long string of buildings and fences at the coast make such movements difficult or impossible and thereby have a cumulative negative impact on local populations.

3.3.15 Improvement of the conservation status of undeveloped land

The site of the new nuclear power station, and the land surrounding it, are currently owned by Eskom but have no particular conservation status. If Eskom retains ownership of the land and manages the natural, undisturbed parts as a private nature reserve, as is presently the case at Koeberg Private Nature Reserve, it is clear that there will be a significant improvement in the conservation status of the Thyspunt site. This would be of especial significance to populations of various Threatened species. In addition, conservation status could be enhanced through improved conservation management, for example, removal of invasive alien vegetation. Such conservation actions would contribute to national conservation targets as defined, for example, in Rouget et al. (2005), and could represent significant offsets for the loss of habitats and individuals at the development footprint.

3.4 Alternative: No development

The predicted impacts of the no-development option will be briefly discussed for each site.

3.4.1 No development at Duynefontein

There are no predicted negative impacts of Nuclear-1 not being developed at Duynefontein, for the simple reason that the construction site is presently managed as part of Koeberg Private Nature Reserve, and therefore the land is currently well protected and managed for conservation. It is clear that, with regard to site-specific environmental impacts, the no-go option is greatly preferable to development at Duynefontein.

3.4.2 No development at Bantamsklip

Negative impacts arising from Nuclear-1 not being developed at Bantamsklip are largely dependent on land ownership. If the land remains in the hands of Eskom, and if Eskom maintains current land use and management, there would be few, if any, negative impacts other than those currently operating. Current negative impacts are the spread of invasive alien vegetation, uncontrolled access by the public and their vehicles, and poaching. However, even on these issues, it is apparent that Eskom is attempting to mitigate their effects.

On the other hand, if Eskom were to dispose of the land and land use were to change to, for example, residential or resort, massive negative impacts could potentially occur.

While it is obvious that there will be significant negative impacts from development at Bantamsklip, the negative impacts of NPS development need to be weighed against the potential benefits of protection and management of the undeveloped portions of the Eskom-owned properties. The benefits could, potentially, outweigh the negative impacts of development, making the no-go option less desirable than the development option. However, such a positive outcome would depend largely on the degree to which recommended mitigations are implemented in the development plan and EMP.

3.4.3 No development at Thyspunt

Negative impacts arising from Nuclear-1 not being developed at Thyspunt are similar to those of Bantamsklip in that they are largely dependent on land ownership. If the land remains in the hands of Eskom, and if Eskom maintains current land use and management, there would be few, if any, negative impacts other than those currently operating. Current negative impacts are the spread of invasive alien vegetation, uncontrolled access by the public and their vehicles, and poaching. However, it is apparent that these issues have been addressed by Eskom and are largely under control.

On the other hand, if Eskom were to dispose of the land and land use were to change to, for example, residential or resort at the coast, and agriculture on the inland portion, massive negative impacts could potentially occur. It is apparent from existing developments on site, and the spread of new holiday residences from the Cape St Francis side, that the trend is decidedly towards creeping development sprawl into this important nature area. The inland portion is already used for agriculture, but further degradation of natural habitats is certainly possible. Eskom ownership, must, therefore, be viewed as an important positive factor for nature conservation.

While it is obvious that there will be significant negative impacts from development at Thyspunt, the negative impacts of NPS development need to be weighed against the potential benefits of protection and management of the undeveloped portions of the Eskom-owned property. The benefits could, potentially, outweigh the negative impacts of development, making the no-go option less desirable than the development option. However, such a positive outcome would depend largely on the degree to which recommended mitigations are implemented in the development plan and EMP.

3.5 Decommissioning

The information provided on the decommissioning process is broad-brush and generic, as one could expect for a scenario so far removed in time from the present (IAEA 1999; Van Schalkwyk 2006; ARCUS GIBB 2008). However, what is clear is that decommissioning is a complex and expensive process, comparable in many ways to the construction and commissioning of the plant. Probably the most significant difference between construction, commissioning and operation of the plant and its subsequent decommissioning, is the level of risk of contamination of the environment with radioactive waste material.

Given the extensive and intensive nature of the decommissioning process, it is reasonable to assume that the range of impacts identified for construction and operation will also be relevant to the decommissioning process. These were:

- Destruction of natural habitats and populations
- Reduction in populations of Threatened species
- Fragmentation of natural habitats and patterns of animal movement

- Road mortality
- Mortality associated with overhead-transmission lines and substations
- Disturbance of sensitive breeding populations
- Dust pollution beyond the building site
- Pollution of soil and water beyond the building site
- Light pollution beyond the building site
- Alteration of surface and groundwater levels and flows; knock-on effects
- Poaching of local wildlife
- Problem-animal scenarios
- Accumulation of radioisotopes in the environment and in the bodies of wild animals
- Cumulative impacts.

Added to these on-site issues would be equivalent off-site issues with regard to the transport, disposal and storage of radioactive waste material. Given that storage is likely to be long term, it may well be that the greatest impacts would refer to proposed storage sites, and not necessarily to the site of the decommissioned plant itself.

4 RECOMMENDED MITIGATION MEASURES

Recommended mitigation measures are described for each of the identified impacts (see section 3, above), in turn.

A mitigation hierarchy is applied:

- ***Avoidance***: impact is prevented or substantially prevented (most preferred)
- ***Reduction***: impact in reduced in magnitude and/or significance
- ***Rectification***: impact is mitigated after it has occurred, e.g., rehabilitation of areas disturbed by construction
- ***Compensation***: providing a substitute resource for a resource that has been lost because of the project (e.g., "conservation offsets")
- ***No action*** (least preferred).

The predicted effectiveness of the mitigations is indicated by the relevant level of the hierarchy. This is mentioned at the beginning of each set of mitigations.

4.1 Duynefontein: recommended mitigation measures

4.1.1 Mitigation of destruction of natural habitats and populations

This impact cannot be avoided, but it can be reduced, partially rectified and compensated for. The recommended mitigations are:

- *Restrict development to recommended areas.* The recommended areas are those with low or medium faunal sensitivity (see Figs 10 and 45). In areas of high faunal sensitivity, development is likely to cause irreparable and/or unacceptable damage to ecosystems and animal populations. ***Note that (a) "development" is intended to include all on-site buildings, installations and laydowns, including areas for storage of topsoil and spoil, and (b) quarries were not included in these deliberations. It is assumed that quarries will require separate EIA processes.***
- *Restrict the footprint of the development to the smallest area possible.* While the actual footprints of the buildings may be fixed, other areas are likely to be more flexible in their extent, e.g., areas for lay down, storage of topsoil, parking, etc. Consolidate all affected areas into one impacted node and avoid impact sprawl.
- *Dispose of spoil at sea.* If the marine-biology assessment finds that disposal of spoil at sea is a viable option, this is the preferred option because it will greatly reduce the footprint of the development in terrestrial habitats.
- *Create laydowns in previously disturbed areas.* Avoid creating laydowns and storage areas for overburden in areas of high quality habitat. Areas that have been previously disturbed and degraded are preferable because their biodiversity will already have been depressed

and there will be less nett loss of biodiversity. Disturbed areas off site but reasonably nearby should be considered for laydowns so that good quality habitats on site can be preserved.

- *Use natural topographical features as boundaries.* Cutting across natural features, such as dune ridges and wetlands, will make rehabilitation of the areas that remain more difficult and less effective. The preferred footprint (see Fig. 34 and legend) indicates suitable boundaries based, wherever possible, on natural features (see Fig. 35 and legend).

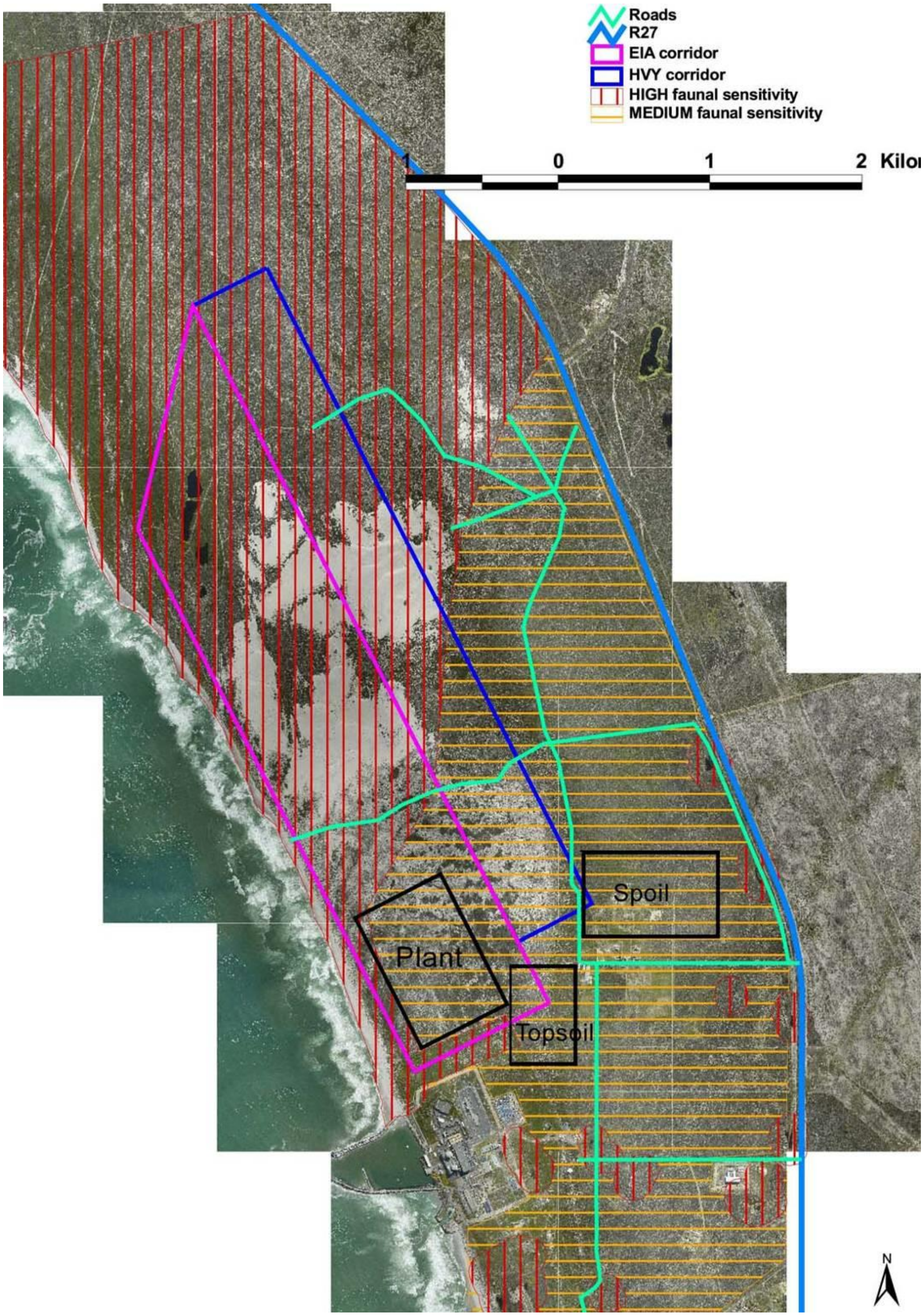

Figure 46: Recommended footprints for the Duynefontein site. The plant, topsoil and spoil footprints are to the scale provided by Eskom. Note that the recommended footprints avoid the mobile dunes to the north, and make provision for a wide coastal corridor and a corridor between KNPS and the Nuclear-1 NPS.

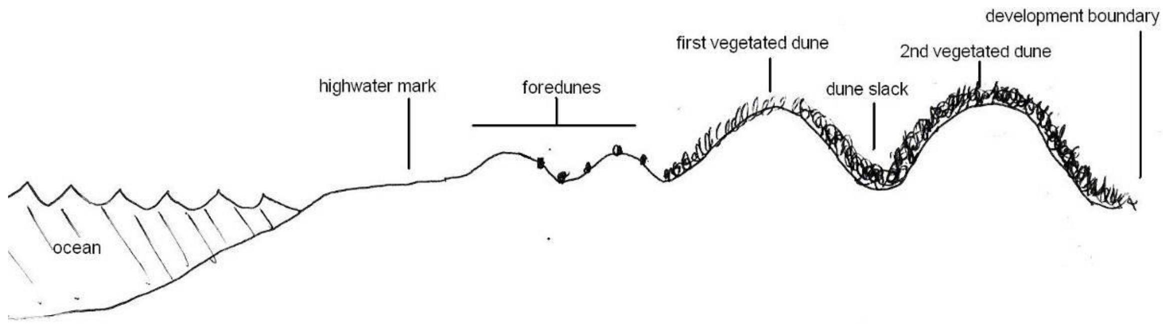

Figure 47: Characteristics of a coastal corridor. The coastal corridor must include a full suite of coastal habitat types in order to function optimally as an ecological corridor. The diagram illustrates the minimum features which should be included in a corridor on a sandy shore. Requirements for sandy and rocky shores are similar, but the details of relevant habitat types will vary with type of shore and with locality. Provided that all relevant habitat types are included, and a natural edge is used as a boundary, the width of the corridor is not critical, but is likely to fall somewhere between 200 and 300 m from the highwater mark.

- *Clear the site in a logical sequence.* Initial site clearance should be carried out in manner that allows mobile species to escape. This means that clearance should start from an area of relatively high disturbance and progress in an orderly manner in the direction of least disturbance and least physical obstruction. For example, begin clearing from an existing fence and clear towards an area that is not yet fenced and is still covered by natural habitat.
- *Mark off the affected area.* The footprint area, within which all construction is to take place, should be demarcated with stakes and hazard tape ***prior*** to site clearance, and should be fenced ***after*** initial site clearance. The tape and fence are important in demarcating the limits of allowable disturbance of natural areas.
- *Rehabilitate affected areas, where possible.* Areas that are used only during the construction phase, e.g., laydowns, should be rehabilitated during the operational phase, so that their normal ecological functioning is restored. Within security areas, where high vegetation cannot be allowed, natural vegetation should also be encouraged, but be kept low by regular mowing. This will allow small and fossorial animals and many invertebrates to recolonize the area.
- *Compensate for loss of habitats.* See 4.1.15, below, for recommended conservation offsets.

4.1.2 Mitigation of reduction in populations of Threatened species

This impact cannot be entirely avoided, but it can be reduced and partially rectified. The recommended mitigations are:

- *All of the mitigations listed under 4.1.1* (above).
- *Facilitate search-and-rescue operations before and during site clearance.* Individuals of Threatened species rescued during site clearance can be re-located in neighbouring, protected areas on site.

- *Facilitate collection of scientific material and information before and during site clearance.* Benefit can be derived from the biological material that will otherwise be totally lost during site clearance. Appropriate specialists should be commissioned to collect specimens for deposit in museums, herbaria, etc. The information collected will also be valuable for the management of the protected parts of Duynefontein.

4.1.3 Mitigation of fragmentation of natural habitats and patterns of animal movement

This impact cannot be entirely avoided, but it can be reduced and partially rectified. The recommended mitigations are:

- *All of the mitigations listed under 4.1.1* (above).
- *Make provision for ecological corridors.* Ecological corridors provide connections of natural habitat between habitats at either end of the corridor. Such corridors are provided for by the preferred footprints (Fig. 46). (See Fig. 47 and Appendix 4 for background information on ecological corridors.)
- *Construct under- and overpasses across roads.* Wherever a road crosses watercourses, box culverts must be installed to facilitate animal movement under the road. (See Appendix 5 for recommended specifications.) Large, incised watercourses should be crossed by means of raised bridges. Where a road runs between high points for more than 500 m (e.g., in the slack between dune ridges), overpasses should be constructed at 500-m intervals. (See Appendix 5 for alternative designs.)
- *Keep roads as far away from wetlands as possible.* Wetlands are an important resource for many animals. Roads reduce access to this resource.
- *Use recommended types of security fencing.* Suitable types of fencing can greatly improve the permeability of boundaries for small animals. Palisade fencing generally has a lower negative impact than mesh fencing. See Appendix 6 for further details on fencing.
- *Wherever possible, place pipelines and cables underground, and rehabilitate.* Underground pipelines do not present surface barriers, especially if topsoil is replaced and the surface is rehabilitated.
- *Reduce the number of roads and tracks and place them carefully*. Roads are a major cause of fragmentation. Wherever possible, roads should be placed within or along the edges of areas that are already disturbed or are to be developed. Roads across large areas of natural habitat must be kept to the absolute minimum necessary for access to the building site.
- *Make roads off limits for fixed periods every day.* (See next sub-section.)

4.1.4 Mitigation of road mortality

This impact cannot be entirely avoided, but it can be reduced. The recommended mitigations are:

- *Reduce the number of roads and tracks and place them carefully.* Wherever possible roads should be placed within or along the edges of areas that are already disturbed or are to be developed. It is generally better to use or upgrade existing roads than to create new ones. Roads across large areas of natural habitat must be kept to an absolute minimum and be planned in consultation with an ecologist.

- *Construct under- and overpasses across roads.* (See previous sub-section above.)
- *Keep roads as far away from wetlands as possible.* Wetlands are an important resource for many animals and they tend to move regularly to and from wetlands.
- *Restrict speed on roads.* Enforce a speed limit of no more than 60 kph on roads that traverse natural areas. Erect speed humps if necessary (but with appropriate features for stormwater runoff).
- *Make roads off limits for fixed periods every day.* Roads which cross areas of natural habitat should be off limits for at least four hours – preferably six hours – at night: 11 pm to 5 am is suitable because it includes some twilight conditions at dawn. The only exceptions to such exclusion should be in cases of emergency. The quiet period provides animals with a safe and undisturbed time in which to move across roads.
- *Place warning signage in appropriate places.* In places where roadkills frequently occur, warning signage should be erected.
- *Use appropriate curb designs.* Curbs and roadside gutters should have low, sloping profiles without any vertical surfaces. Good designs facilitate the movements of small animals such as frogs, lizards and mice.

4.1.5 Mitigation of mortality associated with overhead-transmission lines and substations

This impact cannot be entirely avoided, but it can be reduced. The recommended mitigations are:

- *Fit standard devices on all new routes.* Where new transmission routes are established, the birds in the area will be unused to the structures and will benefit from devices that improve the visibility of the cables (e.g., “flappers” or reflectors or “balls”). Such measures are especially important in areas where fog or mist occurs regularly.
- *Monitor routes and installations.* Monitoring (as recommended below) will reveal where mortality is occurring. Mitigation measures (see above) should be applied in such areas. The details of specific types of mitigation are well known to the relevant Eskom employees.

4.1.6 Mitigation of disturbance of sensitive breeding populations

This impact can be largely avoided, and also reduced. The recommended mitigations are:

- *Determine location and extent of sensitive bird areas.* These are well known at Duynefontein and no additional fieldwork should be necessary. The bird areas include KNPS harbour and the beach. Other sensitive bird areas will not be affected.
- *Quarantine sensitive bird areas.* Areas which hold sensitive breeding colonies of Threatened birds (see sections 2.1.5 and 3.1.6, above) must be made out-of-bounds to all personnel, at all times. These areas will have to be identified and demarcated by the relevant specialist once the preferred site is selected. The sensitive areas must be cordoned off, in

consultation with Eskom's design team, prior to commencement of construction activities. Note that such areas are usually also important roost sites and are therefore also sensitive in the non-breeding season. Because virtually the whole coastline is sensitive owing to breeding pairs of oystercatchers and plovers, all activities at the coast need to be kept to a minimum, especially the use of off-road vehicles. (Normal, low-impact recreational activities can be allowed to resume on the beaches during the operational phase.)

- *Restrict the timing of blasting.* Blasting on site should take place outside of the peak breeding season of sensitive populations of seabirds, that is, ***not*** in the summer-autumn period of November-May. In other words, blasting ***should be*** carried out in the period of June-October and, therefore, these activities should be carefully planned, well in advance.
- *Create a wide buffer zone.* All sensitive bird breeding sites must be surrounded by a no-go buffer zone of at least 200-m width.
- *Restrict air traffic.* All air traffic associated with the construction and operation of the power station, including fixed-wing aircraft and helicopters, must be kept at least one kilometre away from sensitive bird-breeding areas.
- *Restrict water traffic.* Where breeding areas are situated on islands or in wetlands, no boating of any kind should be allowed within 300 m of the sensitive area.
- *Enforce all restrictions.* The Environmental Control Officer (ECO) on site must monitor and enforce compliance with all relevant restrictions.
- *Institute a programme of monitoring* of the regionally important breeding colonies of seabirds near to the construction site so that changes in populations are documented as an aid to effective environmental management.

4.1.7 Mitigation of dust pollution beyond the building site

This impact can be partially avoided, and substantially reduced. The recommended mitigations are:

- *Apply standard mitigation measures.* Apply standard measures for the reduction of airborne dust at construction sites, e.g., damping down with freshwater, use of cloth or brush barrier fences, covering dumps with plastic sheeting, etc. These measures must also be applied on all dirt roads that service the construction site.
- *Do not use seawater.* Only freshwater should be used on roads and building sites to suppress dust. Seawater would pollute and degrade natural habitats, especially any natural waterbodies near to roads.

4.1.8 Mitigation of pollution of soil and water beyond the building site

This impact can be partially avoided and reduced. The recommended mitigations are:

- *Apply standard mitigation measures.* Apply standard measures for avoiding spills and mitigating those that occur at construction sites. These measures must also be applied on all roads that service the construction site, and on all laydown areas.

- *Remove all polluted soil and water from site.* Polluted soil and water should not be left *in situ*, and should not be stockpiled or dumped on site, but should be removed from the site and, where necessary, to a designated hazardous-waste dump.
- *Dispose of brine from desalination into the sea.* Do this in a manner that will promote rapid dilution, e.g., outlet into surf zone.
- *Dispose of sewage in a sustainable manner.* This would entail either the connection of an on-site sewerage system to an existing off-site system, or the creation of an on-site sewerage treatment plant. The former option would have the lesser impact. Under no circumstances should raw or treated sewage be allowed to contaminate wetlands or groundwater. Pumping sewage out to sea may be an option, but the specialist study on marine ecology should be consulted in this regard.

4.1.9 Mitigation of light pollution beyond the building site

This impact can be partially avoided and substantially reduced. The recommended mitigations are:

- *Reduce exterior lighting* to the minimum necessary for essential functions.
- *Use only long-wavelength lights* (red or orange) for exterior lighting.
- *Use directional fittings* for exterior lights that direct light downward, not up or to the sides.
- *Screen interior lighting* with blinds, curtains, etc, to prevent exterior light pollution.

4.1.10 Mitigation of alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands

Mitigation of this impact is largely beyond my field of expertise and, therefore, the achievable level of mitigation is unknown. The specialist reports on geohydrology and freshwater ecology should be consulted for details and recommended mitigations. This specialist's recommended mitigations are:

- *Avoid sites where damage to important wetlands is inevitable.* If the advice of the relevant specialists indicates that major damage to important wetlands cannot be effectively mitigated, an alternative construction site should be found.
- *Do not use wetlands or groundwater as sources of freshwater.* Connection to local water reticulation or on-site desalinated seawater are the preferred options for the provision of freshwater, during both the construction and operational phases.
- *Engineer solutions to the flow of groundwater.* Where construction interacts with the flow of groundwater, ensure that such flow is redirected in such a way that downstream impacts are minimized.
- *Engineer solutions to the flow of surface runoff.* Erosion of topsoil and contamination of streams and wetlands must be avoided through proper management of runoff from hardened surfaces such as roads and buildings.

4.1.11 Mitigation of poaching of local wildlife

This impact can be largely avoided and/or reduced. The recommended mitigations are:

- *Educate workers.* All workers, at all levels of responsibility, need to be informed and actively educated as to the high conservation status of the fauna and flora around the construction site. Everyone must be made to understand that exploitation of wildlife resources is not permitted and will not be tolerated. Workers should be provided with controlled cooking areas and random 'braais' must not be allowed.
- *Patrol the area.* The on-site ECO must patrol areas where snares and traps are likely to be set. Efforts should be made to apprehend the perpetrators and to apply penalties.
- *Control materials.* Access to materials that can be used to create snares and traps, such as wire and poisons, should be strictly controlled at stores and laydowns.
- *Control firearms.* Employees should not be allowed to bring firearms onto the site unnecessarily.
- *Control after-hours access.* Access to the site after hours, especially at night, is likely to lead to poaching and should not be allowed.
- *Control access to non-construction areas.* Access to areas of the site that are not involved in construction or operation of the plant should be controlled. Tracks that provide such access should be gated and locked.

4.1.12 Mitigation of problem-animal scenarios

This impact can be largely avoided and/or reduced. The recommended mitigations are:

- *Do not allow feeding of wild animals.* Feeding should be strongly discouraged by both educational information and law enforcement.
- *Keep attractive resources out of reach.* It is of utmost importance that all food and water, including refuse, be kept completely out of reach of wild animals. This may require inventive and quite extreme measures because baboons, for example, are dextrous and intelligent animals.
- *Exercise rigorous control of edible refuse.* All refuse must not be dumped or stored on site, but be completely removed from site at frequent and regular intervals.
- *Eliminate feral cats and dogs.* Feral cats and dogs are a serious threat to wildlife and should be aggressively exterminated by the ECO.
- *Do not allow pets on site.* Pets interact negatively with wildlife and must not be allowed into protected nature areas.

4.1.13 Mitigation of accumulation of radioisotopes in the environment and in the bodies of wild animals

No mitigations, beyond those required by human health and safety regulations, are recommended.

4.1.14 Mitigation of cumulative impacts

Cumulative impacts cannot be completely avoided, especially at Duynefontein, because many of the impacts will have an ongoing effect during the operational phase of Nuclear-1. If Nuclear-1 is followed by the addition of second- and third-phase expansions, cumulative impacts will increase substantially. However, cumulative impacts can and should be reduced by means of diligent implementation of all recommended mitigation measures (above). The recommended mitigations that will contribute most to the reduction of cumulative impacts are:

- choice of a suitable development footprint
- rehabilitation of degraded areas, post construction
- use of a suitable design for boundary fences (Appendix 6)
- use of suitable exterior lighting (see above)
- avoidance and mitigation of impacts on groundwater
- enforcement of restrictions on disturbance and poaching of wildlife
- monitoring of sensitive populations to aid environmental management
- monitoring of radioisotope pollution to aid environmental management.

4.1.15 Mitigation/offset of impacts through improved conservation of undeveloped land

At Duynefontein, this form of compensation for negative impacts can only be brought about by means of improvements to the management and status of Koeberg Private Nature Reserve (KPNR). Recommended improvements are:

- Enlarge the reserve through the acquisition of neighbouring farms
- Elevation of the legal status of KPNR to a statutory nature reserve
- Replacement of unsuitable mesh fences with palisade fences (see Appendix 6)
- Increased spending on the removal of invasive alien plants
- Installation of two or three underpasses and/or overpasses across the R27, and major on-site access roads, to facilitate animal movements (see Appendix 5)
- Commissioning of detailed surveys of inadequately surveyed animal groups, viz., reptiles and small mammals, to inform management
- Commissioning of a programme to monitor the populations of sensitive species, to inform management.

4.1.16 Recommended monitoring and evaluation programme

An appropriate monitoring and auditing programme should be put in place to track the efficacy of the mitigation measures. Monitoring requirements must be built into the auditing procedures of the EMPs for the construction, operational and decommissioning phases, but input during the design phase is also important for the demarcation of sensitive areas. The programme should include monitoring directed specifically at sensitive faunal populations. The recommended programmes are outlined in Table 4.1.

Table 4.1: Recommended monitoring and evaluation programmes at Duynefontein.

Recommended monitoring programme	Duration of monitoring	Reporting frequency	Management objectives
1) Condition of wetlands near to footprint	Construction phase, plus three years	Quarterly	Maintenance of pre-development wetland ecology.
2) Size and breeding success of local breeding	Commence prior to construction phase and continue during	Annual	No reduction in colony size and average breeding success

colonies of seabirds	operational phase; ongoing		rate.
3) Mortality associated with transmission lines and substations	Commence after construction and continue until problems solved	Monthly	Reduction of frequency of bird mortality to low levels.
4) Mortality associated with roads	Commence at beginning of construction phase and continue until problems solved	Monthly	Reduction of frequency of roadkills to low levels.
5) Population strength of selected sensitive species, e.g., Blouberg Dwarf Burrowing Skink	Commence prior to construction and continue during operational phase; ongoing	Annual	Stabilization or improvement of populations, post construction.
6) Regular audits of the EMP for construction phase	Construction phase	Quarterly	Compliance with all provisions of the EMP.
7) Regular audits of the EMP for operational phase	Operational phase	Three-yearly	Compliance with all provisions of the EMP.

Notes:

- The “reporting frequency” is the frequency at which survey results must be written up and presented to the Environmental Control Officer (ECO).
- The frequency of actual field surveys is not specified here. Survey protocols must be designed by the relevant specialists who are appointed to do the monitoring.
- The breeding colonies in monitoring programme #2 are those at Koeberg harbour. ***Note that monitoring must begin prior to the construction phase so that a baseline for monitoring can be established.***
- Monitoring programmes 3 and 4 should be the responsibility of the on-site ECO.
- The sensitive species in monitoring programme #5 are those identified in 3.1.2 (above). ***Note that monitoring of these species must begin before site clearance so that a baseline for monitoring can be established.***
- Audits of the EMPs (#6 and #7) should be carried out by independent consultants.

In addition to the specific monitoring programmes recommended above, it is recommended that an Environmental Advisory Committee be appointed for the site. The committee should comprise experienced and respected members of the scientific community, preferably local residents, who have specific expertise in environmental matters. The function of this committee would be to assist the ECO in achieving his objectives and specifically to provide assistance in:

- Interpretation of the results of environmental monitoring;
- Formulating action plans for specific problems;
- Communicating environmental information and recommendations to senior managers in Eskom;
- Communicating relevant information to the public.

4.2 Bantamsklip: recommended mitigation measures

4.2.1 Mitigation of destruction of natural habitats and populations

This impact cannot be avoided, but it can be reduced, partially rectified and compensated for. The recommended mitigations are:

- *Restrict development to recommended areas.* The recommended areas are those with low or medium faunal sensitivity (see Figs 18 and 48). In areas of high faunal sensitivity, development is likely to cause irreparable and/or unacceptable damage to ecosystems and animal populations. ***Note that (a) "development" is intended to include all on-site buildings, installations and laydowns, including areas for storage of topsoil and spoil, and (b) quarries were not included in these deliberations. It is assumed that quarries will require separate EIA processes.***
- *Restrict the footprint of the development to the smallest area possible.* While the actual footprints of the buildings may be fixed, other areas are likely to be more flexible in their extent, e.g., areas for lay down, storage of topsoil, parking, etc. Consolidate all affected areas into one impacted node and avoid impact sprawl.
- *Dispose of spoil at sea.* If the marine-biology assessment finds that disposal of spoil at sea is a viable option, this is the preferred option because it will greatly reduce the footprint of the development in terrestrial habitats.
- *Create laydowns in previously disturbed areas.* Avoid creating laydowns and storage areas for overburden in areas of high quality habitat. Areas that have been previously disturbed and degraded are preferable because their biodiversity will already have been depressed and there will be less nett loss of biodiversity. Disturbed areas off site but reasonably nearby should be considered for laydowns so that good quality habitats on site can be preserved.
- *Use natural topographical features as boundaries.* Cutting across natural features, such as dune ridges and wetlands, will make rehabilitation of the areas that remain more difficult and less effective. The preferred footprint locations (Fig. 48) indicates suitable boundaries based, wherever possible, on natural features. At Bantamsklip, a coastal limestone ridge provides a suitable natural boundary.
- *Clear the site in a logical sequence.* Initial site clearance should be carried out in manner that allows mobile species to escape. This means that clearance should start from an area of relatively high disturbance and progress in an orderly manner in the direction of least disturbance and least physical obstruction. For example, begin clearing from an existing fence and clear towards an area that is not yet fenced and is still covered by natural habitat.
- *Mark off the affected area.* The footprint area, within which all construction is to take place, should be demarcated with stakes and hazard tape ***prior*** to site clearance, and should be fenced ***after*** initial

site clearance. The tape and fence are important in demarcating the limits of allowable disturbance of natural areas.

- *Rehabilitate affected areas, where possible.* Areas that are used only during the construction phase, e.g., laydowns, should be rehabilitated during the operational phase, so that ecological functioning is restored. Within security areas, where high vegetation cannot be allowed, natural vegetation should also be encouraged, but be kept low by regular mowing. This will allow small and fossorial animals and many invertebrates to recolonize the area.
- *Compensate for loss of habitats.* See 4.2.15, below, for recommended conservation offsets.

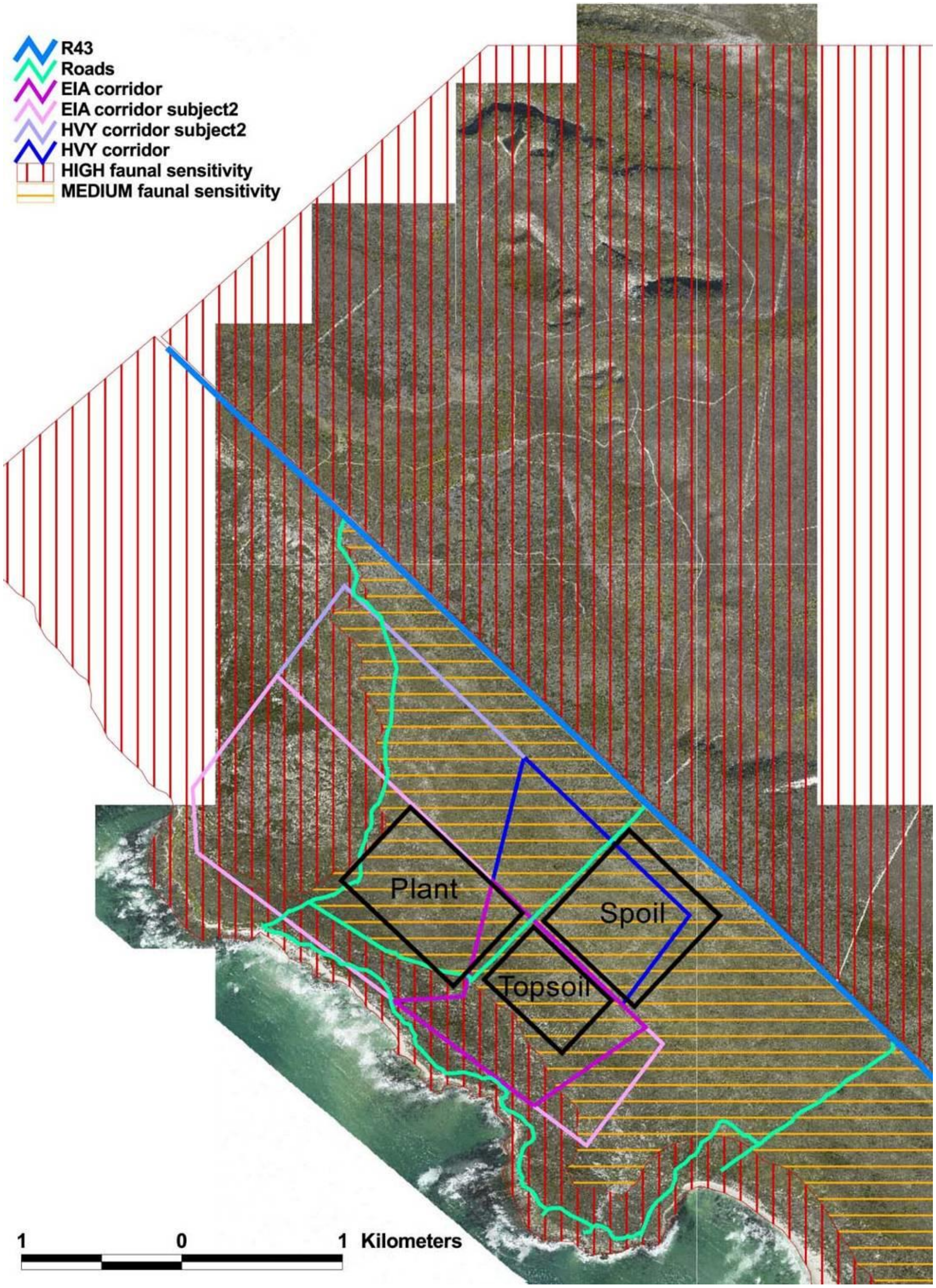

Figure 48: Recommended footprints for the Bantamsklip site. The plant, topsoil and spoil footprints are to the scale provided by Eskom. Note that the recommended footprint avoids the dunes to the northwest and limestone ridge to the southeast, and makes provision for a broad coastal corridor.

Figure 49: A section of coast at Bantamsklip which illustrates well the habitats that need to be included in a coastal corridor.

Figure 49: The relatively level area to the north of the limestone ridge (foreground) where the recommended footprint for Bantamsklip is located.

4.2.2 Mitigation of reduction in populations of Threatened species

This impact cannot be entirely avoided, but it can be reduced and partially rectified. The recommended mitigations are:

- *All of the mitigations listed under 4.2.1* (above).
- *Facilitate search-and-rescue operations before and during site clearance.* Individuals of Threatened species rescued during site clearance can be re-located in neighbouring, protected areas on site.
- *Facilitate collection of scientific material and information before and during site clearance.* Benefit can be derived from the biological material that will otherwise be totally lost during site clearance. Appropriate specialists should be commissioned to collect specimens for deposit in museums, herbaria, etc. The information collected will also be valuable for the management of the protected parts of Bantamsklip.

4.2.3 Mitigation of fragmentation of natural habitats and patterns of animal movement

This impact cannot be entirely avoided, but it can be reduced and partially rectified. The recommended mitigations are:

- *All of the mitigations listed under 4.2.1* (above).
- *Make provision for ecological corridors.* Ecological corridors provide connections of natural habitat between habitats at either end of the corridor. Such corridors are provided for in the preferred layout (Fig. 48). (See Fig. 47 and Appendix 4 for background information on ecological corridors.)
- *Construct under- and overpasses across roads.* Wherever a road crosses watercourses, box culverts must be installed to facilitate animal movement under the road. (See Appendix 5 for recommended specifications.) Large, incised watercourses should be crossed by means of raised bridges. Where a road runs between high points for more than 500 m (e.g., in the slack between dune ridges), overpasses should be constructed at 500-m intervals. (See Appendix 5 for alternative designs.)
- *Keep roads as far away from wetlands as possible.* Wetlands are an important resource for many animals. Roads reduce access to this resource.
- *Use recommended types of security fencing.* Suitable types of fencing can greatly improve the permeability of boundaries for small animals. Palisade fencing generally has a lower negative impact than mesh fencing. See Appendix 6 for further details.
- *Wherever possible, place pipelines and cables underground, and rehabilitate.* Underground pipelines do not present surface barriers, especially if topsoil is replaced and the surface is rehabilitated.
- *Reduce the number of roads and tracks and place them carefully.* Roads are a major cause of fragmentation. Wherever possible, roads should be placed on existing tracks, or within areas that are already disturbed or are to be developed. Roads across large areas of natural habitat must be kept to the absolute minimum necessary for access to the building site.
- *Make roads off limits for fixed periods every day.* (See next sub-section below.)

4.2.4 Mitigation of road mortality

This impact cannot be entirely avoided, but it can be reduced. The recommended mitigations are:

- *Reduce the number of roads and tracks and place them carefully.* Wherever possible roads should be placed within or along the edges of areas that are already disturbed or are to be developed. It is generally better to use or upgrade existing roads than to create new ones. Roads across large areas of natural habitat must be kept to an absolute minimum.
- *Keep roads as far away from wetlands as possible.* Wetlands are an important resource for many animals and they tend to move regularly to and from wetlands.
- *Construct under- and overpasses across roads.* (See previous sub-section above.)
- *Restrict speed on roads.* Enforce a speed limit of no more than 50 kph on roads that traverse natural areas. Erect speed humps if necessary (but with appropriate features for stormwater runoff).
- *Make roads off limits for fixed periods every day.* Roads which cross areas of natural habitat should be off limits for at least four hours – preferably six hours – at night: 11 pm to 5 am is suitable because it includes some twilight conditions at dawn. The only exceptions to such exclusion should be in cases of emergency. The quiet period provides animals with a safe and undisturbed time in which to move across roads.
- *Place warning signage in appropriate places.* In places where roadkills frequently occur, warning signage should be erected.
- *Use appropriate curb designs.* Curbs and roadside gutters should have low, sloping profiles without any vertical surfaces. Good designs facilitate the movements of small animals such as frogs, lizards and mice.

4.2.5 Mitigation of mortality associated with overhead-transmission lines and substations

This impact cannot be entirely avoided, but it can be reduced. The recommended mitigations are:

- *Fit standard devices on all new routes.* Where new transmission routes are established, the birds in the area will be unused to the structures and will benefit from devices that improve the visibility of the cables (e.g., “flappers” or reflectors or “balls”). Such measures are especially important in areas where fog or mist occurs regularly.
- *Monitor routes and installations.* Monitoring (as recommended below) will reveal where mortality is occurring. Mitigation measures (see above) should be applied in such areas. The details of specific types of mitigation are well known to the relevant Eskom employees.

4.2.6 Mitigation of disturbance of sensitive breeding populations

This impact can be largely avoided, and also reduced. The recommended mitigations are:

- *Determine location and extent of sensitive bird and frog areas.* The areas highlighted by Allen & Hockey (1989) and De Villiers (1989) need to be checked for current relevance, together with sites highlighted in this report and possible additional sites. This will require a few days of fieldwork by an appropriate specialist, prior to commencement of construction and in the appropriate seasons.
- *Quarantine sensitive bird and frog areas.* Areas which hold sensitive breeding colonies of Threatened birds and frogs (see sections 2.2.5 and 3.2.6, above) must be made out-of-bounds to all personnel, at all times. These areas will have to be identified and demarcated by the relevant specialist once the preferred site is selected. The sensitive areas must be cordoned off, in consultation with Eskom's design team, prior to commencement of construction activities. Note that such areas are usually also important roost sites and are therefore also sensitive in the non-breeding season. Because virtually the whole coastline is sensitive owing to breeding pairs of oystercatchers and plovers, as well as roost sites, all activities at the coast need to be kept to a minimum, especially the use of off-road vehicles. (Normal, low-impact recreational activities can be allowed to resume during the operational phase.)
- *Restrict the timing of blasting.* Blasting on site should take place outside of the peak breeding seasons of sensitive bird populations. Given the varying breeding seasons of the relevant species, the preferred period would ***not*** be in the late winter-spring-summer period of July-March. In other words, blasting ***should be*** carried out in the narrow window period of April-June and, therefore, these activities should be carefully planned, well in advance.
- *Create a wide buffer zone.* All sensitive bird breeding sites must be surrounded by a no-go buffer zone of at least 200-m width.
- *Restrict air traffic.* All air traffic associated with the construction and operation of the power station, including fixed-wing aircraft and helicopters, must be kept at least one kilometre away from sensitive bird-breeding areas.
- *Restrict water traffic.* Where breeding areas are situated on islands or in wetlands, no boating of any kind should be allowed within 300 m of the sensitive area.
- *Enforce all restrictions.* The Environmental Control Officer (ECO) on site must monitor and enforce compliance with all relevant restrictions.
- *Institute a programme of monitoring* of the regionally important breeding colonies of seabirds near to the construction site so that changes in populations are documented as an aid to effective environmental management.

4.2.7 Mitigation of dust pollution beyond the building site

This impact can be partially avoided, and substantially reduced. The recommended mitigations are:

- *Apply standard mitigation measures.* Apply standard measures for the reduction of airborne dust at construction sites, e.g., damping down with freshwater, use of cloth or brush barrier fences, covering dumps with plastic sheeting, etc. These measures must also be applied on all dirt roads that service the construction site.

- *Do not use seawater.* Only freshwater should be used on roads and building sites to suppress dust. Seawater would pollute and degrade natural habitats, especially any natural waterbodies near to roads.

4.2.8 Mitigation of pollution of soil and water beyond the building site

This impact can be partially avoided and reduced. The recommended mitigations are:

- *Apply standard mitigation measures.* Apply standard measures for avoiding spills and mitigating those that occur at construction sites. These measures must also be applied on all roads that service the construction site, and on all laydown areas.
- *Remove all polluted soil and water from site.* Polluted soil and water should not be left *in situ*, and should not be stockpiled or dumped on site, but should be removed from the site and, where necessary, to a designated hazardous-waste dump.
- *Dispose of brine from desalination into the sea.* Do this in a manner that will promote rapid dilution, e.g., outlet into surf zone.
- *Dispose of sewage in a sustainable manner.* This would entail either the connection of an on-site sewerage system to an existing off-site system, or the creation of an on-site sewerage treatment plant. The former option would have the lesser impact. Under no circumstances should raw or treated sewage be allowed to contaminate wetlands or groundwater. Pumping sewage out to sea may be an option, but the specialist study on marine ecology should be consulted in this regard.

4.2.9 Mitigation of light pollution beyond the building site

This impact can be partially avoided and substantially reduced. The recommended mitigations are:

- *Reduce exterior lighting* to the minimum necessary for essential functions.
- *Use only long-wavelength lights* (red or orange) for exterior lighting.
- *Use directional fittings* for exterior lights that direct light downward, not up or to the sides.
- *Screen interior lighting* with blinds, curtains, etc, to prevent exterior light pollution.

4.2.10 Mitigation of alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands

Mitigation of this impact is largely beyond this specialist's field of expertise and, therefore, the achievable level of mitigation is unknown. The specialist reports on geohydrology and freshwater ecology should be consulted for details and recommended mitigations. This specialist's recommended mitigations are:

- *Avoid sites where damage to important wetlands is inevitable.* If the advice of the relevant specialists indicates that major damage to important wetlands cannot be effectively mitigated, an alternative construction site should be found.

- *Do not use wetlands or groundwater as sources of freshwater.* Connection to local water reticulation or on-site desalinated seawater are the preferred options for the provision of freshwater, during both the construction and operational phases.
- *Engineer solutions to the flow of groundwater.* Where construction does interact with the flow of groundwater, ensure that such flow is redirected in such a way that downstream impacts are minimized.
- *Engineer solutions to the flow of surface runoff.* Erosion of topsoil and contamination of streams and wetlands must be avoided through proper management of runoff from hardened surfaces such as roads and buildings.

4.2.11 Mitigation of poaching of local wildlife

This impact can be largely avoided and/or reduced. The recommended mitigations are:

- *Educate workers.* All workers, at all levels of responsibility, need to be informed and actively educated as to the high conservation status of the fauna and flora around the construction site. Everyone must be made to understand that exploitation of wildlife resources is not permitted and will not be tolerated. Workers should be provided with controlled cooking areas and random 'braais' must not be allowed.
- *Patrol the area.* The on-site ECO must patrol areas where snares and traps are likely to be set. Efforts should be made to apprehend the perpetrators and to apply penalties.
- *Control materials.* Access to materials that can be used to create snares and traps, such as wire and poisons, should be strictly controlled at stores and laydowns.
- *Control firearms.* Employees should not be allowed to bring firearms onto the site unnecessarily.
- *Control after-hours access.* Access to the site after hours, especially at night, is likely to lead to poaching and should not be allowed.
- *Control access to non-construction areas.* Access to areas of the site that are not involved in construction or operation of the plant should be controlled. Tracks that provide such access should be gated and locked.

4.2.12 Mitigation of problem-animal scenarios

This impact can be largely avoided and/or reduced. The recommended mitigations are:

- *Do not allow feeding of wild animals.* Feeding should be strongly discouraged by both educational information and law enforcement.
- *Keep attractive resources out of reach.* It is of utmost importance that all food and water, including refuse, be kept completely out of reach of wild animals. This may require inventive and quite extreme measures because baboons, for example, are dextrous and intelligent animals.
- *Exercise rigorous control of edible refuse.* All refuse must not be dumped or stored on site, but be completely removed from site at frequent and regular intervals.

- *Eliminate feral cats and dogs.* Feral cats and dogs are a serious threat to wildlife and should be aggressively exterminated by the ECO.
- *Do not allow pets on site.* Pets interact negatively with wildlife and must not be allowed into protected nature areas.

4.2.13 Mitigation of accumulation of radioisotopes in the environment and in the bodies of wild animals

No mitigations, beyond those required by human health and safety regulations, are recommended.

4.2.14 Mitigation of cumulative impacts

Cumulative impacts cannot be completely avoided because many of the impacts will have an ongoing effect during the operational phase of Nuclear-1. If Nuclear-1 is followed by the addition of second- and third-phase expansions, cumulative impacts will increase substantially. However, cumulative impacts can and should be reduced by means of diligent implementation of all recommended mitigation measures (above). The recommended mitigations that will contribute most to the reduction of cumulative impacts are:

- choice of a suitable development footprint
- rehabilitation of degraded areas, post construction
- use of a suitable design for boundary fences (Appendix 6)
- use of suitable exterior lighting (see above)
- avoidance and mitigation of impacts on groundwater
- enforcement of restrictions on disturbance and poaching of wildlife
- monitoring of sensitive populations to aid environmental management
- monitoring of radioisotope pollution to aid environmental management.

4.2.15 Mitigation/offset of impacts through improved conservation of undeveloped land

At Bantamsklip, this form of compensation for negative impacts can be brought about by declaring the undeveloped portions of Eskom-owned land as a private nature reserve and by managing that reserve effectively for conservation purposes. A model is provided by Koeberg Private Nature Reserve. Further offsets are possible by elevating the legal status of the reserve to a statutory protected area, and by devoting resources to improved management. Such improvements could include:

- Increasing the size of the reserve with the addition of neighbouring farms
- Replacement of unsuitable mesh fences with palisade fences (see Appendix 6)
- Increased spending on the removal of invasive alien plants
- Installation of two or three underpasses and/or overpasses across the R43, and major access roads on site, to facilitate animal movements (see Appendix 5)
- Commissioning of detailed surveys of inadequately surveyed animal groups, viz., reptiles and small mammals, to inform management
- Commissioning of a programme to monitor the populations of sensitive species, to inform management.

4.2.16 Recommended monitoring and evaluation programme

An appropriate monitoring and auditing programme should be put in place to track the efficacy of the mitigation measures. Most of this monitoring must be built into the auditing procedures of the EMPs for the construction and operational phases, but input during the design phase is also important for the demarcation of sensitive areas. The programme should include monitoring directed specifically at sensitive aspects of faunal populations. The recommended programmes are outlined in Table 4.2.

Table 4.2: Recommended monitoring and evaluation programmes at Bantamsklip.

Recommended monitoring programme	Duration of monitoring	Reporting frequency	Management objectives
1) Condition of wetlands near to footprint	Construction phase, plus three years	Quarterly	Maintenance of pre-development wetland ecology.
2) Size and breeding success of local breeding colonies of seabirds	Commence prior to construction phase and continue during operational phase; ongoing	Annual	No reduction in colony size and average breeding success rate.
3) Mortality associated with transmission lines and substations	Commence after construction and continue until problems solved	Monthly	Reduction of frequency of bird mortality to low levels.
4) Mortality associated with roads	Commence at beginning of construction phase and continue until problems solved	Monthly	Reduction of frequency of roadkills to low levels.
5) Population strength of selected sensitive species, e.g., Micro Frog	Commence prior to construction and continue during operational phase; ongoing	Annual	Stabilization or improvement of populations, post construction.
6) Regular audits of the EMP for construction phase	Construction phase	Quarterly	Compliance with all provisions of the EMP.
7) Regular audits of the EMP for operational phase	Operational phase	Three-yearly	Compliance with all provisions of the EMP.

Notes:

- The "reporting frequency" is the frequency at which survey results must be written up and presented to the Environmental Control Officer (ECO).
- The frequency of actual field surveys is not specified here. Survey protocols must be designed by the relevant specialists who are appointed to do the monitoring.
- The breeding colonies in monitoring programme #2 are those listed under 3.2.6 (above). ***Note that monitoring must begin prior to the construction phase so that a baseline for monitoring can be established.***
- Monitoring programmes 3 and 4 should be the responsibility of the on-site ECO.
- The sensitive species in monitoring programme #5 are those identified in 3.2.2 (above). ***Note that monitoring of these species must begin before site clearance so that a baseline for monitoring can be established.***
- Audits of the EMPs (#6 and #7) should be carried out by independent consultants.

In addition to the specific monitoring programmes recommended above, it is recommended that an Environmental Advisory Committee be appointed for the site. The committee should comprise experienced and respected members of the scientific community, preferably local residents, who have specific expertise in environmental matters. The function of this committee would be to assist the ECO in achieving his objectives and specifically to provide assistance in:

- Interpretation of the results of environmental monitoring;
- Formulating action plans for specific problems;
- Communicating environmental information and recommendations to senior managers in Eskom;
- Communicating relevant information to the public.

4.3 Thyspunt: recommended mitigation measures

4.3.1 Mitigation of destruction of natural habitats and populations

This impact cannot be avoided, but it can be reduced, partially rectified and compensated for. The recommended mitigations are:

- *Restrict development to recommended areas.* The recommended areas are those with low or medium faunal sensitivity (see Figs 42 and 51). In areas of high faunal sensitivity, development is likely to cause irreparable and/or unacceptable damage to ecosystems and animal populations. ***Note (a) that "development" is intended to include all on-site buildings, installations and laydowns, including areas for storage of topsoil and spoil, and (b) quarries were not included in these deliberations.*** It is assumed that quarries will require separate EIA processes.
- *Plan the routing of new roads carefully.* At Thyspunt it is proposed that new access roads be created: a relatively minor road from Oyster Bay in the west, a major, heavy-duty road from Cape St Francis in the east, and a road across the dune field to the inland panhandle part of the property (Fig. 52). These roads should:
    - Avoid wetlands and seeps; see recommendations of the freshwater specialist, especially with regard to the western access road.
    - Follow existing road routes as much as possible to minimize additional habitat destruction.
    - Preferably be created in dune slacks where there is less potential for destabilization of dunes and visual impacts are reduced.
    - Follow the recommendations of the dune specialist with regard to the routing of the northern access road across the dune field.
    - Avoid areas of dune forest.
    - Follow, as far as possible, areas where there are thickets of alien vegetation, i.e., where natural habitats have already been degraded. Unfortunately, dune forest and alien thickets have not yet been mapped to a degree of accuracy that permits such planning (Barrie Low pers. comm.). ***Additional botanical***

survey work needs to be carried out to map these details to a level of accuracy that will inform the road-planning process.

  - (e) The routing of the road through the dunes should follow the recommendations of the dune specialist (Werner Illenberger).

- *Plan all routes across the dunes in conjunction.* It is essential that all infrastructural routes across the dune field (roads, transmission lines and conveyors for spoil) be ***constructed within the same narrow corridor.*** This is so that all of the direct impacts on the dune field are restricted to a limited area and so that a single road can service all of the needs for access to the dune field, thus minimizing impact sprawl. The actual route chosen should follow the recommendations of the dune specialist (Werner Illenberger).
- *Restrict the footprint of the development to the smallest area possible.* While the actual footprints of the buildings may be fixed, other areas are likely to be more flexible in their extent, e.g., areas for lay down, storage of topsoil, parking, etc. Consolidate all affected areas into one impacted node and avoid impact sprawl.
- *Dispose of spoil at sea.* If the marine-biology assessment finds that disposal of spoil at sea is a viable option, this is the preferred option because it will greatly reduce the footprint of the development in terrestrial habitats.
- *Create laydowns in previously disturbed areas.* Avoid creating laydowns and storage areas for overburden in areas of high quality habitat. Areas that have been previously disturbed and degraded are preferable because their biodiversity will already have been depressed and there will be less nett loss of biodiversity. Disturbed areas off site, but reasonably nearby, should be considered for laydowns so that good quality habitats on site can be preserved. At Thyspunt, there is insufficient space in the development corridor, or any other part of the property, for a spoil dump (see Fig. 51). ***It is recommended that an additional inland property be acquired to supplement the Eskom property and make provision for this dump.***

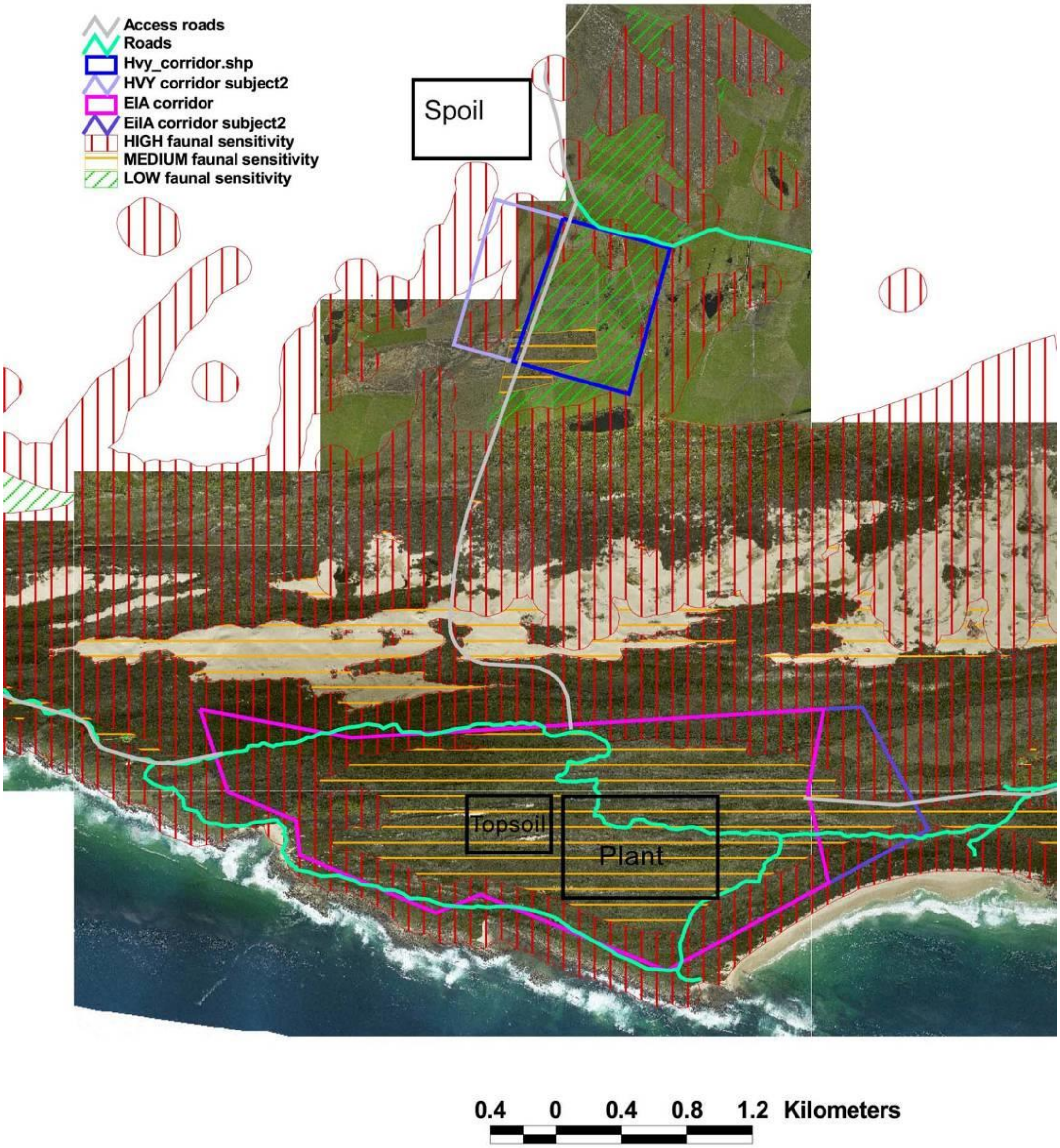

Figure 51: Recommended footprints on the Thyspunt site. The plant, topsoil and spoil footprints are to the scale provided by Eskom. Note that the recommended footprints avoid areas of high sensitivity and make provision for a broad coastal corridor. Note too that there is insufficient space for the spoil footprint on site. Additional land of relatively low sensitivity will have to be acquired adjacent to the "panhandle" portion of the property (not necessarily in the position indicated by the spoil footprint).

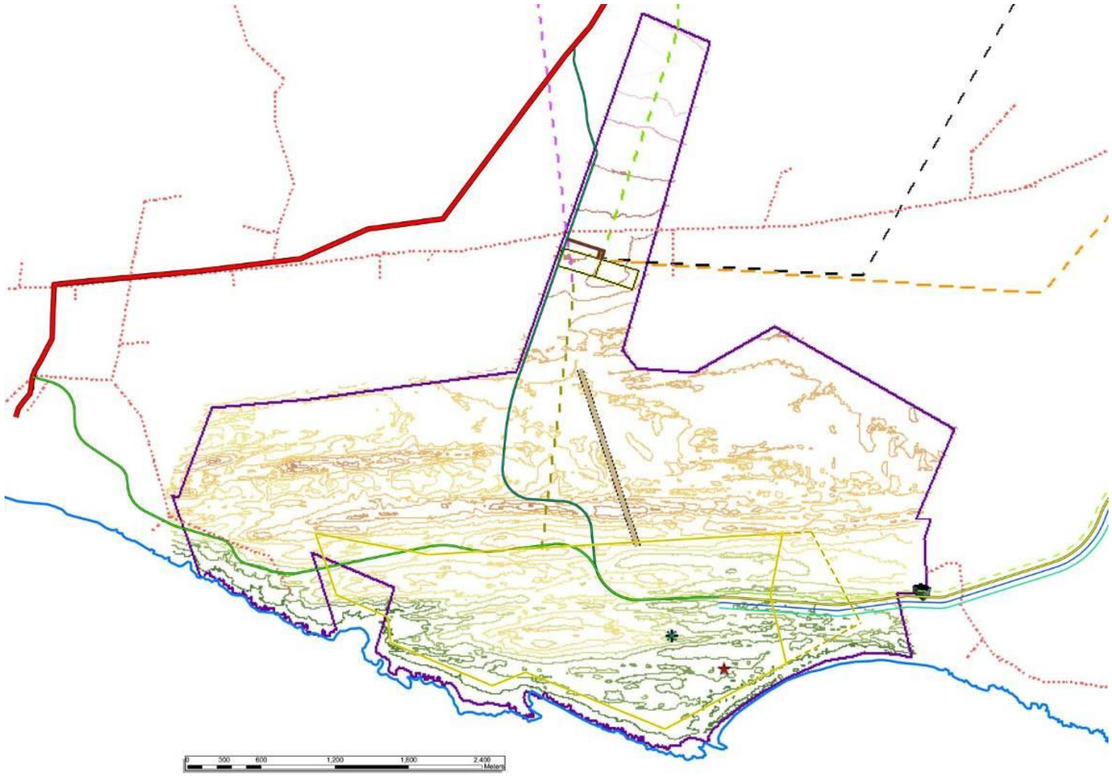

Figure 52: Proposed new roads at Thyspunt (see text for description).

- *Use natural topographical features as boundaries.* Cutting across natural features, such as dune ridges and wetlands, will make rehabilitation of the areas that remain more difficult and less effective.
- *Clear the site in a logical sequence.* Initial site clearance should be carried out in manner that allows mobile species to escape. This means that clearance should start from an area of relatively high disturbance and progress in an orderly manner in the direction of least disturbance and least physical obstruction. For example, begin clearing from an existing fence and clear towards an area that is not yet fenced and is still covered by natural habitat.
- *Mark off affected areas.* The footprint areas, within which all construction activities are to take place, should be demarcated with stakes and hazard tape ***prior*** to site clearance, and should be fenced ***after*** initial site clearance. The tape and fence are important in demarcating the limits of allowable disturbance of natural areas.
- *Rehabilitate affected areas, where possible.* Areas that are used only during the construction phase, e.g., laydowns, should be rehabilitated during the operational phase, so that their normal ecological functioning is restored. Within security areas, where high vegetation cannot be allowed, natural vegetation should also be encouraged, but be kept low by regular mowing. This will allow small and fossorial animals and many invertebrates to recolonize the area.
- *Compensate for loss of habitats.* See 4.3.15, below, for recommended conservation offsets.

Figure 53: Coastal wetlands and seeps that require protection on the rocky shore at Thyspunt.

4.3.2 Mitigation of reduction in populations of Threatened species

This impact cannot be entirely avoided, but it can be reduced and partially rectified. The recommended mitigations are:

- *All of the mitigations listed under 4.3.1* (above).
- *Facilitate search-and-rescue operations before and during site clearance.* Individuals of Threatened species rescued during site clearance can be re-located in neighbouring, protected areas on site.
- *Facilitate collection of scientific material and information before and during site clearance.* Benefit can be derived from the biological material that will otherwise be totally lost during site clearance. Appropriate specialists should be commissioned to collect specimens for deposit in museums, herbaria, etc. The information collected will also be valuable for the management of the protected parts of Thyspunt.

4.3.3 Mitigation of fragmentation of natural habitats and patterns of animal movement

This impact cannot be entirely avoided, but it can be reduced and partially rectified. The recommended mitigations are:

- *All of the mitigations listed under 4.3.1* (above).
- *Make provision for ecological corridors.* Ecological corridors provide connections of natural habitat between habitats at either end of the corridor. Such corridors are provided for in the preferred footprint locations (Fig. 51). (See Fig. 47 and Appendix 4 for background information on ecological corridors.)
- *Construct under- and overpasses across roads.* Wherever a road crosses watercourses, box culverts must be installed to facilitate animal movement under the road. (See Appendix 5 for recommended specifications.) Large, incised watercourses should be crossed by means

of raised bridges. Where a road runs between high points for more than 500 m (e.g., in the slack between dune ridges), overpasses should be constructed at 500-m intervals. (See Appendix 5 for alternative designs.)

- *Keep roads as far away from wetlands as possible.* Wetlands are an important resource for many animals. Roads reduce access to this resource.
- *Use recommended types of security fencing.* Suitable types of fencing can greatly improve the permeability of boundaries for small animals. Palisade fencing generally has a lower negative impact than mesh fencing. See Appendix 6 for further details.
- *Wherever possible, place pipelines and cables underground, and rehabilitate.* Underground pipelines do not present surface barriers, especially if topsoil is replaced and the surface is rehabilitated.
- *Reduce the number of roads and tracks and place them carefully.* Roads are a major cause of fragmentation. Wherever possible, roads should be placed within or along the edges of areas that are already disturbed or are to be developed. Roads across large areas of natural habitat must be kept to the absolute minimum necessary for access to the building site (see 4.3.1 above).
- *Make roads off limits for fixed periods every day.* (See next sub-section below.)

4.3.4 Mitigation of road mortality

This impact cannot be entirely avoided, but it can be reduced. The recommended mitigations are:

- *Reduce the number of roads and tracks and place them carefully.* Wherever possible roads should be placed within or along the edges of areas that are already disturbed or are to be developed. It is generally better to use or upgrade existing roads than to create new ones. Roads across large areas of natural habitat must be kept to an absolute minimum and be planned in consultation with an ecologist.
- *Keep roads as far away from wetlands as possible.* Wetlands are an important resource for many animals and they tend to move regularly to and from wetlands.
- *Construct under- and overpasses across roads.* (See previois sub-section above.)
- *Restrict speed on roads.* Enforce a speed limit of no more than 50 kph on roads that traverse natural areas. Erect speed humps if necessary (but with appropriate features for stormwater runoff).
- *Make roads off limits for fixed periods every day.* Roads which cross areas of natural habitat should be off limits for at least four hours – preferably six hours – at night: 11 pm to 5 am is suitable because it includes some twilight conditions at dawn. The only exceptions to such exclusion should be in cases of emergency. The quiet period provides animals with a safe and undisturbed time in which to move across roads.
- *Place warning signage in appropriate places.* In places where roadkills frequently occur, warning signage should be erected.

- *Use appropriate curb designs.* Curbs and roadside gutters should have low, sloping profiles without any vertical surfaces. Good designs facilitate the movements of small animals such as frogs, lizards and mice.

4.3.5 Mitigation of mortality associated with overhead-transmission lines and substations

This impact cannot be entirely avoided, but it can be reduced. The recommended mitigations are:

- *Fit standard devices on all new routes.* Where new transmission routes are established, the birds in the area will be unused to the structures and will benefit from devices that improve the visibility of the cables (e.g., "flappers" or reflectors or "balls"). Such measures are especially important in areas where fog or mist occurs regularly.
- *Monitor routes and installations.* Monitoring (as recommended below) will reveal where mortality is occurring. Mitigation measures (see above) should be applied in such areas. The details of specific types of mitigation are well known to the relevant Eskom employees.

4.3.6 Mitigation of disturbance of sensitive breeding populations

This impact can be largely avoided, and also reduced. The recommended mitigations are:

- *Quarantine sensitive bird and other areas.* Areas which hold sensitive breeding colonies of Threatened birds (see sections 2.3.5 and 3.3.6, above) must be made out-of-bounds to all personnel, at all times. These areas will have to be identified and demarcated by the relevant specialist once the preferred site is selected. At Thyspunt, the most sensitive areas are those where Denham's Bustard, White-bellied Korhaan and Black-winged Lapwing are likely to breed, on the northern part of the panhandle, and equivalent habitat on neighbouring properties. Sensitive areas must be cordoned off, in consultation with Eskom's design team, prior to commencement of construction activities. Because virtually the whole coastline is sensitive owing to breeding pairs of oystercatchers and plovers, and roost sites of terns, cormorants and gulls, all construction-related activities at the coast need to be kept to a minimum, especially the use of off-road vehicles. (Normal, low-impact recreational activities at the coast can be allowed to resume during the operational phase.)
- *Restrict the timing of blasting.* Blasting on site should take place outside of the peak breeding seasons of sensitive bird populations. Given the varying breeding seasons of the relevant species, the preferred period would ***not be*** in the late winter-spring-summer period of July-March. In other words, blasting ***should be*** carried out in the narrow window period of April-June and, therefore, these activities should be carefully planned, well in advance.
- *Restrict air traffic.* All air traffic associated with the construction and operation of the power station, including fixed-wing aircraft and helicopters, must be kept at least one kilometre away from sensitive bird-breeding areas.

- *Enforce all restrictions.* The ECO on site must monitor and enforce compliance with all relevant restrictions.
- *Institute a programme of monitoring* of the regionally important breeding colonies and/or roost sites of seabirds near to the construction site so that changes in populations are documented as an aid to effective environmental management.

4.3.7 Mitigation of dust pollution beyond the building site

This impact can be partially avoided, and substantially reduced. The recommended mitigations are:

- *Apply standard mitigation measures.* Apply standard measures for the reduction of airborne dust at construction sites, e.g., damping down with freshwater, use of cloth or brush barrier fences, covering dumps with plastic sheeting, etc. These measures must also be applied on all dirt roads that service the construction site.
- *Do not use seawater.* Only freshwater should be used on roads and building sites to suppress dust. Seawater would pollute and degrade natural habitats, especially any natural waterbodies near to roads.

4.3.8 Mitigation of pollution of soil and water beyond the building site

This impact can be partially avoided and reduced. The recommended mitigations are:

- *Apply standard mitigation measures.* Apply standard measures for avoiding spills and mitigating those that occur at construction sites. These measures must also be applied on all roads that service the construction site, and on all laydown areas.
- *Remove all polluted soil and water from site.* Polluted soil and water should not be left *in situ*, and should not be stockpiled or dumped on site, but should be removed from the site and, where necessary, to a designated hazardous-waste dump.
- *Dispose of brine from desalination into the sea.* Do this in a manner that will promote rapid dilution, e.g., outlet into surf zone.
- *Dispose of sewage in a sustainable manner.* This would entail either the connection of an on-site sewerage system to an existing off-site system, or the creation of an on-site sewerage treatment plant. The former option would have the lesser impact. Under no circumstances should raw or treated sewage be allowed to contaminate wetlands or groundwater. Pumping sewage out to sea may be an option, but the specialist study on marine ecology should be consulted in this regard.

4.3.9 Mitigation of light pollution beyond the building site

This impact can be partially avoided and substantially reduced. The recommended mitigations are:

- *Reduce exterior lighting* to the minimum necessary for essential functions.
- *Use only long-wavelength lights* (red or orange or yellow) for exterior lighting.

- *Use directional fittings* for exterior lights that direct light downward, not up or to the sides.
- *Screen interior lighting* with blinds, curtains, etc, to prevent exterior light pollution.

4.3.10 Mitigation of alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands

Mitigation of this impact is largely beyond my field of expertise and, therefore, the achievable level of mitigation is unknown. The specialist reports on geohydrology and freshwater ecology should be consulted for details and recommended mitigations. This specialist's recommended mitigations are:

- *Avoid sites where damage to important wetlands is inevitable.* If the advice of the relevant specialists indicates that major damage to important wetlands cannot be effectively mitigated, an alternative construction site should be found.
- *Do not use wetlands or groundwater as sources of freshwater.* Connection to local water reticulation or on-site desalinated seawater are the preferred options for the provision of freshwater, during both the construction and operational phases.
- *Engineer solutions to the flow of groundwater.* Where construction does interact with the flow of groundwater, ensure that such flow is redirected in such a way that upstream and downstream impacts are minimized. ***At Thyspunt this is an especially important category of mitigations because of the large number of sensitive wetlands on site. Currently there is a lack of definitive information on whether adequate engineering solutions are available to avoid serious impacts on wetlands. Such information is essential to the EIA process and the necessary studies need to be carried out as a matter of urgency so that appropriate mitigation can be specified.*** The studies need to elucidate the groundwater dynamics of the coastal seeps, Langefonteinvlei, and the wetlands of the mobile-dune field.
- *Engineer solutions to the flow of surface runoff.* Erosion of topsoil and contamination of streams and wetlands must be avoided through proper management of runoff from hardened surfaces such as roads and buildings.

4.3.11 Mitigation of poaching of local wildlife

This impact can be largely avoided and/or reduced. The recommended mitigations are:

- *Educate workers.* All workers, at all levels of responsibility, need to be informed and actively educated as to the high conservation status of the fauna and flora around the construction site. Everyone must be made to understand that exploitation of wildlife resources is not permitted and will not be tolerated. Workers should be provided with controlled cooking areas and random 'braais' must not be allowed.
- *Patrol the area.* The on-site ECO must patrol areas where snares and traps are likely to be set. Efforts should be made to apprehend the perpetrators and to apply penalties.

- *Control materials.* Access to materials that can be used to create snares and traps, such as wire and poisons, should be strictly controlled at stores and laydowns.
- *Control firearms.* Employees should not be allowed to bring firearms onto the site unnecessarily.
- *Control after-hours access.* Access to the site after hours, especially at night, is likely to lead to poaching and should not be allowed.
- *Control access to non-construction areas.* Access to areas of the site that are not involved in construction or operation of the plant should be controlled. Tracks that provide such access should be gated and locked.

4.3.12 Mitigation of problem-animal scenarios

This impact can be largely avoided and/or reduced. The recommended mitigations are:

- *Do not allow feeding of wild animals.* Feeding should be strongly discouraged by both educational information and law enforcement.
- *Keep attractive resources out of reach.* It is of utmost importance that all food and water, including refuse, be kept completely out of reach of wild animals. This may require inventive and quite extreme measures because baboons, for example, are dextrous and intelligent animals.
- *Exercise rigorous control of edible refuse.* All refuse must not be dumped or stored on site, but be completely removed from site at frequent and regular intervals.
- *Eliminate feral cats and dogs.* Feral cats and dogs are a serious threat to wildlife and should be aggressively exterminated by the ECO.
- *Do not allow pets on site.* Pets interact negatively with wildlife and must not be allowed into protected nature areas.

4.3.13 Mitigation of accumulation of radioisotopes in the environment and in the bodies of wild animals

No mitigations, beyond those required by human health and safety regulations, are recommended.

4.3.14 Mitigation of cumulative impacts

Cumulative impacts cannot be completely avoided because many of the impacts will have an ongoing effect during the operational phase of Nuclear-1. However, cumulative impacts can and should be reduced by means of diligent implementation of all recommended mitigation measures (above). The recommended mitigations that will contribute most to the reduction of cumulative impacts are:

- choice of a suitable development footprint
- rehabilitation of degraded areas, post construction
- use of a suitable design for boundary fences (Appendix 6)
- use of suitable exterior lighting (see above)
- avoidance and mitigation of impacts on groundwater
- enforcement of restrictions on disturbance and poaching of wildlife
- monitoring of sensitive populations to aid environmental management

- monitoring of radioisotope pollution to aid environmental management.

4.3.15 Mitigation/offset of impacts through improved conservation of undeveloped land

At Thyspunt, this form of compensation for negative impacts can be brought about by declaring the undeveloped portions of Eskom-owned land as a private nature reserve and by managing that reserve effectively for conservation purposes. A model is provided by Koeberg Private Nature Reserve. Further offsets are possible by elevating the legal status of the reserve to a statutory protected area, and by devoting resources to improved management. Such improvements could include:

- Increasing the size of the reserve with the addition of neighbouring farms
- Replacement of unsuitable mesh fences with palisade fences (see Appendix 6)
- Increased spending on the removal of invasive alien plants
- Installation of underpasses and/or overpasses across the new, tarred access roads to facilitate animal movements (see Appendix 5)
- Commissioning of detailed surveys of poorly surveyed animal groups, viz., reptiles and small mammals, to inform management
- Commissioning of a programme to monitor the populations of sensitive species, to inform management.

4.3.16 Recommended monitoring and evaluation programme

An appropriate monitoring and auditing programme should be put in place to track the efficacy of the mitigation measures. Most of this monitoring must be built into the auditing procedures of the EMPs for the construction and operational phases, but input during the design phase is also important for the demarcation of sensitive areas. The programme should include monitoring directed specifically at sensitive aspects of faunal populations. The recommended programmes are outlined in Table 4.3.

Table 4.3: Recommended monitoring and evaluation programmes at Thyspunt.

Recommended monitoring programme	Duration of monitoring	Reporting frequency	Management objectives
1) Condition of wetlands near to footprint	Construction phase, plus three years	Quarterly	Maintenance of pre-development wetland ecology.
2) Size of local seabird roosts	Commence prior to construction phase and continue during operational phase; ongoing	Annual	No reduction in colony size.
3) Mortality associated with transmission lines and substations	Commence after construction and continue until problems solved	Monthly	Reduction of frequency of bird mortality to low levels.
4) Mortality associated with roads	Commence at beginning of construction phase and continue until problems solved	Monthly	Reduction of frequency of roadkills to low levels.
5) Population strength of selected sensitive species, e.g., Elandsberg Dwarf Chameleon	Commence prior to construction and continue during operational phase; ongoing	Annual	Stabilization or improvement of populations, post construction.
6) Regular audits of the EMP for construction phase	Construction phase	Quarterly	Compliance with all provisions of the EMP.
7) Regular audits of the	Operational phase	Three-	Compliance with all provisions

EMP for operational phase		yearly	of the EMP.

Notes:

- The "reporting frequency" is the frequency at which survey results must be written up and presented to the Environmental Control Officer (ECO).
- The frequency of actual field surveys is not specified here. Survey protocols must be designed by the relevant specialists who are appointed to do the monitoring.
- The roosts in monitoring programme #2 are those listed under 3.3.6 (above). ***Note that monitoring must begin prior to the construction phase so that a baseline for monitoring can be established.***
- Monitoring programmes 3 and 4 should be the responsibility of the on-site ECO.
- The sensitive species in monitoring programme #5 are those identified in 3.3.2 (above). ***Note that monitoring of these species must begin before site clearance so that a baseline for monitoring can be established.***
- Audits of the EMPs (#6 and #7) should be carried out by independent consultants.

In addition to the specific monitoring programmes recommended above, it is recommended that an Environmental Advisory Committee be appointed for the site. The committee should comprise experienced and respected members of the scientific community, preferably local residents, who have specific expertise in environmental matters. The function of this committee would be to assist the ECO in achieving his objectives and specifically to provide assistance in:

- Interpretation of the results of environmental monitoring;
- Formulating action plans for specific problems;
- Communicating environmental information and recommendations to senior managers in Eskom;
- Communicating relevant information to the public.

4.4 Mitigating for climate change

Present and future climate change will bring about three important changes on all three Nuclear-1 sites: (a) sea level will rise and portions of coastal land will be intermittently flooded by high tides and storm surges (Prestedge et al. 2009); (b) rainfall patterns will change, both in terms of quantity of precipitation and the seasonal distribution of precipitation; and (c) mean (and possibly maximum and minimum) temperatures will increase. Arising from these changes, there will be important secondary ecological effects in the form of changes in habitat as plant growth, wetlands, soil temperatures, frequency of fires, etc., all change in response to changing climate.

A tertiary level of outcome will be that animals will either adapt to the new conditions, or they will need to move to areas where habitat conditions are more favourable. Animals that are not able to move in response to change will be challenged to adapt and if they are unable to adapt sufficiently, local extinction of species will be the outcome. A quaternary level of change will be the ecosystem changes resulting from local extinctions where the extirpation of certain species results in knock-on impacts on other species. For example, if a pollinator species becomes extinct, the plants that depend on that pollinator will also tend to die out, which in turn will negatively impact other species that are dependent on those plants.

Climate change has been an integral part of the earth's history and the history of life. However, in the past, continuity of habitat types, and continuity between habitat types, has been much greater than today. Human development of various kinds has fragmented the landscape and broken connections between patches of habitat. As a result, populations of species have become isolated in small patches of habitat and much more vulnerable to local extinction (see Appendix 4 on ecological corridors).

The only practical way in which habitat fragmentation can be mitigated is by creating and maintaining ecological corridors. Such corridors help to preserve the connections between patches of habitat and give animals the opportunity to not only disperse and access resources, but also to make adaptive migrations when conditions change, as will happen as a result of climate change. If refugia of suitable habitat are not available within a particular area, it is only by movement between areas that animals (and plants) will have a chance of finding refugia where they can survive and adapt to live another day.

The recommendations in this report emphasize the need for ecological corridors on the sites, both to connect different parts of a given site, and to connect the site with neighbouring properties. A vitally important corridor is the coastal corridor which has been recommended to extend at least 200 m above the high-water mark. Given that the high-water mark will move inland in response to a rise in sea-level, the coastal corridor must be measured from a projected new high-water mark. The projected 100-year floodline in 2075 (Prestedge et al. 2009) is used in this report.

Altitudinal movement is one important way in which species can adapt to changing temperature because temperature decreases with increasing altitude. For this reason, corridors that are perpendicular to the coast, connecting low-lying coastal habitats with higher inland habitats, are also of vital importance and have been recommended in this report.

Habitat types that are already patchily distributed in the landscape, e.g., wetlands and forests, and the fauna that depend on them, are especially vulnerable to climate change because of their relative isolation or inability to relocate to new areas. Such habitats have been flagged as being especially sensitive and requiring adequate preservation on site.

4.5 No-development alternative: recommended mitigation measures

Recommended mitigation measures for the no-development alternative are listed for each of the three sites.

4.5.1 Duynefontein: no-development mitigations

- Continue conservation management as at present, or preferably introduce improvements (see 2.1.15 above).
- Commission additional detailed surveys of cryptic fauna on site.
- Commission ongoing monitoring of sensitive populations of breeding birds.
- Postpone consideration of an additional conventional nuclear power plant until after completion of the PBMR DPP.

4.5.2 Bantamsklip: no-development mitigations

- Maintain Eskom ownership of the land. This and other recommendations assume that the site is not chosen for Nuclear-1, but that it will be retained as an option for Nuclear-2 or 3.
- Declare the land a private nature reserve, and enter into a stewardship agreement with CapeNature.
- Institute a programme to reduce and control the spread of invasive alien vegetation.
- Improve access control to the site, especially by vehicles.
- Commission additional detailed surveys of cryptic fauna on site.

4.5.3 Thyspunt: no-development mitigations

- Maintain Eskom ownership of the land. This and other recommendations assume that the site is not chosen for Nuclear-1, but that it will be retained as an option for Nuclear-2 or 3.
- Declare the land a private nature reserve, and enter into a stewardship agreement with the Eastern Cape department of nature conservation.
- Continue with the existing programme to reduce and control the spread of invasive alien vegetation.
- Commission additional surveys of cryptic fauna on site.
- Commission additional studies of wetland and groundwater systems.

Figure 54: Clearance of invasive alien vegetation at Thyspunt. This is an example of the positive impacts that conservation management by Eskom can bring to bear on their properties.

4.6 Decommissioning

IAEA (1999) and Van Schalkwyk (2006) recommend/require that an EIA process specific to the decommissioning phase be carried out. This study strongly supports that requirement. Such an EIA should be carried out close to the relevant time, so that current technology and status of environments can be properly taken into account.

The EIA itself is the most significant mitigation measure that can be recommended at this stage. However, given that many of the identified impacts are likely to be similar to those identified for construction and operation, it is reasonable to assume that many of the recommended mitigation measures will also be similar. It will be essential to include in the EIA process all transport routes for waste materials and especially all storage sites for same.

There is no reason to believe that the challenges of mitigation of decommissioning will be insurmountable, however, we would argue that there is no justification for attempting to give detailed recommendations in this regard, at this stage, for the simple reason that not enough specific information is available. What can be said with confidence is that, whichever site it is that needs to undergo the decommissioning process, it will by then have become a nature conservation area of national importance, and therefore the decommissioning process will need to be carried out with due consideration for the conservation status of the surrounding land.

5 IMPACT ASSESSMENT (UNMITIGATED AND MITIGATED)

The objective of the assessment of impacts is to identify and assess all the significant impacts that may arise as a result of Nuclear-1. The impacts for the three alternative sites are assessed in tables which include the impacts relevant to both the construction and operational phases of Nuclear-1. Assessment of the no-development option and of the decommissioning phase are in separate sections, below.

Assessment is in accordance with Government Notice R.385, promulgated in terms of Section 24 of the NEMA, and the criteria are drawn from the IEM Guidelines Series, Guideline 5: Assessment of Alternatives and Impacts, published by the DEAT (April 1998).

5.1 Duynefontein: assessment of impacts

Impacts are assessed in the table below. Shaded cells require particular attention.

Table 5.1: Assessment of on-site impacts on terrestrial vertebrate fauna at Duynefontein.

Description of impact	Nature of impact	Extent of impact	Intensity of impact	Duration of impact	Consequence of impact (extent +intensity+ duration)	Probability of impact
1. Destruction of natural habitats and populations, resulting from site clearance, buildings, laydown areas and infrastructure.						
Unmitigated	Negative	National	High	Permanent	High	Definite
Mitigated	Negative	National	Medium	Permanent	High	Definite
2. Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality.						
Unmitigated	Negative	National	Low	Permanent	Medium	Probable
Mitigated	Negative	National	Low	Permanent	Medium	Probable
3. Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences.						
Unmitigated	Negative	Local	Medium	Permanent	Medium	Highly probable
Mitigated	Negative	Local	Low	Permanent	Low	Highly probable
4. Road mortality (roadkills), resulting from traffic on roads through natural habitats.						
Unmitigated	Negative	Local	Medium	Permanent	Medium	Probable
Mitigated	Negative	Local	Low	Permanent	Low	Probable
5. Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions.						
Unmitigated	Negative	Local	Medium	Permanent	Medium	Probable
Mitigated	Negative	Local	Low	Permanent	Low	Probable
6. Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance.						
Unmitigated	Negative	regional	Medium	Short term	Low	Probable
Mitigated	Negative	regional	Low	Short term	Low	Probable
7. Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads.						
Unmitigated	Negative	Local	Medium	Short term	Low	Highly probable
Mitigated	Negative	Local	Low	Short term	Low	Highly probable
8. Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage.						

Unmitigated	Negative	Local	Medium	Medium term	Medium	Probable
Mitigated	Negative	Local	Low	Medium term	Low	Probable
9. Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings.						
Unmitigated	Negative	Local	High	Long term	High	Highly probable
Mitigated	Negative	Local	Low	Long term	Low	Highly probable
10. Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods.						
Unmitigated	Negative	Local	Medium	Permanent	Medium	Possible
Mitigated	Negative	Local	Low	Permanent	Low	Possible
11. Poaching of local wildlife during construction phase, resulting from hunting and trapping by workers and employees, for sport and for the pot.						
Unmitigated	Negative	Local	High	Short term	Low	Probable
Mitigated	Negative	Local	Low	Short term	Low	Probable
12. Problem-animal scenarios, resulting mainly from human interaction with animals.						
Unmitigated	Negative	Local	Medium	Long term	Medium	Possible
Mitigated	Negative	Local	Low	Long term	Low	Possible
13. Accumulation of radioisotopes in the environment and in the bodies of wild animals, during operational phase, resulting from routine gaseous emissions from the reactors.						
Unmitigated	Neutral	Local	Negligible	Long term	Low	Highly probable
Mitigated	Neutral	Local	Negligible	Long term	Low	Highly probable
14. Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time.						
Unmitigated	Negative	regional	High	Long term	High	Highly probable
Mitigated	Negative	regional	Low	Long term	Medium	Highly probable
15. Improved conservation of undeveloped land, resulting from improved legal status and/or management.						
Unmitigated	Neutral	National	Not applicable	Long term	Low	Definite
Mitigated	positive	National	Potentially medium	Long term to permanent	Medium	Definite

Table 5.1: Assessment of on-site impacts on terrestrial vertebrate fauna at Duynefontein (continued).

Description of impact	Reversibility of impact	Irreplaceability of impacted resources	Significance of impact (consequence + probability)	Confidence level in this assessment
1. Destruction of natural habitats and populations, resulting from site clearance, buildings, laydown areas and infrastructure.				
Unmitigated	Low	Yes	High	High
Mitigated	Medium	Yes	High	High
2. Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality.				
Unmitigated	Low	Yes	Medium	Medium
Mitigated	Medium	Yes	Medium	Medium
3. Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences.				
Unmitigated	Low	Yes	Medium	High
Mitigated	Medium	Yes	Low	High
4. Road mortality (roadkills), resulting from traffic on roads through natural habitats.				
Unmitigated	Medium	No	Medium	High
Mitigated	High	No	Low	High
5. Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions.				
Unmitigated	Low	No	Medium	High
Mitigated	High	No	Low	High
6. Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance.				
Unmitigated	Medium	Yes	Low	Medium
Mitigated	High	Yes	Low	Medium
7. Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads.				

Unmitigated	High	Yes	Low	High
Mitigated	High	Yes	Low	High
8. Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage.				
Unmitigated	Medium	Yes	Medium	Medium
Mitigated	High	Yes	Low	Medium
9. Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings.				
Unmitigated	Low	Yes	High	High
Mitigated	High	Yes	Low	High
10. Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods.				
Unmitigated	Low	No	Low	Low
Mitigated	Low	No	Low	Low
11. Poaching of local wildlife, resulting from hunting and trapping by workers and employees, for sport and for the pot.				
Unmitigated	Medium	No	Low	High
Mitigated	High	No	Low	High
12. Problem-animal scenarios, resulting mainly from human interaction with animals.				
Unmitigated	Medium	No	Low	Medium
Mitigated	High	No	Low	Medium
13. Accumulation of radioisotopes in the environment and in the bodies of wild animals, resulting from routine gaseous emissions from the reactors.				
Unmitigated	High	No	Low	High
Mitigated	High	No	Low	High
14. Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time.				
Unmitigated	Low	Yes	High	High
Mitigated	Medium	Yes	Medium	High
15. Improved conservation of undeveloped land, resulting from improved legal status and/or management.				
Unmitigated	High (bad)	Yes	Low	High
Mitigated	Low (good)	Yes	Medium (positive)	High

Notes:

- National extent (impacts 1, 2, 15) refers to vegetation types and species which are Threatened at the national or global scale. Similarly for regional extent (impact 6).
- The positive nature, and high significance, of impact 15 arises from potential improvements in the legal status of Koeberg Private Nature Reserve and in its conservation management, as recommended.
- Although the significance of impacts 1 and 2 remains high with mitigation, the intensity is significantly reduced and reversibility is also improved with mitigation.
- All other instances of high or medium significance are reduced to low significance with mitigation, except for 14 which is reduced to medium.
- Interpret impact #15 remembering that it is a ***positive impact*** if mitigation is applied. In other words, this should be seen as an ***offset*** to the other negative impacts.

5.2 Bantamsklip: assessment of impacts

Impacts are assessed in the table below. Shaded cells require particular attention. As the whole of the planned footprint is on the coastal portion of the site, it is only this portion that is considered under this impact assessment, ***except impact 15***, which does take the inland portion into account. Activities which may affect the inland portion (Hagelkraal), such as the routing of transmission lines, are the subject of separate EIA processes.

Table 5.2: Assessment of on-site impacts on terrestrial vertebrate fauna at Bantamsklip, coastal portion only.

Description of impact	Nature of impact	Extent of impact	Intensity of impact	Duration of impact	Consequence of impact (extent +intensity+ duration)	Probability of impact
1. Destruction of natural habitats and populations, resulting from site clearance, buildings, laydown areas and infrastructure.						
Unmitigated	Negative	National	High	Permanent	High	Definite
Mitigated	Negative	National	Medium	Permanent	High	Definite
2. Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality.						
Unmitigated	Negative	National	Medium	Permanent	High	Probable
Mitigated	Negative	National	Low	Permanent	High	Probable
3. Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences.						
Unmitigated	Negative	Local	Medium	Permanent	Medium	Highly probable
Mitigated	Negative	Local	Low	Permanent	Low	Highly probable
4. Road mortality (roadkills), resulting from traffic on roads through natural habitats.						
Unmitigated	Negative	Local	Medium	Permanent	Medium	Probable
Mitigated	Negative	Local	Low	Permanent	Low	Probable
5. Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions.						
Unmitigated	Negative	Local	Medium	Permanent	Medium	Probable
Mitigated	Negative	Local	Low	Permanent	Low	Probable
6. Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance.						
Unmitigated	Negative	Regional	Medium	Short term	Low	Probable
Mitigated	Negative	Regional	Low	Short term	Low	Probable
7. Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads.						
Unmitigated	Negative	Local	Medium	Short term	Low	Highly probable
Mitigated	Negative	Local	Low	Short term	Low	Highly probable
8. Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage.						
Unmitigated	Negative	Local	Medium	Medium term	Medium	Probable
Mitigated	Negative	Local	Low	Medium term	Low	Probable
9. Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings.						
Unmitigated	Negative	Local	High	Long term	High	Highly probable
Mitigated	Negative	Local	Low	Long term	Low	Highly probable
10. Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods.						
Unmitigated	Negative	Local	Low	Permanent	Medium	Possible
Mitigated	Negative	Local	Low	Permanent	Low	Possible
11. Poaching of local wildlife during construction phase, resulting from hunting and trapping by workers and employees, for sport and for the pot.						
Unmitigated	Negative	Local	High	Short term	Low	Probable
Mitigated	Negative	Local	Low	Short term	Low	Probable
12. Problem-animal scenarios, resulting mainly from human interaction with animals.						
Unmitigated	Negative	Local	High	Long term	High	Probable
Mitigated	Negative	Local	Low	Long term	Low	Probable
13. Accumulation of radioisotopes in the environment and in the bodies of wild animals, during operational phase, resulting from routine gaseous emissions from the reactors.						
Unmitigated	Neutral	Local	Negligible	Long term	Low	Highly probable
Mitigated	Neutral	Local	Negligible	Long term	Low	Highly probable
14. Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time.						

Unmitigated	Negative	Regional	High	Long term	High	Highly probable
Mitigated	Negative	Regional	Low	Long term	Medium	Highly probable
15. Improved conservation of undeveloped land, resulting from improved legal status and/or management.						
Unmitigated	Neutral	National	Not applicable	Long term	Low	Definite
Mitigated	Positive	National	High	Long term to permanent	High	Definite

Table 5.2: Assessment of on-site impacts on terrestrial vertebrate fauna at Bantamsklip, coastal portion only (continued).

Description of impact	Reversibility of impact	Irreplaceability of impacted resources	Significance of impact (consequence + probability)	Confidence level in this assessment
1. Destruction of natural habitats and populations, resulting from site clearance, buildings, laydown areas and infrastructure.				
Unmitigated	Low	Yes	High	High
Mitigated	Medium	Yes	High	High
2. Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality.				
Unmitigated	Low	Yes	High	Medium
Mitigated	Medium	Yes	High	Medium
3. Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences.				
Unmitigated	Low	Yes	Medium	High
Mitigated	Medium	Yes	Low	High
4. Road mortality (roadkills), resulting from traffic on roads through natural habitats.				
Unmitigated	Medium	No	Medium	High
Mitigated	High	No	Low	High
5. Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions.				
Unmitigated	Low	No	Medium	High
Mitigated	High	No	Low	High
6. Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance.				
Unmitigated	Medium	Yes	Low	Medium
Mitigated	High	Yes	Low	Medium
7. Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads.				
Unmitigated	High	Yes	Low	High
Mitigated	High	Yes	Low	High
8. Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage.				
Unmitigated	Medium	Yes	Medium	Medium
Mitigated	High	Yes	Low	Medium
9. Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings.				
Unmitigated	Low	Yes	High	High
Mitigated	High	Yes	Low	High
10. Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods.				
Unmitigated	Low	No	Low	Low
Mitigated	Low	No	Low	Low
11. Poaching of local wildlife, resulting from hunting and trapping by workers and employees, for sport and for the pot.				
Unmitigated	Medium	No	Low	High
Mitigated	High	No	Low	High
12. Problem-animal scenarios, resulting mainly from human interaction with animals.				
Unmitigated	Medium	No	High	High
Mitigated	High	No	Low	High
13. Accumulation of radioisotopes in the environment and in the bodies of wild animals, resulting from routine gaseous emissions from the reactors.				
Unmitigated	High	No	Low	High

Mitigated	High	No	Low	High
14. Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time.				
Unmitigated	Low	Yes	High	High
Mitigated	Medium	Yes	Medium	High
15. Improved conservation of undeveloped land, resulting from improved legal status and/or management.				
Unmitigated	high (bad)	Yes	Low	High
Mitigated	low (good)	Yes	High (positive)	High

Notes:

- National extent (impacts 1, 2, 15) refers to vegetation types and species which are Threatened at the national or global scale. Similarly for regional extent (impact 6).
- The positive nature, and high significance, of impact 15 arises from potential improvements in the legal status of undeveloped land, especially on Hagelkraal, and in its conservation management, as recommended.
- Although the significance of impacts 1 and 2 remains high with mitigation, the intensity is significantly reduced and reversibility is also improved with mitigation.
- All other instances of high or medium significance are reduced to low significance with mitigation, except for 14 which is reduced to medium.
- Interpret impact #15 remembering that it is a ***positive impact*** if mitigation is applied. In other words, this should be seen as an ***offset*** to the other negative impacts.

5.3 Thyspunt: assessment of impacts

Impacts are assessed in the table below. Shaded cells require particular attention. As the planned footprint covers both inland and coastal portions of the site, both are considered under this impact assessment.

Table 5.3: Assessment of on-site impacts on terrestrial vertebrate fauna at Thyspunt, coastal portion only.

Description of impact	Nature of impact	Extent of impact	Intensity of impact	Duration of impact	Consequence of impact (extent +intensity+ duration)	Probability of impact
1. Destruction of natural habitats and populations, resulting from site clearance, buildings, laydown areas and infrastructure.						
Unmitigated	Negative	National	High	Permanent	High	Definite
Mitigated	Negative	National	Medium	Permanent	High	Definite
2. Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality.						
Unmitigated	Negative	National	Medium	Permanent	High	Probable
Mitigated	Negative	National	Low	Permanent	High	Probable
3. Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences.						
Unmitigated	Negative	Local	High	Permanent	High	Highly probable
Mitigated	Negative	Local	Medium	Permanent	medium	Highly probable
4. Road mortality (roadkills), resulting from traffic on roads through natural habitats.						
Unmitigated	Negative	Local	High	Permanent	High	Probable
Mitigated	Negative	Local	Low	Permanent	Medium	Probable

5. Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions.						
Unmitigated	Negative	Local	Medium	Permanent	Medium	Probable
Mitigated	Negative	Local	Low	Permanent	Low	Probable
6. Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance.						
Unmitigated	Negative	Regional	Medium	Short term	Medium	Probable
Mitigated	Negative	Regional	Low	Short term	Low	Probable
7. Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads.						
Unmitigated	Negative	Local	Medium	Short term	Low	Highly probable
Mitigated	Negative	Local	Low	Short term	Low	Highly probable
8. Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage.						
Unmitigated	Negative	Local	High	Medium term	Medium	Probable
Mitigated	Negative	Local	Low	Medium term	Low	Probable
9. Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings.						
Unmitigated	Negative	Local	High	Long term	High	Highly probable
Mitigated	Negative	Local	Low	Long term	Low	Highly probable
10. Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods.						
Unmitigated	Negative	Local	High	Permanent	High	Probable
Mitigated	Negative	Local	Medium	Permanent	Medium	Probable
11. Poaching of local wildlife during construction phase, resulting from hunting and trapping by workers and employees, for sport and for the pot.						
Unmitigated	Negative	Local	High	Short term	Medium	Probable
Mitigated	Negative	Local	Low	Short term	Low	Probable
12. Problem-animal scenarios, resulting mainly from human interaction with animals.						
Unmitigated	Negative	Local	High	Long term	High	Probable
Mitigated	Negative	Local	Low	Long term	Low	Probable
13. Accumulation of radioisotopes in the environment and in the bodies of wild animals, during operational phase, resulting from routine gaseous emissions from the reactors.						
Unmitigated	Neutral	Local	Negligible	Long term	Low	Highly probable
Mitigated	Neutral	Local	Negligible	Long term	Low	Highly probable
14. Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time.						
Unmitigated	Negative	Regional	High	Long term	High	Highly probable
Mitigated	Negative	Regional	Low	Long term	Medium	Highly probable
15. Improved conservation of undeveloped land, resulting from improved legal status and/or management.						
Unmitigated	Neutral	National	Not applicable	Long term	Low	Definite
Mitigated	Positive	National	High	Long term to permanent	High	Definite

Table 5.3: Assessment of on-site impacts on terrestrial vertebrate fauna at Thyspunt, coastal portion only (continued).

Description of impact	Reversibility of impact	Irreplaceability of impacted resources	Significance of impact (consequence + probability)	Confidence level in this assessment
1. Destruction of natural habitats and populations, resulting from site clearance, buildings, laydown areas and infrastructure.				
Unmitigated	Low	Yes	High	High
Mitigated	Medium	Yes	High	High
2. Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality.				
Unmitigated	Low	Yes	High	Medium
Mitigated	Medium	Yes	High	Medium
3. Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences.				
Unmitigated	Low	Yes	High	High
Mitigated	Medium	Yes	Medium	High

4. Road mortality (roadkills), resulting from traffic on roads through natural habitats.				
Unmitigated	Medium	No	High	High
Mitigated	High	No	Low	High
5. Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions.				
Unmitigated	Low	No	Medium	High
Mitigated	High	No	Low	High
6. Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance.				
Unmitigated	Medium	Yes	Medium	Medium
Mitigated	High	Yes	Low	Medium
7. Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads.				
Unmitigated	High	Yes	Low	High
Mitigated	High	Yes	Low	High
8. Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage.				
Unmitigated	Medium	Yes	Medium	Medium
Mitigated	High	Yes	Low	Medium
9. Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings.				
Unmitigated	Low	Yes	High	High
Mitigated	High	Yes	Low	High
10. Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods.				
Unmitigated	Low	No	High	Low
Mitigated	Low	No	Medium	Low
11. Poaching of local wildlife, resulting from hunting and trapping by workers and employees, for sport and for the pot.				
Unmitigated	Medium	No	Medium	High
Mitigated	High	No	Low	High
12. Problem-animal scenarios, resulting mainly from human interaction with animals.				
Unmitigated	Medium	No	High	High
Mitigated	High	No	Low	High
13. Accumulation of radioisotopes in the environment and in the bodies of wild animals, resulting from routine gaseous emissions from the reactors.				
Unmitigated	High	No	Low	High
Mitigated	High	No	Low	High
14. Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time.				
Unmitigated	Low	Yes	High	High
Mitigated	Medium	Yes	Medium	High
15. Improved conservation of undeveloped land, resulting from improved legal status and/or management.				
Unmitigated	high (bad)	Yes	Low	High
Mitigated	low (good)	Yes	High (positive)	High

Notes:

- National extent (impacts 1, 2, 15) refers to vegetation types and species which are Threatened at the national or global scale. Similarly for regional extent (impact 6).
- The positive nature, and high significance, of impact 15 arises from potential improvements in the legal status of undeveloped land and in its conservation management, as recommended.
- Although the significance of impacts 1 and 2 remains high with mitigation, the intensity is reduced and reversibility is also improved with mitigation.
- All other instances of high or medium significance are reduced to low significance with mitigation, except for 14 which is reduced to medium.

- Interpret impact #15 remembering that it is a ***positive impact*** if mitigation is applied. In other words, this should be seen as an ***offset*** to the other negative impacts.

5.4 Alternative: No development: assessment of impacts

The no-development option is not accompanied by any specific proposals or scenarios, hence it is not possible to assess the impacts of no development in a detailed manner. However, if one assumes that Eskom will dispose of properties that are not available for development of power stations, the no-development scenario will involve a probable change of land ownership and a possible to probable change in land use. This is does not apply to Duynefontein because of the existing KNPS and Koeberg Private Nature Reserve and the planned PBMR DPP, but it is a reasonable assumption for both Bantamsklip and Thyspunt. These two properties both comprise coastal and inland portions. The coastal portions are likely, over time, to be developed for holiday housing, resorts and the like, while the inland portions are likely to continue to be used for some form of agriculture which could be intensified. At Hagelkraal (inland Bantamsklip), the prevailing agriculture is sustainable harvesting of wild flowers, while at Thyspunt it is stock and dairy farming. For the purposes of impact assessment of the unmitigated condition (in the tables below), it is assumed that these are the most likely types of land use for the respective sites.

Mitigation of the no-development option is discussed under section 4.4. (above) and in all three cases mitigation involves the retention of the properties by Eskom, and their management as nature reserves. However, under these mitigated scenarios, *it must be assumed that development of at least one nuclear power station will eventually occur at Bantamsklip and Thyspunt, but not necessarily at Duynefontein*. Therefore, for assessment of the mitigated condition (in the tables below), these assumptions are made for the long term.

Given these likely scenarios, the impacts of no development, with and without recommended mitigations (section 4.4, above), are assessed for each of the three alternative sites.

5.4.1 Duynefontein: no-development impact assessment

Table 5.4.1: Assessment of on-site impacts of the no-development option, on terrestrial vertebrate fauna at Duynefontein.

Description of impact	Nature of impact	Extent of impact	Intensity of impact	Duration of impact	Consequence of impact (extent +intensity+ duration)	Probability of impact
No development of an additional conventional nuclear power station, in the long term.						
Unmitigated	Positive	National	Low	Permanent	High	Definite
Mitigated	Positive	National	Medium	Permanent	High	Definite

Table 5.4.1: Assessment of on-site impacts of the no-development option, on terrestrial vertebrate fauna at Duynefontein (continued).

Description of impact	Reversibility of impact	Irreplaceability of impacted resources	Significance of impact (consequence + probability)	Confidence level in this assessment
No development of an additional conventional nuclear power station, in the long term.				
Unmitigated	Low (good)	Yes	High positive	High
Mitigated	Low (good)	Yes	High positive	High

5.4.2 Bantamsklip: no-development impact assessment

Table 5.4.2: Assessment of on-site impacts of the no-development option, on terrestrial vertebrate fauna at Bantamsklip.

Description of impact	Nature of impact	Extent of impact	Intensity of impact	Duration of impact	Consequence of impact (extent +intensity+ duration)	Probability of impact
No development of any nuclear power station, in the long term.						
Unmitigated	Negative	National	High	Permanent	High negative	Definite
Mitigated	Positive	National	High	Permanent	High positive	Definite

Table 5.4.2: Assessment of on-site impacts of the no-development option, on terrestrial vertebrate fauna at Bantamsklip (continued).

Description of impact	Reversibility of impact	Irreplaceability of impacted resources	Significance of impact (consequence + probability)	Confidence level in this assessment
No development of any nuclear power station, in the long term.				
Unmitigated	Low (bad)	Yes	High negative	High
Mitigated	Low (good)	Yes	High positive	High

5.4.3 Thyspunt: no-development impact assessment

Table 5.4.3: Assessment of on-site impacts of the no-development option, on terrestrial vertebrate fauna at Thyspunt.

Description of impact	Nature of impact	Extent of impact	Intensity of impact	Duration of impact	Consequence of impact (extent +intensity+ duration)	Probability of impact
No development of any nuclear power station, in the long term.						
Unmitigated	Negative	National	High	Permanent	High negative	Definite
Mitigated	Positive	National	medium	Permanent	Medium positive	Definite

Table 5.4.3: Assessment of on-site impacts of the no-development option, on terrestrial vertebrate fauna at Thyspunt (continued).

Description of impact	Reversibility of impact	Irreplaceability of impacted resources	Significance of impact (consequence + probability)	Confidence level in this assessment
No development of any nuclear power station, in the long term.				
Unmitigated	Low (bad)	Yes	High negative	High
Mitigated	Low (good)	Yes	Medium positive	High

Notes:

- The overall NEGATIVE impact of the unmitigated condition at both Bantamsklip and Thyspunt is based on the assumption of more widespread habitat destruction and less conservation management under alternative ownership.
- At Duynefontein, the overall POSITIVE impact of the unmitigated scenario is based on the assumption of continuation of the status quo.
- Under the mitigated scenarios, reversibility of the POSITIVE impacts is assumed to be low because the resultant protected areas will have long-term security. Similarly for the unmitigated scenario at Duynefontein.
- Under the unmitigated scenarios at Bantamsklip and Thyspunt, reversibility of the NEGATIVE impacts (e.g., of alternative land use) is also assumed to be low.
- Note that the POSITIVE nature of the mitigated impacts at Bantamsklip and Thyspunt is ***despite the probability that there <u>will</u> be development of a nuclear power station, in the long term***, but the positive consequences are relatively moderate at Thyspunt because the negative impacts of development are greater than at Bantamsklip.

5.5 Decommissioning

Any attempt to specifically assess the impacts of decommissioning is not possible or reasonable at this stage. However, we can foresee no impacts that would be so negative as to render the development of Nuclear-1 unacceptable, in principle. Many would argue that the unresolved issues around disposal of high-level radioactive waste is a fatal flaw in all plans for nuclear power. We would not agree with this point of view because the problems appear to be simply those of adequate containment and storage, and there seems to be no reason to believe that these objectives cannot be achieved in a manner that adequately protects the natural and human environment.

6 CONCLUSIONS

The following conclusions are intended to summarize the findings of this report and provide direction for the decisions that need to be taken with regard to Nuclear-1.

6.1 Duynefontein conclusions

The amount of land that is available for development, and that is not of high faunal sensitivity, is limited but sufficient to allow for Nuclear-1. However, further future expansion of power-generating facilities within the present Eskom property, to the north of KNPS, should not be considered.

Development of Nuclear-1 at Duynefontein would have significant negative impacts, mainly because of the direct impacts on faunal habitats within the footprint areas. Assessment of the no-development option indicated that Duynefontein would benefit from no development. This is because the land is already managed as part of a private nature reserve. Opportunities for on-site conservation offsets are limited.

6.2 Bantamsklip conclusions

The amount of land, on the coastal side of the R43, available for development and that is not of high faunal sensitivity, is more than sufficient to allow for Nuclear-1. The portion of the property inland of the R43 is highly sensitive and should not be developed at all.

Development of Nuclear-1 at Bantamsklip would have significant negative impacts, mainly because of the direct impacts on faunal habitats within the footprint areas. However, highly significant potential offsets are possible at Bantamsklip if undeveloped land is declared a nature reserve and is effectively managed as such. This would depend especially on the protection and management of the inland portion, as well as an adequate coastal corridor.

The no-development option at Bantamsklip is not positive because it can be assumed that it will lead to a change of land ownership and probable residential and/or resort development at the coast, and a possible increase in intensity of agricultural exploitation on the inland portion.

6.3 Thyspunt conclusions

The amount of land that is available for development, and that is not of high faunal sensitivity, is severely constrained and not sufficient to allow for Nuclear-1. However, if additional land were purchased adjacent to the pan-handle portion of the property, this deficit could be overcome.

Development of Nuclear-1 at Thyspunt would have significant negative impacts, mainly because of (a) the direct impacts on faunal habitats within the footprint areas, (b) the development of three major new access roads, and (c) the need for a development corridor across a large field of mobile dunes, making this site highly problematic with respect to fauna and faunal habitats. On the other hand, highly significant potential offsets are possible at Thyspunt if undeveloped land is declared a nature reserve and is effectively managed as such. Such offsets could be significantly strengthened by acquisition of additional land.

The no-development option at Thyspunt is not positive because it can be assumed that it will lead to a change of land ownership and probable residential and/or resort development at the coast, and a probable increase in intensity of agricultural exploitation on the inland portion.

An important negative factor is the lack of definitive information on whether adequate engineering solutions are available to avoid serious negative impacts on groundwater flows and sensitive wetlands at Thyspunt. There are similar needs for more information on the dynamics of the mobile-dune field, and better mapping of dune forests and thickets of alien vegetation. It is essential that the necessary studies be carried out as a matter of urgency to inform the EIA process.

6.4 Overall conclusions

From the perspective of faunal conservation, the following overall conclusions are reached:

- Given the present uncertainty around groundwater and wetlands as well as other aspects of the biophysical environment, and the inadequate amount of suitable land for development, the proposal for development at Thyspunt is currently flawed. This situation must be improved by completion of relevant studies, and acquisition of additional land, if necessary.
- Outstanding issues at Thyspunt should be satisfactorily resolved before final decisions are made and in time for full specification of necessary mitigation measures. This may have the effect of postponement of development at Thyspunt.
- Nuclear-1 could be developed at either Duynefontein or Bantamsklip, without further faunal EIA investigations.

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APPENDIX 1: Fauna lists for Duynefontein, including Koeberg Private Nature Reserve.

The following tables are based on species lists for the Western Cape, with species that definitely do not occur on site omitted from the lists. For listed species, the likelihood of occurrence is indicated as "possible", "probable" or "confirmed". In the category "possible", there may be several species, perhaps even the majority, that in fact do not occur on site, or do so only rarely. The purpose of their inclusion in the lists is to flag the possibility that they may occur. Species in the category "probable", on the other hand, should be assumed to occur on site, and planning should take such occurrence into account. "Confirmed" species are those for which direct evidence of occurrence was obtained during the baseline survey or from other reliable sources.

Regardless of category of occurrence, if plans are likely to impact highly threatened species (i.e., Critically Endangered and Endangered species), it may be recommended that additional surveys determine the extent of occurrence and approximate population sizes of those species so that planning and management can proceed with the necessary information. Additional information on significant species is given in the relevant text (above).

SABAP lists for birds are courtesy of the ADU, University of Cape Town. Reptile conservation status courtesy of SARCA, ADU, University of Cape Town.

Table 1: Duynefontein amphibians. 0 = not endemic, 1 = near endemic, 2 = endemic.

Species	Common name	Red List status	WCape endemism	SA endemism	Occurrence: * = possible ** = probable *** = confirmed	Koeberg Private NR list	Notes on status and location
Family Bufonidae	**toads**						
Vandijkophrynus angusticeps	Cape Sand Toad	LC	1	2	***	***	Probably common in sandy habitat with seasonal wetlands.
Family Microhylidae	**rain frogs**						
Breviceps namaquensis	Namaqua Rain Frog	LC	0	2	***		Probably common in sandy habitat. Melkbos is southern distribution limit.
Breviceps rosei	Rose's Rain Frog	LC	2	2	***	***	Probably common, especially nearer to the coast.
Family Pipidae	**platannas**						
Xenopus laevis	Common Platanna	LC	0	0	***	***	Common in permanent freshwater wetlands; and possibly also seasonal wetlands.

Family Pyxicephalidae	**bullfrogs, river frogs & allies**						
Amietia fuscigula	Cape River Frog	LC	0	1	*		Known from adjacent cell 3318DA. May occur at larger permanent wetlands.
Cacosternum capense	Cape Caco	**VU**	2	2	*		Known from Duynefontein cell, 3318CB. Status unknown.
Cacosternum platys	Flat Caco	NE	2	2	**		Known from adjacent cell 3318DA.
Strongylopus grayii	Clicking Stream Frog	LC	0	1	***		Common at most of the wetlands.
Tomopterna delalandii	Cape Sand Frog	LC	1	2	***	***	Common. Mainly seasonal wetlands.

Table 2: Duynefontein reptiles. pT = potentially Threatened, 0 = not endemic, 1 = near-endemic, 2 = endemic.

Species	Common names	Red List status 2009	WC endemism	SA endemism	Occurrence: * = possible ** = probable *** = confirmed	Koeberg Private NR list	Notes on status and location
Family Testudinidae	**tortoises**						
Chersina angulata	Angulate Tortoise	LC	0	1	***	***	Common.
Homopus areolatus	Parrot-beaked Padloper	LC	0	2	**	***	Probably present, but likely to be uncommon.
Psammobates geometricus	Geometric Tortoise	**CR**	2	2		***	Listed for Koeberg Private NR, but unlikely to occur. Known from adjacent cell 3318AD.
Family Pelomedusidae	**side-necked terrapins**						
Pelomedusa subrufa	Marsh Terrapin	LC	0	0	**		Likely to occur in larger, more permanent wetlands.
Family Typhlopidae	**blind snakes**						
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake LC		0	0	***	***	Probably common.
Family Leptotyphlopidae	**thread snakes**						
Leptotyphlops nigricans	Black Thread Snake	LC	0	2	**		Status unknown.
Family Atractaspidae	**African burrowing snakes**						
Homoroselaps lacteus	Spotted Harlequin Snake	LC	0	2	***	***	Probably common.
Family Colubridae	**typical snakes**						
Amplorhinus multimaculatus	Many-spotted Snake	LC	0	1	*		Occurs in adjacent cell 3318 CD & DC, but is likely absent from Koeberg.

Crotaphopeltis hotamboeia	Herald Snake	LC	0	0	**		Probably common around wetlands.
Dasypeltis scabra	Rhombic Egg-eater	LC	0	0	**	***	Probably common.
Dispholidus typus	Boomslang	LC	0	0	***	***	Probably common.
Duberria lutrix	Common Slug-eater	LC	0	2	**		Likely to be common in moist regions.
Lamprophis aurora	Aurora House Snake	LC	0	2	**		Known from the adjacent cell 3318CD. Status unknown.
Lamprophis capensis	Brown House Snake	LC	0	0	**		Known from adjacent cell 3318DA. Status unknown.
Lamprophis fuscus	Yellow-bellied House Snake	**NT**	0	2	*		Known from the adjacent cell 3318CD. Likely to be rare if it occurs here at all.
Lamprophis guttatus	Spotted House Snake	LC	0	1	*	***	Probably rare, and confined to areas with rocks.
Lamprophis inornatus	Olive House Snake	LC	0	2	**		Known from the adjacent cell 3318CD. Status unknown.
Lycodonomorphus rufulus	Common Brown Water Snake	LC	0	0	**		Probably common at wetlands.
Prosymna sundevallii	Sundevall's Shovel-snout	LC	0	1	*		Status unknown.
Psammophis crucifer	Crossed Whip Snake	LC	0	1	**		Probably common.
Psammophis leightoni	Cape Whip Snake	**VU**	2	2	**	***	Status unknown.
Psammophis notostictus	Karoo Whip Snake	LC	0	0	***	***	Probably common.
Psammophylax r. rhombeatus	Rhombic Skaapsteker	LC	0	1	***	***	Common.
Pseudaspis cana	Mole Snake	LC	0	0	***	***	Common.
Family Elapidae	**front-fanged snakes**						
Aspidelaps lubricus lubricus	Coral Shield Cobra	LC	0	0	**		Status unknown.
Hemachatus haemachatus	Rinkhals	LC	0	1	*		Possible, but unlikely to occur. Known from the adjacent cell 3318DC.
Naja nivea	Cape Cobra	LC	0	0	**	***	Probably common.
Family Viperidae	**vipers**						
Bitis arietans arietans	Puff Adder	LC	0	0	**		May possibly occur, but have never been recorded from the Koeberg site.
Bitis armata	Southern Adder	**VU**	2	2	**		Probably rare.
Bitis cornuta	Many-horned Adder	LC	0	0	*		Probably rare.
Family Scincidae	**skinks**						
Acontias meleagris meleagris	Cape Legless Skink	LC	1	2	***		Probably common.

Scelotes bipes	Silvery Dwarf Burrowing Skink	LC	2	2	***	***	Common.
Scelotes gronovii	Gronovi's Dwarf Burrowing Skink	**NT**	2	2	**		Probably uncommon.
Scelotes montispectus	Blouberg Dwarf Burrowing skink	**NT**	2	2	***		Probably uncommon.
Trachylepis capensis	Cape Skink	LC	0	0	***	***	Common.
Trachylepis homalocephala	Red-sided Skink	LC	0	2	***		Common.
Trachylepis variegata variegate	Variegated Skink	LC	0	0	**		Status unknown.
Typhlosaurus caecus	Cuvier's Blind Legless Skink	LC	2	2	***		Common.
Family Lacertidae	**lacertid lizards**						
Meroles knoxii	Knox's Desert Lizard	LC	0	1	***		Common.
Family Gerrhosauridae	**plated lizards**						
Tetradactylus seps	Short-legged Seps	LC	0	2	***		Status unknown.
Family Cordylidae	**girdled lizards**						
Chamaesaura anguina	Cape Grass Lizard	**NT**	0	2	**		Status unknown.
Cordylus cordylus	Cape Girdled Lizard	LC	0	2	**	***	Probably rare at Koeberg. Restricted to rocky habitat.
Cordylus macropholis	Large-scaled Girdled Lizard	**VU**	0	2	*		Koeberg may be southern distribution limit for this species.
Cordylus niger	Black Girdled Lizard	**VU**	2	2	*		If present, it will be restricted to rocky habitat.
Cordylus polyzonus	Karoo Girdled Lizard		0	0	*		If present, it will be restricted to rocky habitat.
Family Agamidae	**agamas**						
Agama atra	Southern Rock Agama	LC	0	1	*		If present, it will be restricted to rocky habitat.
Agama hispida	Southern Spiny Agama	LC	0	1	*		Probably rare, if present.
Family Chamaeleonidae	**chameleons**						
Bradypodion pumilum	Cape Dwarf Chameleon	**VU**	2	2	*		No chameleons recorded from Koeberg before. If present, likely to be rare.
Bradypodion occidentale	Western Dwarf Chameleon	LC	0	2	**		No chameleons recorded from Koeberg before. If present, likely to be rare.
Family Gekkonidae	**geckos**						
Afrogecko porphyreus	Marbled Leaf-toed Gecko	LC	0	2	**		Status unknown.
Goggia lineate	Striped Dwarf Leaf-toed Gecko LC		0	1	**		Probably common.

Pachydactylus austeni	Austen's Thick-toed Gecko	LC	0	2	***		Common along the coastal dunes.
Pachydactylus geitje	Ocellated Thick-toed Gecko	LC	0	2	***		Probably common.

Table 3: Duynefontein mammals. 0 = not endemic, 1 = near-endemic, 2 = endemic.

Scientific name	Common name	Red List Status	WC endemism	SA endemism	Occurrence: * = possible ** = probable *** = confirmed	Koeberg NR list	Notes on status and location
Family Chrysochloridae	**golden moles**						
Chrysochloris asiatica	Cape Golden Mole	**DD**	1	2	***	***	Common in coastal dunes, and possibly elsewhere too.
Family Leporidae	**hares, rabbits and rock rabbits**						
Lepus capensis	Cape Hare	LC	0	0	*		May occur.
Lepus saxatilis	Scrub Hare	LC	0	0	***	***	Probably common.
Family Bathyergidae	**mole-rats**						
Bathyergus suillus	Cape Dune Mole-Rat	LC	2	2	***	***	Common.
Cryptomys hottentotus	African Mole-Rat	LC	0	0	**		Probably common.
Georychus capensis	Cape Mole-Rat	LC	0	2	**		Probably common.
Family Hystricidae	**Porcupines**						
Hystrix africaeaustralis	Cape Porcupine	LC	0	0	***	***	Probably common.
Family Muridae	**rats and mice**						
Acomys subspinosus	Cape Spiny Mouse	LC	2	2	*		Probably absent because rocky habitat not available.
Dendromus melanotis	Grey Climbing Mouse	LC	0	0	***		Common in coastal dunes.
Dendromus mesomelas	Brant's Climbing Mouse	LC	0	0	*		May occur.
Desmodillus auricularis	Cape Short-Tailed Gerbil	LC	0	0	*		May occur.
Gerbillurus paeba	Hairy-Footed Gerbil	LC	0	0	***		Common along coastal zone.

Malacothrix typical	Gerbil Mouse	LC	0	0	*		Probably not present at Koeberg.
Mus minutoides	Pygmy Mouse	LC	0	0	**		Probably common.
Myomyscus verreauxi	Verreaux's Mouse	LC	2	2	*		Uncertain.
Mystromys albicaudatus	White-Tailed Mouse	**EN**	0	1	*		Status unknown. Probably uncommon to absent.
Otomys irroratus	Vlei Rat	LC	0	1	***	***	Most common around wetlands.
Otomys unisulcatus	Bush Vlei Rat	LC	0	2	*		May occur.
Rhabdomys pumilio	Four-Striped Grass Mouse	LC	0	0	***	***	Very common.
Steatomys krebsii	Kreb's Fat Mouse	LC	0	0	**		Status unknown.
Tatera afra	Cape Gerbil	LC	1	2	***	***	Common, particularly away from the coastal zone.
Family Soricidae	**Shrews**						
Crocidura cyanea	Reddish-Grey Musk Shrew	**DD**	0	0	***		ID uncertain. Common throughout.
Crocidura flavescens	Greater Red Musk Shrew	**DD**	0	0	**		Status unknown.
Suncus varilla	Lesser Dwarf Shrew	**DD**	0	0	***		ID uncertain. Relatively uncommon.
Family Molossidae	**free-tailed bats**						
Tadarida aegyptiaca	Egyptian Free-Tailed Bat	LC	0	0	*		Possible visitor. Variety of roosting habitats.
Family Vespertilionidae	**vesper bats**						
Eptesicus hottentotus	Long-Tailed Serotine Bat	LC	0	0	*		Possible visitor. Often uses cave habitat for roosting.
Miniopterus schreibersii	Schreiber's Long-Fingered Bat	**NT**	0	0	*		Possible visitor, but probably absent. Roosts in caves.
Myotis tricolour	Temminck's Hairy Bat	**NT**	0	0	*		Possible visitor, but probably absent. Roosts in caves.
Neoromicia capensis	Cape Serotine Bat	LC	0	0	*		May occur.
Family Nycteridae	**slit-faced bats**						
Nycteris thebaica	Egyptian Slit-Faced Bat	LC	0	0	**		Probably most common bat. Probably shelters off site.
Family Rhinolophidae	**horseshoe bats**						
Rhinolophus capensis	Cape Horseshoe Bat	**NT**	0	2	*		Possible visitor roosting outside of Koeberg.
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	**NT**	0	0	*		Possible visitor roosting outside of Koeberg.
Family Felidae	**Cats**						

Caracal caracal	Caracal	LC	0	0	**	***	Uncommon.
Felis silvestris	African Wild Cat	LC	0	0	**	***	Uncommon.
Family Viverridae	**Genets**						
Genetta genetta	Small-Spotted Genet	LC	0	0	**	***	Probably common.
Genetta tigrina	South African Large-Spotted Genet	LC	0	0	**		Probably uncommon.
Family Herpestidae	**suricates and mongooses**						
Atilax paludinosus	Marsh Mongoose	LC	0	0	**		Probably common around wetlands.
Cynictis penicillata	Yellow Mongoose	LC	0	0	**	***	Uncommon.
Galerella pulverulenta	Cape Grey Mongoose	LC	0	0	***	***	Common.
Herpestes ichneumon	Large Grey Mongoose	LC	m	0	**	***	Uncommon.
Family Canidae	**foxes and jackals**						
Canis mesomelas	Black-Backed Jackal	LC	0	0	**	***	Uncommon.
Otocyon megalotis	Bat-eared Fox	LC	0	0	**	***	Uncommon.
Vulpes chama	Cape Fox	LC	0	0	**		Probably uncommon.
Family Mustelidae	**otters, weasels and polecats**						
Mellivora capensis	Honey Badger	**VU**	0	0	**		Confirmed at Blaauwberg.
Aonyx capensis	African Clawless Otter	LC	0	0	**	***	Uncommon.
Ictonyx striatus	Striped Polecat	LC	0	0	**		Probably common.
Family Equidae	**Zebras**						
Equus quagga	Plains Zebra	LC	0	0	***	***	Introduced game species.
Family Bovidae	**Antelope**						
Alcelaphus buselaphus	Red Hartebeest	LC	0	0		***	Introduced game species.
Antidorcas marsupialis	Springbok	LC	0	0	***	***	Introduced game species.
Connochaetes taurinus	Blue Wildebeest	LC	0	0	***	***	Introduced game species.
Damaliscus p. pygargus	Bontebok	**VU**	2	2	***	***	Introduced game species.
Oryx gazelle	Gemsbok	LC	0	0		***	Introduced game species.
Raphicerus campestris	Steenbok	LC	0	0	***	***	Common.

Raphicerus melanotis	Cape Grysbok	LC	0	2	**	***	Uncommon.
Sylvicapra grimmia	Common Duiker	LC	0	0	***	***	More common away from coastal zone.
Tragelaphus oryx	Eland	LC	0	0	***	***	Introduced game species.

Table 4: Duynefontein birds. The list is based on the bird atlas list for grid cell 3318CB Melkbosstrand (Southern African Bird Atlas Project 1, Animal Demography Unit). The reporting rate is a percentage and indicates the frequency at which the species was recorded during SABAP1. Pelagic seabirds are omitted from this list. Species in **bold** can be considered confirmed for Duynefontein and are either resident or occasional to regular visitors. Those not in bold should mostly be considered of possible to unlikely occurrence, and not of regular occurrence, unless a comment states otherwise.

Common name	Red List status	Reporting rate	Koeberg Private NR list	Survey reporting rate	Comments
1 Common Ostrich		34			
3 African Penguin	**VU**	**6**	***		Non-breeding
6 Great Crested Grebe		3	***		
7 Black-necked Grebe		2	***		
8 Little Grebe		**30**	***	**40**	
49 Great White Pelican	NT	9	***		
55 White-breasted Cormorant		**44**	***	**20**	
56 Cape Cormorant	**NT**	**50**	***		
57 Bank Cormorant	**EN**	**7**	***		
58 Reed Cormorant		**31**	***	**20**	
59 Crowned Cormorant	**NT**	**43**	***		
60 African Darter		**12**	***		
62 Grey Heron		**24**	***	**20**	Vulnerable to collision with transmission lines.
63 Black-headed Heron		**36**	***	**20**	Vulnerable to collision with transmission lines.
64 Goliath Heron		-	***		
65 Purple Heron		**2**	***		Vulnerable to collision with transmission lines.
66 Great White Egret		-	***		
67 Little Egret		**31**	***		
68 Yellow-billed Egret		**5**	***		
71 Cattle Egret		**61**	***	**20**	
76 Black-crowned Night-Heron		**12**	***		
78 Little Bittern		1			Probably does occur
81 Hamerkop		5			
84 Black Stork	NT	2			
90 Yellowbilled Stork		-	***		
91 African Sacred Ibis		**21**	***		
93 Glossy Ibis		**9**	***		
94 Hadeda Ibis		**14**	***	**20**	
95 African Spoonbill		**14**	***		
96 Greater Flamingo	NT	1	***		
101 White-backed Duck		2			
102 Egyptian Goose		**36**	***	**20**	

103 South African Shelduck		**20**	***		
104 Yellow-billed Duck		**35**	***		
105 African Black Duck		1			
106 Cape Teal		7			
108 Red-billed Teal		**29**	***		
112 Cape Shoveler		**31**	***		
113 Southern Pochard		6			
116 Spur-winged Goose		**27**	***		
117 Maccoa Duck		**16**	***		
118 Secretarybird	**NT**	**0**	***		
127 Black-shouldered Kite		**85**	***	**20**	
888 Yellow-billed Kite		**18**	***	**20**	
131 Verreaux's (Black) Eagle		1			
140 Martial Eagle	VU	0			
148 African Fish-Eagle		5	***		
149 Steppe Buzzard		**32**	***		
152 Jackal Buzzard		**3**	***		
165 African Marsh-Harrier	**VU**	**4**	***		
166 Montagu’s Harrier		-	***		
168 Black Harrier	**NT**	**4**	***	**20**	
169 African Harrier-Hawk (Gymnogene)		1			
171 Peregrine Falcon	NT	-	***		
172 Lanner Falcon	NT	2	***		
173 Northern Hobby Falcon		-	***		
181 Rock Kestrel		**12**	***		
183 Lesser Kestrel	VU	0			
190 Grey-winged Francolin		**23**	***		
195 Cape Spurfowl		**70**	***	**100**	
200 Common Quail		**3**	***		
203 Helmeted Guineafowl		**50**	***	**40**	
206 Black-rumped Buttonquail (pre-split)	EN	0	***		
208 Blue Crane	**VU**	**3**	***		
210 African Rail		4			Probably does occur.
213 Black Crake		11			Probably does occur.
223 African Purple Swamphen (Gallinule)		10			Probably does occur.
226 Common Moorhen		**31**	***		
228 Red-knobbed Coot		**42**	***		
239 Black Korhaan		**21**	***		
244 African Black Oystercatcher	**NT**	**49**	***		Potentially affected.
245 Common Ringed Plover		12	***		
246 White-fronted Plover		**55**	***		
248 Kittlitz's Plover		**41**	***		
249 Three-banded Plover		**35**	***	**20**	

254 Grey (Black-bellied) Plover		2			
255 Crowned Lapwing (Plover)		**65**	***		
258 Blacksmith Lapwing (Plover)		**67**	***	**80**	
262 Ruddy Turnstone		30			Probably does occur.
264 Common Sandpiper		4			Probably does occur.
266 Wood Sandpiper		**14**	***		
269 Marsh Sandpiper		**2**	***		
270 Common Greenshank		**9**	***		
271 Red Knot		2			
272 Curlew Sandpiper		**22**	***		
274 Little Stint		13			Probably does occur.
281 Sanderling		23			Probably does occur.
284 Ruff		**6**	***		
286 African (Ethiopian) Snipe		12			Probably does occur.
288 Bar-tailed Godwit		1			
294 Pied (Avocet) Avocet		6			
295 Black-winged Stilt		**15**	***		
297 Spotted Thick-knee (Dikkop)		**13**	***	**20**	
298 Water Thick-knee (Dikkop)		**0**	***		
312 Kelp Gull		**86**	***	**80**	
315 Grey-headed Gull		**8**	***		
316 Hartlaub's Gull		**84**	***	**20**	
322 Caspian Tern	NT	0			
324 Swift (Great Crested) Tern		**21**	***		Potentially affected.
326 Sandwich Tern		**31**	***		
327 Common Tern		**29**	***		
328 Arctic Tern		7			
329 Antarctic Tern		2			
338 Whiskered Tern		0			
339 White-winged Tern		**5**	***		
344 Namaqua Sandgrouse		1			
348 Rock (Feral) Dove (Pigeon)		**13**	***		
349 Speckled (Rock) Pigeon		**56**	***	**60**	
352 Red-eyed Dove		**38**	***	**40**	
354 Cape Turtle (Ring-necked) Dove		**86**	***	**80**	
355 Laughing (Palm) Dove		**85**	***	**40**	
356 Namaqua Dove		**31**	***	**20**	
377 Red-chested Cuckoo		1			
385 Klaas's Cuckoo		**6**	***		
386 Diederik Cuckoo		**1**	***		
391 Burchell's Coucal		**4**	***		
392 Barn Owl		**2**	***		
393 Grass Owl		-	***		

400 Cape Eagle Owl	-	***		
401 Spotted Eagle-Owl	**16**	***		
405 Fiery-necked Nightjar	**2**	***		
411 Common (European) Swift	1			
412 African Black Swift	**23**	***		
415 White-rumped Swift	**10**	***		
416 Horus Swift	0			
417 Little Swift	**41**	*******	**20**	
418 Alpine Swift	**18**	***		
424 Speckled Mousebird	**9**	***		
425 White-backed Mousebird	**38**	***	**40**	
426 Red-faced Mousebird	**17**	***	**40**	
428 Pied Kingfisher	**17**	***		
429 Giant Kingfisher	**8**	***		
431 Malachite Kingfisher	**14**	***		
438 European Bee-eater	**13**	*******	**20**	
451 African Hoopoe	**18**	***		
465 Acacia Pied Barbet	**39**	***		
476 Lesser Honeyguide	-	***		
486 Cardinal Woodpecker	1			
495 Cape Clapper Lark	7			Probably does occur.
500 Long-billed Lark	1			
502 Karoo Lark	7			Probably does occur.
507 Red-capped Lark	**23**	***		
512 Large-billed Lark	**15**	***		
516 Grey-backed Sparrowlark (Finchlark)	0			
518 Barn (European) Swallow	**30**	*******		
520 White-throated Swallow	**21**	*******	**20**	
523 Pearl-breasted Swallow	**20**	*******		
526 Greater Striped-Swallow	**4**	***	**60**	
529 Rock Martin	**20**	***		
532 Sand Martin (Bank Swallow)	0			
533 Brown-throated (Plain) Martin	**45**	*******		
534 Banded Martin	6			
536 Black Sawwing Swallow	-	***		
543 Eurasian Golden Oriole	-	***		
547 Cape (Black) Crow	1	***		
548 Pied Crow	**78**	***	**100**	
551 (Southern) Grey Tit	1			
557 Cape (Southern) Penduline-Tit	**6**	***		
566 Cape Bulbul	**81**	***	**100**	
572 Sombre Greenbul (Bulbul)	0			
577 Olive Thrush	**2**	***		

586 Mountain Chat (Wheatear)	0			
587 Capped Wheatear	**31**	***		
589 Familiar Chat	1			
595 Southern Anteating Chat	3			
596 African (Common) Stonechat	**12**	***		
601 Cape Robin-Chat	**61**		**80**	
614 Karoo Scrub-Robin	**59**	***	**60**	
621 Chestnut-vented Tit-Babbler	**18**	***	**60**	
622 Layard's Tit-Babbler	**10**	***		
631 African Reed-Warbler	4			
635 Lesser Swamp- (Cape Reed) Warbler	**27**	***	**40**	
638 Little Rush- (African Sedge) Warbler	**7**	***		
645 Bar-throated Apalis	**16**	***	**60**	
651 Long-billed (Cape) Crombec	**18**	***		
661 Cape Grassbird	**5**	***	**20**	
664 Zitting (Fan-tailed) Cisticola	4			Probably does occur.
666 Cloud (Tink-tink) Cisticola	5			
669 Grey-backed (Red-headed) Cisticola	**36**	***	**100**	
677 Le Vaillant's (Tinkling) Cisticola	**28**	***	**20**	
686 Spotted Prinia	**57**	***	**100**	
689 Spotted Flycatcher	2			
690 African Dusky Flycatcher	0			
698 Fiscal Flycatcher	**29**	***		
700 Cape Batis	1			
706 Fairy Flycatcher (Warbler)	0			
713 Cape Wagtail	**84**	***	**60**	
716 African (Grassveld) Pipit	**18**	***	**20**	
727 Orange-throated Longclaw	**12**	***		
732 Common Fiscal (Shrike)	**80**	***	**60**	
736 Southern Boubou	**3**	***		
746 Bokmakierie	**68**	***	**80**	
757 European Starling	**82**	***	**80**	
759 (African) Pied Starling	**62**	***	**60**	
760 Wattled Starling	**14**	***		
643 Willow Warbler	-	***		
769 Red-winged Starling	**5**	***	**40**	
773 Cape Sugarbird	9			
775 Malachite Sunbird	**49**	***	**60**	
783 Srn Double-collared Sunbird	**55**	***	**80**	
788 Dusky Sunbird	0			
796 Cape White-eye	**36**	***	**80**	
801 House Sparrow	**41**	***		
803 Cape Sparrow	**77**	***	**100**	

813 Cape Weaver	**66**	***	**80**	
814 Srn Masked-Weaver	**14**	***	**40**	
824 Srn Red (Red) Bishop	**30**	***	**40**	
827 Yellow (Yellow-rumped) Widow	**49**	***	**60**	
846 Common Waxbill	**23**	***	**60**	
860 Pin-tailed Whydah	**16**	***		
872 Cape Canary	21			Probably does occur.
876 Blackheaded Canary	-	***		
877 Brimstone (Bully) Canary	**5**	*****	**20**	
878 Yellow Canary	**71**	***	**40**	
879 White-throated Canary	**36**		**20**	
881 Streaky-headed Seedeater	3	***		
885 Cape Bunting	**45**	*****	**40**	
887 Larklike Bunting	-	***		

APPENDIX 2: Fauna lists for Bantamsklip, including coastal and inland (Hagelkraal) portions.

The following tables are based on species lists for the Western Cape, with species that definitely do not occur on site omitted from the lists. For listed species, the likelihood of occurrence is indicated as "possible", "probable" or "confirmed". In the category "possible", there may be several species, perhaps even the majority, that in fact do not occur on site, or do so only rarely. The purpose of their inclusion in the lists is to flag the possibility that they may occur. Species in the category "probable", on the other hand, should be assumed to occur on site, and planning should take such occurrence into account. "Confirmed" species are those for which direct evidence of occurrence was obtained during the baseline survey or from other reliable sources.

Regardless of category of occurrence, if plans are likely to impact highly threatened species (i.e., Critically Endangered and Endangered species), it may be recommended that additional surveys determine the extent of occurrence and approximate population sizes of those species so that planning and management can proceed with the necessary information. Additional information on significant species is given in the relevant text (above).

SABAP lists for birds are courtesy of the ADU, University of Cape Town. Reptile conservation status courtesy of SARCA, ADU, University of Cape Town.

TABLE 1: Bantamsklip amphibians. 0 = not endemic; 1 = near endemic; 2= endemic; WC = Western Cape; SA = South Africa.

Scientific name	**Common name**	**Red List 2004**	**Endemic**		**Bantamsklip**		**De Villiers 1989** P=probable, C=confirmed	**Comments**
			WC	**SA**	**Coast**	**Inland**		
Family Bufonidae	**toads**							
Amietophrynus pantherinus	Western Leopard Toad	**EN**	2	2	*	**	P	Known from Donkergat, Pearly Beach & Baardskeerdersbos
Amietophrynus rangeri	Raucous Toad	LC	0	2	*	*		Known from Donkergat (De Villiers 1989)
Vandijkophrynus angusticeps	Cape Sand Toad	LC	1	2	**	**	P	Known from Donkergat (De Villiers 1989)
Family Hyperoliidae	**leaf-folding and reed frogs**							
Hyperolius horstockii	Arum Lily Frog	LC	1	2	*	*		Known from Donkergat (De Villiers 1989)
Semnodactylus wealii	Rattling Frog	LC	0	1	*	*		Known from Donkergat (De Villiers 1989)
Family Microhylidae	**rain frogs**							
Breviceps rosei	Rose's Rain Frog	LC	2	2	***	*	C	Known from Donkergat & Bantamsklip (De Villiers 1989)
Family Pipidae	**platannas**							
Xenopus gilli	Cape Platanna	**EN**	2	2	**	***		Known from Groothagelkraal (De Villiers in lit. 2008)
Xenopus laevis	Common Platanna	LC	0	0	*	***		Known from Donkergat (De Villiers 1989)
Family Pyxicephalidae	**bullfrogs, river frogs & allies**							

Amietia fuscigula	Cape River Frog	LC	0	1	*	***		Known from Donkergat (De Villiers 1989)
Arthroleptella villiersi	De Villiers' Moss Frog	LC	2	2	*	***		Recorded at Donkergat as A. lightfooti (De Villiers 1989)
Cacosternum platys	Flat Caco		2	2	*	*		Recorded at Donkergat as C. boettgeri (De Villiers 1989)
Microbatrachella capensis	Micro Frog	**CR**	2	2		***		Main population ~3km NE of Hagelkraal homestead
Strongylopus bonaespei	Banded Stream Frog	LC	1	2	*	***		
Strongylopus grayii	Clicking Stream Frog	LC	0	1	*	***		Known from Donkergat (De Villiers 1989)
Tomopterna delalandii	Cape Sand Frog	LC	1	2	**	**	P	Known from Donkergat (De Villiers 1989)

Table 2: Bantamsklip reptiles. pT = potentially Threatened, 0 = not endemic, 1 = near-endemic, 2 = endemic; WC = W. Cape; SA = South Africa.

Scientific name	**Common name**	**Red List 2009**	**Endemic**		**Bantamsklip**		**De Villiers 1989** P=probable, C=confirmed	**Comments**
			WC	**SA**	**Coast**	**Inland**		
Family Testudinidae	**tortoises**							
Chersina angulata	Angulate Tortoise	LC	0	1	**	**	C	Recorded at Bantamsklip (De Villiers 1989)
Stigmochelys pardalis	Leopard Tortoise	LC	0	0	*	**		An introduced species
Homopus areolatus	Parrot-beaked Padloper	LC	0	2	*	**		
Family Pelomedusidae	**side-necked terrapins**							
Pelomedusa subrufa	Marsh Terrapin	LC	0	0		**		
Family Typhlopidae	**blind snakes**							
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake	LC	0	0	***	**	P	Recorded as *Typhlops lalandei* by De Villiers (1989)
Family Leptotyphlopidae	**thread snakes**							
Leptotyphlops nigricans	Black Thread Snake	LC	0	2	***	**	P	
Family Atractaspidae	**African burrowing snakes**							
Homoroselaps lacteus	Spotted Harlequin Snake	LC	0	2	**	**	P	
Family Colubridae	**typical snakes**							
Amplorhinus multimaculatus	Many-spotted Snake	LC	0	1	*	**		
Crotaphopeltis hotamboeia	Herald Snake	LC	0	0	**	**	C	Recorded at Bantamsklip (De Villiers 1989)
Dasypeltis scabra	Rhombic Egg-eater	LC	0	0	***	**	P	
Dispholidus typus	Boomslang	LC	0	0	**	**	C	Recorded at Bantamsklip (De Villiers 1989)
Duberria lutrix	Common Slug-eater	LC	0	2	**	**	P	
Lamprophis aurora	Aurora House Snake	LC	0	2	**	**	P	

Lamprophis capensis	Brown House Snake	LC	0	0	*	*		
Lamprophis fuscus	Yellow-bellied House Snake	**NT**	0	2	*	**	P	
Lamprophis guttatus	Spotted House Snake	LC	0	1	*	*	P	
Lamprophis inornatus	Olive House Snake	LC	0	2	**	**	C	Recorded at Bantamsklip (De Villiers 1989)
Lycodonomorphus rufulus	Common Brown Water Snake	LC	0	0	**	**		
Lycophidion capense	Cape Wolf Snake	LC	0	0	**	**	P	
Prosymna sundevallii	Sundevall's Shovel-snout	LC	0	1	**	**	P	
Psammophis crucifer	Crossed Whip Snake	LC	0	1	**	**	C	Recorded at Bantamsklip (De Villiers 1989)
Psammophis leightoni	Cape Whip Snake	**VU**	2	2				
Psammophis notostictus	Karoo Whip Snake	LC	0	0	**	**	P	
Psammophylax rhombeatus	Rhombic Skaapsteker	LC	0	1	**	**	P	
Pseudaspis cana	Mole Snake	LC	0	0	***	**	C	Recorded at Bantamsklip (De Villiers 1989)
Family Elapidae	**front-fanged snakes**							
Aspidelaps lubricus lubricus	Coral Shield Cobra	LC	0	0		*		
Hemachatus haemachatus	Rinkhals	LC	0	1	**	***	P	Occurs at Hagelkraal (K. Dunn, pers. comm. 2008)
Naja nivea	Cape Cobra	LC	0	0	**	***	C	Occurs at Hagelkraal (K. Dunn, pers. comm. 2008)
Family Viperidae	**vipers**							
Bitis arietans	Puff Adder	LC	0	0	**	***	C	Occurs at Hagelkraal (K. Dunn, pers. comm. 2008)
Bitis armata	Southern Adder	**VU**	2	2	**	**	P	Recorded as *B. cornuta* by De Villiers (1989)
Bitis atropos	Berg Adder	LC	0	0	**	**	P	
Family Scincidae	**skinks**							
Acontias meleagris	Cape Legless Skink	LC	1	2	**	**	P	
Scelotes bipes	Silvery Dwarf Burrowing Skink	LC	2	2	**	**	P	
Trachylepis capensis	Cape Skink	LC	0	0	***	**	C	Recorded at Bantamsklip (De Villiers 1989)
Trachylepis homalocephala	Red-sided Skink	LC	0	2	**	***	C	Recorded at Bantamsklip (De Villiers 1989)
Family Lacertidae	**lacertid lizards**							
Nucras lalandii	Delalande's Sandveld Lizard	LC	0	2		*		
Pedioplanis burchelli	Burchell's Sand Lizard	LC	0	2		*		
Pedioplanis pulchella	Pulchell's Sand Lizard	LC	0	1	**	**	P	
Tropidosaura montana Montana	Common Mountain Lizard	LC	0	2		*		
Family Gerrhosauridae	**plated lizards**							
Gerrhosaurus flavigularis	Yellow-throated Plated Lizard	LC	0	0	***	**	C	Recorded at Bantamsklip (De Villiers 1989)
Tetradactylus seps	Short-legged Seps	LC	0	2	**	**	P	

Tetradactylus tetradactylus	Common Long-tailed Seps	LC	0	2	*	*		
Family Cordylidae	**girdled lizards**							
Chamaesaura anguina anguina	Cape Grass Lizard	**NT**	0	2	*	**		
Cordylus cordylus	Cape Girdled Lizard	LC	0	2	***	**	C	Recorded at Bantamsklip (De Villiers 1989)
Pseudocordylus m. microlepidotus	Cape Crag Lizard	LC	0	2		*		
Family Agamidae	**agamas**							
Agama atra	Southern Rock Agama	LC	0	1	**	**	C	Recorded at Bantamsklip (De Villiers 1989)
Family Chamaeleonidae	**chameleons**							
Bradypodion pumilum	Cape Dwarf Chameleon	**VU**	2	2	**	**	P	
Family Gekkonidae	**geckos**							
Afrogecko porphyreus	Marbled Leaf-toed Gecko	LC	0	2	***	**	C	Recorded at Bantamsklip (De Villiers 1989)
Chondrodactylus bibronii	Bibron's Gecko	LC	0	1		**	C	Recorded at Bantamsklip (De Villiers 1989)
Pachydactylus geitje	Ocellated Gecko	LC	0	2	***	**	C	Recorded at Bantamsklip (De Villiers 1989)

Table 3: Bantamsklip mammals. 0 = not endemic, 1 = near-endemic, 2 = endemic; WC = Western Cape; SA = South Africa.

Scientific name	Common name	Red List 2004	Endemic WC	Endemic SA	Bantamsklip Coast	Bantamsklip Inland	Palmer 1989 P=probable, C=confirmed	Comments
Family Chrysochloridae	**golden moles**							
Amblysomus corriae	Fynbos Golden Mole	**NT**	1	2	**	**	P	Recorded by Palmer (1989) as *Amblysomus hottentotus*
Chrysochloris asiatica	Cape Golden Mole	**DD**	1	2	**	**	C	Golden mole presence observed at coast and inland sites, but ID not confirmed
Family Macroscelididae	**elephant shrews**							
Elephantulus edwardii	Cape Rock Elephant-Shrew	LC	1	2	*	*		
Family Orycteropodidae	**Aardvark**							
Orycteropus afer	Aardvark	LC	0	0	*	*		Apparently not present at Groot Hagelkraal (K. Dunn, pers. comm. 2008)
Family Procaviidae	**hyraxes**							
Procavia capensis	Rock Hyrax	LC	0	0	*	***		Occurs at Groot Hagelkraal (K. Dunn, pers. comm. 2008)
Family Leporidae	**hares, rabbits & rock rabbits**							
Lepus saxatilis	Scrub Hare	LC	0	0	**	**	P	
Family Bathyergidae	**mole-rats**							

Bathyergus suillus	Cape Dune Mole-Rat	LC	2	2	***	***	C	
Cryptomys hottentotus	African Mole-Rat	LC	0	0	**	**	P	One or both species of smaller mole rats may occur at Bantamsklip
Georychus capensis	Cape Mole-Rat	LC	0	2	**	**	P	One or both species of smaller mole rats may occur at Bantamsklip
Family Hystricidae	**porcupines**							
Hystrix africaeaustralis	Cape Porcupine	LC	0	0	***	***	C	
Family Myoxidae	**dormice**							
Graphiurus murinus	Woodland Dormouse	LC	0	2		*		
Family Muridae	**rats & mice**							
Acomys subspinosus	Cape Spiny Mouse	LC	2	2	**	**	P	
Dasymys capensis	Cape Marsh Rat	**(NT)**	2	2		**		Recorded by Palmer (1989) as *Dasymys incomtus*; likely to be Threatened species
Dendromus melanotis	Grey Climbing Mouse	LC	0	0	**	**	P	
Dendromus mesomelas	Brant's Climbing Mouse	LC	0	0	**	**	P	
Gerbillurus paeba	Hairy-Footed Gerbil	LC	0	0	*	*		
Micaelamys namaquensis	Namaqua Rock Mouse	LC	0	0	*	**	P	
Mus minutoides	Pygmy Mouse	LC	0	0	**	**	C	
Mus musculus	House Mouse	(alien)	0	0	*	**		
Myomyscus verreauxi	Verreaux's Mouse	LC	1	2	*	**		
Mystromys albicaudatus	White-Tailed Mouse	**EN**	0	1	*	*	P	
Otomys irroratus	Vlei Rat	LC	0	0	**	**	C	
Otomys laminatus	Laminate Vlei Rat	LC	0	1			P	Recorded by Palmer (1989); but does not occur
Otomys saundersiae	Saunders' Vlei Rat	LC	0	2			P	Recorded by Palmer (1989); but no longer a valid taxon
Rattus norvegicus	Brown House Rat	(alien)	0	0	*	*		
Rattus rattus	House Rat	(alien)	0	0	*	**		
Rhabdomys pumilio	Four-Striped Grass Mouse	LC	0	0	***	***	C	
Saccostomus campestris	Pouched Mouse	LC	0	0	*	*		
Steatomys krebsii	Kreb's Fat Mouse	LC	0	0	*	*	P	
Tatera afra	Cape Gerbil	LC	1	2	**	***	C	
Family Cercopithecidae	**baboons & monkeys**							
Papio cynocephalus ursinus	Chacma Baboon	LC	0	0	*	*		Known from farms adjacent to Hagelkraal (K. Dunn, pers. comm. 2008)
Family Soricidae	**shrews**							
Crocidura cyanea	Reddish-Grey Musk Shrew	**DD**	0	0	**	**	P	
Crocidura flavescens	Greater Red Musk Shrew	**DD**	0	0	**	**	C	
Myosorex varius	Forest Shrew	**DD**	0	1	**	**	C	

Suncus varilla	Lesser Dwarf Shrew	**DD**	0	0	*	*	P	
Family Molossidae	**free-tailed bats**							
Sauromys petrophilus	Flat-Headed Free-Tailed Bat	LC	0	0	*	*		
Tadarida aegyptiaca	Egyptian Free-Tailed Bat	LC	0	0	**	**		
Family Miniopteridae	**long-fingered bats**							
Miniopterus natalensis	Natal Long-fingered Bat	**NT**	0	0	**	***	P	Possible roosting in limestone caves; treated as *M. schreibersii* (Palmer 1989)
Family Vespertilionidae	**vesper bats**							
Neoromicia capensis	Cape Serotine Bat	LC	0	0	**	**	P	Treated as *Eptesicus capensis* (Palmer 1989)
Myotis tricolor	Temminck's Hairy Bat	**NT**	0	0	**	**	P	
Eptesicus hottentotus	Long-Tailed Serotine Bat	LC	0	0	*	*		
Family Nycteridae	**slit-faced bats**							
Nycteris thebaica	Egyptian Slit-Faced Bat	LC	0	0	**	**		
Family Rhinolophidae	**horseshoe bats**							
Rhinolophus clivosus	Geoffroy's Horseshoe Bat	**NT**	0	0	**	**	P	
Rhinolophus capensis	Cape Horseshoe Bat	**NT**	0	2	**	**	P	
Family Hyaenidae	**hyaenas**							
Proteles cristatus	Aardwolf	LC	0	0		*		Not observed at Groot Hagelkraal (K. Dunn, pers. comm. 2008)
Family Felidae	**cats**							
Panthera pardus	Leopard	LC	0	0	*	***		Tracks observed at Groot Hagelkraal (K. Dunn, pers. comm. 2008)
Caracal caracal	Caracal	LC	0	0	**	**	C	
Felis silvestris	African Wild Cat	LC	0	0	**	**	C	
Felis cattus	Domestic Cat (feral)	(feral alien)	0	0	*	*		
Family Viverridae	**genets**							
Genetta genetta	Small-Spotted Genet	LC	0	0	**	**	P	
Genetta tigrina	South African Large-Spotted Genet	LC	0	0	**	**	C	
Family Herpestidae	**suricates & mongooses**							
Herpestes ichneumon	Large Grey Mongoose	LC	m	0	**	**	C	
Galerella pulverulenta	Cape Grey Mongoose	LC	0	0	***	***	C	
Atilax paludinosus	Marsh Mongoose	LC	0	0	**	**	C	
Family Canidae	**foxes & jackals**							
Otocyon megalotis	Bat-Eared Fox	LC	0	0	*	*		
Vulpes chama	Cape Fox	LC	0	0	**	**	C	
Canis mesomelas	Black-Backed Jackal	LC	0	0	*	*		

Canis vulgaris	Domestic Dog (feral)	(feral alien)	0	0	*	*		
Family Mustelidae	**otters, Honey Badger, weasels & polecats**							
Aonyx capensis	African Clawless Otter	LC	0	0	**	**	C	
Mellivora capensis	Honey Badger	**NT**	0	0	**	**	P	
Poecilogale albinucha	African Striped Weasel	**DD**	0	0	*	*		
Ictonyx striatus	Striped Polecat	LC	0	0	**	**	P	
Family Bovidae	**antelope**							
Tragelaphus scriptus	Bushbuck	LC	0	0		**	P	Probably a small population at Groot Hagelkraal
Sylvicapra grimmia	Common Duiker	LC	0	0	**	***	P	Occurs at Groot Hagelkraal (K. Dunn, pers. comm. 2008)
Pelea capreolus	Grey Rhebok	LC	0	0		***		Occurs at Groot Hagelkraal (K. Dunn, pers. comm. 2008)
Raphicerus campestris	Steenbok	LC	0	0	**	**	C	
Raphicerus melanotis	Cape Grysbok	LC	0	2	***	***	C	
Cervus dama	European Fallow Deer	(feral alien)	0	0		***		Introduced on Groot Hagelkraal (K. Dunn, pers. comm. 2008)

Table 4: Bantamsklip birds. The list is based on the bird atlas list for grid cell 3419DA Baardskeerdersbos (Southern African Bird Atlas Project 1, Animal Demography Unit). The reporting rate is a percentage and indicates the frequency at which the species was recorded during SABAP1. Breeding records are those obtained during SABAP1. Confirmed records obtained by Allan & Hockey (1989) are indicated in column 7. Species observed during a site visit are indicated as confirmed (***), separately for the coastal and inland portions of the site. All species listed should be regarded as of possible to probable occurrence on site, even if not confirmed. Generally speaking, and given the diversity of habitats on site, the higher the reporting rate, the more likely the species is to occur on site.

Species number	Common name	Scientific name	Red Listing	Reporting rate	Breeding record	Allan & Hockey	Coastal area	Inland area	Comments
1	Common Ostrich	*Struthio camelus*		46.7	Y				
3	African Penguin	*Spheniscus demersus*	**VU**	2.8		C			
8	Little Grebe	*Tachybaptus ruficollis*		6.5					
53	Cape Gannet	*Morus capensis*	**VU**	9.3		C			
55	White-breasted Cormorant	*Phalacrocorax carbo*		34.6		C	***		
56	Cape Cormorant	*Phalacrocorax capensis*	**NT**	29.0	Y	C	***		

57	Bank Cormorant	*Phalacrocorax neglectus*	**EN**	11.2	Y	C			
58	Reed Cormorant	*Phalacrocorax africanus*		15.0					
59	Crowned Cormorant	*Phalacrocorax coronatus*	**NT**	15.9	Y	C			
60	African Darter	*Anhinga rufa*		0.9					
62	Grey Heron	*Ardea cinerea*		13.1		C			Vulnerable to collisions with transmission lines.
63	Black-headed Heron	*Ardea melanocephala*		69.2		C	***		Vulnerable to collisions with transmission lines.
65	Purple Heron	*Ardea purpurea*		1.9					Vulnerable to collisions with transmission lines.
66	Great Egret	*Egretta alba*		6.5					
67	Little Egret	*Egretta garzetta*		13.1		C	***		
68	Yellow-billed Egret	*Egretta intermedia*		0.9					
71	Cattle Egret	*Bubulcus ibis*		86.0					
81	Hamerkop	*Scopus umbretta*		20.6					
83	White Stork	*Ciconia ciconia*		2.8					Vulnerable to collisions with transmission lines.
84	Black Stork	*Ciconia nigra*	**NT**	0.9					
90	Yellow-billed Stork	*Mycteria ibis*	**NT**	0.9					
91	African Sacred Ibis	*Threskiornis aethiopicus*		23.4			***		
94	Hadeda Ibis	*Bostrychia hagedash*		12.1				***	
95	African Spoonbill	*Platalea alba*		25.2					Vulnerable to collisions with transmission lines.
102	Egyptian Goose	*Alopochen aegyptiacus*		57.9	Y			***	
103	South African Shelduck	*Tadorna cana*		0.9					
104	Yellow-billed Duck	*Anas undulata*		32.7					
106	Cape Teal	*Anas capensis*		0.9					
108	Red-billed Teal	*Anas erythrorhyncha*		11.2					
112	Cape Shoveler	*Anas smithii*		11.2					
113	Southern Pochard	*Netta erythrophthalma*		0.9					
116	Spur-winged Goose	*Plectropterus gambensis*		57.9	Y				
118	Secretarybird	*Sagittarius serpentarius*	**NT**	12.1					Vulnerable to collisions with transmission lines.
127	Black-shouldered Kite	*Elanus caeruleus*		67.3		C			
140	Martial Eagle	*Polemaetus bellicosus*	**VU**	1.9					May nest on pylons.
148	African Fish-Eagle	*Haliaeetus vocifer*		11.2					
149	Steppe Buzzard	*Buteo vulpinus*		17.8		C			
152	Jackal Buzzard	*Buteo rufofuscus*		19.6	Y	C		***	May nest on pylons.
155	Rufous-chested Sparrowhawk	*Accipiter rufiventris*		1.9					

160	African Goshawk	*Accipiter tachiro*		3.7					
161	Gabar Goshawk	*Melierax gabar*		0.9					
165	African Marsh-Harrier	*Circus ranivorus*	**VU**	12.1	Y				
168	Black Harrier	*Circus maurus*	**NT**	4.7		C	***		
181	Rock Kestrel	*Falco rupicolus*		10.3					
190	Grey-winged Francolin	*Scleroptila africanus*		3.7					
195	Cape Spurfowl	*Pternistis capensis*		72.0	Y	C	***	***	
200	Common Quail	*Coturnix coturnix*		26.2					
203	Helmeted Guineafowl	*Numida meleagris*		71.0	Y				
208	Blue Crane	*Anthropoides paradiseus*	**VU**	50.5	Y	C			Vulnerable to collisions with transmission lines.
210	African Rail	*Rallus caerulescens*		5.6					
213	Black Crake	*Amaurornis flavirostris*		2.8				***	
217	Red-chested Flufftail	*Sarothrura rufa*		8.4					
223	African Purple Swamphen	*Porphyrio madagascariensis*		7.5					
226	Common Moorhen	*Gallinula chloropus*		7.5					
228	Red-knobbed Coot	*Fulica cristata*		23.4					
231	Denham's Bustard	*Neotis denhami*	**VU**	13.1	Y	C			Vulnerable to collisions with transmission lines and disturbance.
235	Karoo Korhaan	*Eupodotis vigorsii*		0.9					Vulnerable to collisions with transmission lines.
239	Southern Black Korhaan	*Afrotis afra*		57.0	Y				Vulnerable to collisions with transmission lines.
244	African Black Oystercatcher	*Haematopus moquini*	**NT**	23.4	Y	C	***		
245	Common Ringed Plover	*Charadrius hiaticula*		0.9		C			
246	White-fronted Plover	*Charadrius marginatus*		24.3	Y	C	***		
248	Kittlitz's Plover	*Charadrius pecuarius*		1.9					
249	Three-banded Plover	*Charadrius tricollaris*		3.7					
254	Grey Plover	*Pluvialis squatarola*		3.7		C			
255	Crowned Lapwing	*Vanellus coronatus*		69.2		C			
258	Blacksmith Lapwing	*Vanellus armatus*		73.8	Y				
262	Ruddy Turnstone	*Arenaria interpres*		9.3		C			
264	Common Sandpiper	*Actitis hypoleucos*		1.9		C			
270	Common Greenshank	*Tringa nebularia*		1.9					
272	Curlew Sandpiper	*Calidris ferruginea*		3.7		C			
281	Sanderling	*Calidris alba*		7.5		C			
286	African Snipe	*Gallinago nigripennis*		15.0					

289	Eurasian Curlew	*Numenius arquata*		0.9		C		
290	Common Whimbrel	*Numenius phaeopus*		12.1		C		
294	Pied Avocet	*Recurvirostra avosetta*		0.9				
295	Black-winged Stilt	*Himantopus himantopus*		3.7				
297	Spotted Thick-knee	*Burhinus capensis*		58.9	Y	C	***	
299	Burchell's Courser	*Cursorius rufus*		0.9				
312	Kelp Gull	*Larus dominicanus*		60.7		C	***	
315	Grey-headed Gull	*Larus cirrocephalus*		2.8				
316	Hartlaub's Gull	*Larus hartlaubii*		24.3		C	***	
324	Swift Tern	*Sterna bergii*		11.2		C	***	
326	Sandwich Tern	*Sterna sandvicensis*		6.5		C		
327	Common Tern	*Sterna hirundo*		6.5		C		
329	Antarctic Tern	*Sterna vittata*		1.9		C		
334	Damara Tern	*Sterna balaenarum*	**EN**	0.9				
338	Whiskered Tern	*Chlidonias hybrida*		2.8				
339	White-winged Tern	*Chlidonias leucopterus*		0.9				
	Feral Pigeon	*Columba livia*						***
349	Speckled Pigeon	*Columba guinea*		67.3	Y	C		
350	African Olive-Pigeon	*Columba arquatrix*		17.8				
352	Red-eyed Dove	*Streptopelia semitorquata*		66.4				***
354	Cape Turtle-Dove	*Streptopelia capicola*		94.4		C	***	***
355	Laughing Dove	*Streptopelia senegalensis*		74.8				
356	Namaqua Dove	*Oena capensis*		0.9				
377	Red-chested Cuckoo	*Cuculus solitarius*		3.7				
385	Klaas's Cuckoo	*Chrysococcyx klaas*		2.8			***	
391	Burchell's Coucal	*Centropus burchelli*		37.4				
392	Barn Owl	*Tyto alba*		1.9	Y			***
401	Spotted Eagle-Owl	*Bubo africanus*		3.7				
405	Fiery-necked Nightjar	*Caprimulgus pectoralis*		16.8				
408	Freckled Nightjar	*Caprimulgus tristigma*		0.9				
412	African Black Swift	*Apus barbatus*		0.9				
415	White-rumped Swift	*Apus caffer*		4.7				
417	Little Swift	*Apus affinis*		1.9				

418	Alpine Swift	*Tachymarptis melba*	1.9				
424	Speckled Mousebird	*Colius striatus*	72.9		C	***	
425	White-backed Mousebird	*Colius colius*	0.9				
426	Red-faced Mousebird	*Urocolius indicus*	3.7				
428	Pied Kingfisher	*Ceryle rudis*	17.8		C		
429	Giant Kingfisher	*Megaceryle maximus*	5.6			***	
431	Malachite Kingfisher	*Alcedo cristata*	7.5				
435	Brown-hooded Kingfisher	*Halcyon albiventris*	0.9				
451	African Hoopoe	*Upupa africana*	43.0				
465	Acacia Pied Barbet	*Tricholaema leucomelas*	60.7	Y	C		
474	Greater Honeyguide	*Indicator indicator*	2.8				
480	Ground Woodpecker	*Geocolaptes olivaceus*	0.9				
486	Cardinal Woodpecker	*Dendropicos fuscescens*	21.5	Y			
495	Cape Clapper Lark	*Mirafra apiata*	3.7				
500	Agulhas Long-billed Lark	*Certhilauda brevirostris*	0.9				
507	Red-capped Lark	*Calandrella cinerea*	8.4				
512	Large-billed Lark	*Galerida magnirostris*	1.9				
518	Barn Swallow	*Hirundo rustica*	24.3				
520	White-throated Swallow	*Hirundo albigularis*	15.0	Y			
523	Pearl-breasted Swallow	*Hirundo dimidiata*	5.6				
526	Greater Striped Swallow	*Hirundo cucullata*	27.1	Y			
529	Rock Martin	*Hirundo fuligula*	11.2		C	***	***
533	Brown-throated Martin	*Riparia paludicola*	12.1				
536	Black Saw-wing	*Psalidoprocne holomelaena*	2.8				
541	Fork-tailed Drongo	*Dicrurus adsimilis*	70.1	Y			
547	Cape Crow	*Corvus capensis*	26.2				
548	Pied Crow	*Corvus albus*	1.9				
550	White-necked Raven	*Corvus albicollis*	13.1		C	***	***
566	Cape Bulbul	*Pycnonotus capensis*	86.9	Y	C	***	***
572	Sombre Greenbul	*Andropadus importunus*	65.4				
577	Olive Thrush	*Turdus olivaceus*	7.5		C		***
587	Capped Wheatear	*Oenanthe pileata*	3.7				
596	African Stonechat	*Saxicola torquatus*	31.8	Y	C	***	

601	Cape Robin-Chat	*Cossypha caffra*	77.6	Y	C	***	***
614	Karoo Scrub-Robin	*Cercotrichas coryphoeus*	1.9				
621	Chestnut-vented Tit-babbler	*Parisoma subcaeruleum*	_				***
631	African Reed-Warbler	*Acrocephalus baeticatus*	1.9				
635	Lesser Swamp-Warbler	*Acrocephalus gracilirostris*	8.4				
638	Little Rush-Warbler	*Bradypterus baboecala*	14.0	Y			***
645	Bar-throated Apalis	*Apalis thoracica*	37.4		C		***
651	Long-billed Crombec	*Sylvietta rufescens*	2.8		C		
661	Cape Grassbird	*Sphenoeacus afer*	58.9	Y	C	***	***
664	Zitting Cisticola	*Cisticola juncidis*	3.7				
666	Cloud Cisticola	*Cisticola textrix*	1.9				
669	Grey-backed Cisticola	*Cisticola subruficapilla*	15.0	Y	C	***	***
677	Levaillant's Cisticola	*Cisticola tinniens*	12.1	Y			
686	Karoo Prinia	*Prinia maculosa*	68.2	Y	C	***	***
690	African Dusky Flycatcher	*Muscicapa adusta*	2.8				
698	Fiscal Flycatcher	*Sigelus silens*	69.2		C		***
700	Cape Batis	*Batis capensis*	0.9				***
710	African Paradise-Flycatcher	*Terpsiphone viridis*	6.5				
713	Cape Wagtail	*Motacilla capensis*	75.7	Y	C	***	
716	African Pipit	*Anthus cinnamomeus*	6.5				
717	Long-billed Pipit	*Anthus similis*	0.9				
718	Plain-backed Pipit	*Anthus leucophrys*	1.9				
727	Cape Longclaw	*Macronyx capensis*	43.0				
732	Common Fiscal	*Lanius collaris*	91.6	Y	C	***	***
736	Southern Boubou	*Laniarius ferrugineus*	79.4		C		***
742	Southern Tchagra	*Tchagra tchagra*	47.7		C		
746	Bokmakierie	*Telophorus zeylonus*	83.2	Y	C	***	***
757	Common Starling	*Sturnus vulgaris*	78.5	Y	C	***	
759	Pied Starling	*Spreo bicolor*	92.5	Y	C		
760	Wattled Starling	*Creatophora cinerea*	3.7				
769	Red-winged Starling	*Onychognathus morio*	64.5	Y		***	***
773	Cape Sugarbird	*Promerops cafer*	56.1		C	***	***
775	Malachite Sunbird	*Nectarinia famosa*	72.9		C		

777	Orange-breasted Sunbird	*Anthobaphes violacea*	48.6	Y	C	***	***
783	Srn Double-collared Sunbird	*Cinnyris chalybeus*	67.3	Y	C	***	***
796	Cape White-eye	*Zosterops capensis*	59.8		C		
801	House Sparrow	*Passer domesticus*	31.8				
803	Cape Sparrow	*Passer melanurus*	13.1				
813	Cape Weaver	*Ploceus capensis*	86.9	Y	C	***	***
814	Southern Masked-Weaver	*Ploceus velatus*	1.9	Y			
824	Southern Red Bishop	*Euplectes orix*	14.0	Y			
827	Yellow Bishop	*Euplectes capensis*	52.3	Y	C		***
846	Common Waxbill	*Estrilda astrild*	61.7		C		
860	Pin-tailed Whydah	*Vidua macroura*	14.0	Y			
872	Cape Canary	*Serinus canicollis*	65.4		C		
877	Brimstone Canary	*Crithagra sulphuratus*	12.1				***
878	Yellow Canary	*Crithagra flaviventris*	15.9		C		
879	White-throated Canary	*Crithagra albogularis*	4.7				
880	Protea Seedeater	*Crithagra leucopterus*	0.9				
885	Cape Bunting	*Emberiza capensis*	11.2		C		***

APPENDIX 3: Fauna lists for Thyspunt, including inland and coastal portions.

The following tables are based on species lists for the Eastern Cape, with species that definitely do not occur on site omitted from the lists. For listed species, the likelihood of occurrence is indicated as "possible", "probable" or "confirmed". In the category "possible", there may be several species, perhaps even the majority, that in fact do not occur on site, or do so only rarely. The purpose of their inclusion in the lists is to flag the possibility that they may occur. Species in the category "probable", on the other hand, should be assumed to occur on site, and planning should take such occurrence into account. "Confirmed" species are those for which direct evidence of occurrence was obtained during the baseline survey or from other reliable sources.

Regardless of category of occurrence, if plans are likely to impact highly threatened species (i.e., Critically Endangered and Endangered species), it may be recommended that additional surveys determine the extent of occurrence and approximate population sizes of those species so that planning and management can proceed with the necessary information. Additional information on significant species is given in the relevant text (above).

SABAP lists for birds are courtesy of the ADU, University of Cape Town. Reptile conservation status courtesy of SARCA, ADU, University of Cape Town.

TABLE 1: Thyspunt amphibians (updated with September 2009 findings)**.** 0 = not endemic; 1 = near endemic; 2= endemic; EC = Eastern Cape; SA = South Africa.

Scientific name	Common name	Red List 2004	Endemic EC	Endemic SA	Thyspunt Coast	Thyspunt Inland	Branch 1986 P=probable	Comments
Family Bufonidae	**toads**							
Amietophrynus pardalis	Eastern Leopard Toad	LC	1	2	***	**		
Amietophrynus rangeri	Raucous Toad	LC	0	2	**	**	P	
Vandijkophrynus angusticeps	Cape Sand Toad	LC	0	2	**	*		Van Teylingen 1993
Family Hyperoliidae	**leaf-folding and reed frogs**							
Hyperolius horstockii	Arum Lily Frog	LC	0	2	**	**		
Hyperolius marmoratus	Painted Reed Frog	LC	0	0	***	**		D. Papenfus, pers. comm. 2008
Semnodactylus wealii	Rattling Frog	LC	0	1	*	**		
Family Microhylidae	**rain frogs**							
Breviceps adspersus pentheri	Penther's Rain Frog	LC	2	2	*	**		
Family Pipidae	**platannas**							
Xenopus laevis	Common Platanna	LC	0	0	***	**	P	Records from Cunningham & Henderson (2008)
Family Pyxicephalidae	**bullfrogs, river frogs & allies**							
Amietia angolensis	Common River Frog	LC	0	0	**	***		
Amietia fuscigula	Cape River Frog	LC	0	1	***	**	P	Records from Cunningham & Henderson (2008)

Cacosternum nanum	Bronze Caco	LC	0	2	***	**		Records from Cunningham & Henderson (2008)
Cacosternum boettgeri	Boettger's Caco	LC	0	0	***	***		Records from Cunningham & Henderson (2008)
Strongylopus fasciatus	Striped Stream Frog	LC	0	0	***	**	P	Records from Cunningham & Henderson (2008)
Strongylopus grayii	Clicking Stream Frog	LC	0	1	***	**	P	Records from Cunningham & Henderson (2008)
Tomopterna delalandii	Cape Sand Frog	LC	0	2	***	**	P	Records from Cunningham & Henderson (2008)

Table 2: Thyspunt reptiles (updated with September 2009 findings). pT = potentially Threatened, 0 = not endemic, 1 = near-endemic, 2 = endemic; EC = E. Cape; SA = South Africa.

Scientific name	Common name	Red List	Endemic		Thyspunt		Branch 1986	Comments
		2009	EC	SA	Coast	Inland	P=probable	
Family Testudinidae	**tortoises**							
Chersina angulata	Angulate Tortoise	LC	0	1	**	**	P	
Stigmochelys pardalis	Leopard Tortoise	LC	0	0	***	***	P	D. Papenfus, G. Seeney pers. comm. 2008
Homopus areolatus	Parrot-beaked Padloper	LC	0	2	**	***		
Family Pelomedusidae	**side-necked terrapins**							
Pelomedusa subrufa	Marsh Terrapin	LC	0	0	**	**		
Family Typhlopidae	**blind snakes**							
Rhinotyphlops lalandei	Delalande's Beaked Blind Snake	LC	0	0	**	***	P	
Family Leptotyphlopidae	**thread snakes**							
Leptotyphlops nigricans	Black Thread Snake	LC	0	2	**	**		
Family Atractaspidae	**African burrowing snakes**							
Homoroselaps lacteus	Spotted Harlequin Snake	LC	0	2	**	**		
Family Colubridae	**typical snakes**							
Crotaphopeltis hotamboeia	Herald Snake	LC	0	0	***	**	P	
Dasypeltis scabra	Rhombic Egg-eater	LC	0	0	***	**	P	
Dispholidus typus	Boomslang	LC	0	0	**	**	P	
Duberria lutrix	Common Slug-eater	LC	0	2	**	**	P	
Lamprophis aurora	Aurora House Snake	LC	0	2	*	**	P	
Lamprophis capensis	Brown House Snake	LC	0	0	**	**	P	
Lamprophis fuscus	Yellow-bellied House Snake	**NT**	0	2	**	***		Branch 1988
Lamprophis guttatus	Spotted House Snake	LC	0	1		*		
Lamprophis inornatus	Olive House Snake	LC	0	2	***	**	P	
Lycodonomorphus rufulus	Common Brown Water Snake	LC	0	0	**	***	P	

Lycodonomorphus laevissimus	Dusky-bellied Water Snake	LC	0	2	*	*		
Lycophidion capense capense	Cape Wolf Snake	LC	0	0	**	**		
Philothamnus hoplogaster	Green Water Snake	LC	0	0	***	***		
Philothamnus natalensis occidentalis	Western Natal Green Snake	LC	0	2	**	**		
Philothamnus semivariegatus	Spotted Bush Snake	LC	0	0	**	**		
Prosymna sundevallii	Sundevall's Shovel-snout	LC	0	1	**	**		
Psammophis crucifer	Crossed Whip Snake	LC	0	1	***	**	P	
Psammophis notostictus	Karoo Whip Snake	LC	0	0	*	**		
Psammophylax rhombeatus rhombeatus	Rhombic Skaapsteker	LC	0	1	**	***	P	
Pseudaspis cana	Mole Snake	LC	0	0	**	**	P	
Family Elapidae	**front-fanged snakes**							
Aspidelaps lubricus lubricus	Coral Shield Cobra	LC	0	0		*		
Hemachatus haemachatus	Rinkhals	LC	0	1	**	**	P	
Naja nivea	Cape Cobra	LC	0	0	***	***	P	D. Papenfus, G. Seeney pers. comm. 2008
Family Viperidae	**vipers**		0					
Bitis arietans	Puff Adder	LC	0	0	***	***	P	G. Greeff, G. Seeney pers. comm. 2008
Bitis atropos	Berg Adder	LC	0	0		*		
Causus rhombeatus	Common or Rhombic Night Adder	LC	0	0	**	***	P	
Family Scincidae	**skinks**							
Acontias gracilicauda gracilicauda	Thin-tailed Legless Skink	LC	0	2	**	**		
Acontias percivali tasmani	Tasman's Legless Skink	LC	2	2	**	**		SARCA in litt.
Acontias lineicauda	Algoa Legless Skink	NE	2	2	**	*		SARCA in litt.
Acontias meleagris orientalis	Eastern Legless Skink	LC	2	2		***	P	
Scelotes anguineus	Algoa Dwarf Burrowing Skink	LC	2	2	**	**		SARCA in litt.
Scelotes caffer	Cape Dwarf Burrowing Skink	LC	0	2		*		SARCA in litt.
Trachylepis capensis	Cape Skink	LC	0	0	**	**	P	
Trachylepis homalocephala	Red-sided Skink	LC	0	2	***	**	P	
Trachylepis varia varia	Variable Skink	LC	0	0	*	**		
Family Lacertidae	**lacertid lizards**							
Nucras lalandii	Delalande's Sandveld Lizard	LC	0	2	**	***		
Pedioplanis burchelli	Burchell's Sand Lizard	LC	0	2		*		
Pedioplanis pulchella	Pulchell's Sand Lizard	LC	0	1	**	**		
Tropidosaura montana montana	Common Mountain Lizard	LC	0	2	**	**		

Family Gerrhosauridae	**plated lizards**							
Gerrhosaurus flavigularis	Yellow-throated Plated Lizard	LC	0	0	**	**		
Tetradactylus fitzsimonsi	FitzSimons' Long-tailed Seps	**VU**	2	2	*	**		SARCA in litt.
Tetradactylus seps	Short-legged Seps	LC	0	2	***	**		
Family Cordylidae	**girdled lizards**							
Chamaesaura anguina anguina	Cape Grass Lizard	**NT**	0	2	*	**		
Cordylus cordylus	Cape Girdled Lizard	LC	0	2	***	***	P	
Cordylus tasmani	Tasman's Girdled Lizard	**VU**	2	2	**	**		SARCA in litt.
Pseudocordylus m. microlepidotus	Cape Crag Lizard	LC	0	2	*	*		
Family Agamidae	**agamas**							
Agama atra	Southern Rock Agama	LC	0	1	***	***	P	
Family Chamaeleonidae	**chameleons**							
Bradypodion ventrale	Eastern Cape Dwarf Chameleon	LC	0	2	**	**	P	
Bradypodion taeniabronchum	Elandsberg Dwarf Chameleon	**EN**	2	2	***	*		Found in Langefonteinvlei (4 specimens)
Family Varanidae	**monitor lizards**							
Varanus albigularis albigularis	Rock or White-throated Monitor	LC	0	0	*	*		
Varanus niloticus	Nile or Water Monitor	LC	0	0	*	*		
Family Gekkonidae	**geckos**							
Afrogecko porphyreus	Marbled Leaf-toed Gecko	LC	0	2	***	**		
Cryptactites peringueyi	Péringuey's Coastal Leaf-toed Gecko	**CR**	2	2	*	*		SARCA in litt. Known from Krom River estuary.
Hemidactylus mabouia	Moreau's Tropical House Gecko	LC			*	*		Introduced to this region
Lygodactylus capensis capensis	Cape Dwarf Gecko	LC	0	0	*	*		Introduced to this region
Pachydactylus maculatus	Spotted Gecko	LC	0	1	***	**	P	

Table 3: Thyspunt mammals (updated with September 2009 findings). 0 = not endemic, 1 = near-endemic, 2 = endemic; EC = Eastern Cape; SA = South Africa.

Scientific name	Common name	Red List 2004	Endemic EC	Endemic SA	Thyspunt Coast	Thyspunt Inland	Swanepoel 1986* P=probable	Comments
Family Chrysochloridae	**golden moles**							
Amblysomus corriae	Fynbos Golden Mole	**NT**	0	2	**	**		Golden mole observed, but ID not confirmed
Amblysomus hottentotus	Hottentot Golden Mole	**DD**	0	2	*	*	P	Golden mole observed, but ID not confirmed
Chlorotalpa duthieae	Duthie's Golden Mole	LC	0	2	**	**	P	Golden mole observed, but ID not confirmed

Family Macroscelididae	**elephant shrews**							
Macroscelides proboscideus	Round-eared Elephant-Shrew	LC	0	0		*		
Family Orycteropodidae	**Aardvark**							
Orycteropus afer	Aardvark	LC	0	0	*	***	P	Characteristic burrows observed
Family Procaviidae	**hyraxes**							
Procavia capensis	Rock Hyrax	LC	0	0	***	***	P	
Family Leporidae	**hares, rabbits & rock rabbits**							
Lepus saxatilis	Scrub Hare	LC	0	0	**	**	P	Observed at Oyster Bay
Pronolagus saundersiae	Hewitt's Red Rock Rabbit	LC	0	2		*		
Family Bathyergidae	**mole-rats**							
Cryptomys hottentotus	African Mole-Rat	LC	0	0	**	**	P	One or both smaller mole rats may occur
Georychus capensis	Cape Mole-Rat	LC	0	2	**	**	P	One or both smaller mole rats may occur
Family Hystricidae	**porcupines**							
Hystrix africaeaustralis	Cape Porcupine	LC	0	0	***	***	P	
Family Myoxidae	**dormice**							
Graphiurus murinus	Woodland Dormouse	LC	0	2	***	*	P	
Graphiurus ocularis	Spectacled Dormouse	LC	0	0	*	*	P	
Family Muridae	**rats & mice**							
Dendromus melanotis	Grey Climbing Mouse	LC	0	0	**	**	P	
Dendromus mesomelas	Brant's Climbing Mouse	LC	0	0	**	**	P	
Mastomys natalensis	Natal Multimammate Mouse	LC	0	0	*	*		
Micaelamys namaquensis	Namaqua Rock Mouse	LC	0	0	**	**	P	
Mus minutoides	Pygmy Mouse	LC	0	0	**	**	P	
Mus musculus	House Mouse	(alien)	0	0	*	**	P	
Otomys irroratus	Vlei Rat	LC	0	0	***	**	P	
Otomys unisulcatus	Bush Vlei Rat	LC	0	2	*	*		
Rattus rattus	House Rat	(alien)	0	0	*	**	P	
Rhabdomys pumilio	Four-Striped Grass Mouse	LC	0	0	***	**	P	
Saccostomus campestris	Pouched Mouse	LC	0	0	**	**	P	
Family Cercopithecidae	**baboons & monkeys**							
Cercopithecus pygerythrus	Vervet Monkey		0	0	***	***	P	D. Papenfus, pers. comm. 2008
Papio cynocephalus ursinus	Chacma Baboon	LC	0	0	*	**		
Family Soricidae	**shrews**							
Crocidura cyanea	Reddish-Grey Musk Shrew	**DD**	0	0	***	**	P	
Crocidura flavescens	Greater Red Musk Shrew	**DD**	0	0	***	**	P	
Myosorex varius	Forest Shrew	**DD**	0	1	**	**	P	

Family Pteropodidae	**fruit-bats**							
Epomorphorus wahlbergi	Wahlberg's Epauletted Fruit-bat	LC	0	0	*	*	P	
Family Emballonuridae	**tomb bats**							
Taphozous mauritianus	Mauritian Tomb Bat	LC	0	0	*	*	P	
Family Molossidae	**free-tailed bats**							
Tadarida aegyptiaca	Egyptian Free-Tailed Bat	LC	0	0	**	**	P	
Family Vespertilionidae	**vesper bats**							
Neoromicia capensis	Cape Serotine Bat	LC	0	0	*	*	P	
Family Nycteridae	**slit-faced bats**							
Nycteris thebaica	Egyptian Slit-Faced Bat	LC	0	0	**	**	P	
Family Felidae	**cats**							
Caracal caracal	Caracal	LC	0	0	***	**	P	D. Papenfus, pers. comm. 2008
Felis cattus	Domestic Cat (feral)	(feral alien)	0	0	**	**		
Felis silvestris	African Wild Cat	LC	0	0	**	**	P	
Panthera pardus	Leopard	LC	0	0	***	**	P	G. Greeff, pers. Comm. 2008
Family Viverridae	**genets**							
Genetta genetta	Small-Spotted Genet	LC	0	0	***	**	P	
Genetta tigrina	South African Large-Spotted Genet	LC	0	0	**	**	P	
Family Herpestidae	**suricates & mongooses**							
Atilax paludinosus	Marsh Mongoose	LC	0	0	**	**	P	
Cynictis penicillata	Yellow Mongoose	LC	0	0	*	***	P	
Galerella pulverulenta	Cape Grey Mongoose	LC	0	0	***	**	P	
Herpestes ichneumon	Large Grey Mongoose	LC	0	0	***	**	P	
Family Canidae	**foxes & jackals**							
Canis mesomelas	Black-Backed Jackal	LC	0	0	*	*	P	
Canis vulgaris	Domestic Dog (feral)	(feral alien)	0	0	**	**		
Otocyon megalotis	Bat-Eared Fox	LC	0	0	**	**		Observed near Oyster Bay (J. Marx, pers. comm. 2008)
Vulpes chama	Cape Fox	LC	0	0	*	*		
Family Mustelidae	**otters, Honey Badger, weasels & polecats**							
Aonyx capensis	African Clawless Otter	LC	0	0	***	**	P	
Ictonyx striatus	Striped Polecat	LC	0	0	**	**	P	
Mellivora capensis	Honey Badger	**NT**	0	0	***	*	P	P. Emms, pers. comm. 2008
Poecilogale albinucha	African Striped Weasel	**DD**	0	0	*	**	P	
Family Suidae	**pigs**							

Potamochoerus larvatus	bushpig	LC	0	0	***	***	P	D. Papenfus, G. Seeney, pers. comm. 2008
Family Bovidae	**antelope**							
Philantomba monticola	Blue Duiker	**VU**	0	0	**	*	P	
Raphicerus campestris	Steenbok	LC	0	0	*	*		
Raphicerus melanotis	Cape Grysbok	LC	0	2	***	**	P	D. Papenfus, pers. comm. 2008
Sylvicapra grimmia	Common Duiker	LC	0	0	***	**	P	
Tragelaphus scriptus	Bushbuck	LC	0	0	***	**	P	

* Swanepoel (1986) listed many other species which are not considered to be possible in the district.

Table 4: Thyspunt birds. The list is based on the bird atlas list for grid cell 3424BA Kruisfontein (Southern African Bird Atlas Project 1, Animal Demography Unit). The reporting rate is a percentage and indicates the frequency at which the species was recorded during SABAP1. Breeding records are those obtained during SABAP1. Species observed during a site visit are indicated as confirmed (***), separately for the coastal and inland portions of the site. All species listed should be regarded as of possible to probable occurrence on site, even if not confirmed. Generally speaking, and given the diversity of habitats on site, the higher the reporting rate, the more likely the species is to occur on site. Updated with September 2009 findings.

Species number	**Common name**	**Scientific name**	**Red Listing**	**Reporting rate**	**Breeding record**	**Coastal area**	**Inland area**	**Comments**
1	Common Ostrich	*Struthio camelus*		19.6				
3	African Penguin	*Spheniscus demersus*	**VU**	5.9				
8	Little Grebe	*Tachybaptus ruficollis*		25.5				
37	Sooty Shearwater	*Puffinus griseus*		2.0				
53	Cape Gannet	*Morus capensis*	**VU**	31.4		***		
55	White-breasted Cormorant	*Phalacrocorax carbo*		41.2		***		
56	Cape Cormorant	*Phalacrocorax capensis*	**NT**	21.6		***		
58	Reed Cormorant	*Phalacrocorax africanus*		31.4		***	***	
60	African Darter	*Anhinga rufa*		7.8				
62	Grey Heron	*Ardea cinerea*		13.7				
63	Black-headed Heron	*Ardea melanocephala*		47.1		***	***	
65	Purple Heron	*Ardea purpurea*		2.0				
67	Little Egret	*Egretta garzetta*		9.8		***		
68	Yellow-billed Egret	*Egretta intermedia*		2.0				
71	Cattle Egret	*Bubulcus ibis*		60.8	Y		***	
81	Hamerkop	*Scopus umbretta*		9.8				

83	White Stork	*Ciconia ciconia*		23.5				
91	African Sacred Ibis	*Threskiornis aethiopicus*		13.7			***	
94	Hadeda Ibis	*Bostrychia hagedash*		43.1			***	
95	African Spoonbill	*Platalea alba*		3.9			***	
101	White-backed Duck	*Thalassornis leuconotus*		2.0				
102	Egyptian Goose	*Alopochen aegyptiacus*		56.9	Y		***	
103	South African Shelduck	*Tadorna cana*		7.8				
104	Yellow-billed Duck	*Anas undulata*		27.5		***	***	
105	African Black Duck	*Anas sparsa*		2.0				
108	Red-billed Teal	*Anas erythrorhyncha*		5.9	Y		***	
112	Cape Shoveler	*Anas smithii*		3.9				
116	Spur-winged Goose	*Plectropterus gambensis*		23.5		***	***	
118	Secretarybird	*Sagittarius serpentarius*	**NT**	3.9				Vulnerable to collisions with transmission lines.
888	Yellow-billed Kite	*Milvus aegyptius*		2.0				
127	Black-shouldered Kite	*Elanus caeruleus*		41.2				
136	Booted Eagle	*Aquila pennatus*		2.0				
140	Martial Eagle	*Polemaetus bellicosus*	**VU**	2.0				May nest on pylons.
148	African Fish-Eagle	*Haliaeetus vocifer*		7.8				
149	Steppe Buzzard	*Buteo vulpinus*		31.4				
152	Jackal Buzzard	*Buteo rufofuscus*		33.3				
160	African Goshawk	*Accipiter tachiro*		9.8				
165	African Marsh-Harrier	*Circus ranivorus*	**VU**	19.6		***	***	Wetland species, especially large reedbeds.
168	Black Harrier	*Circus maurus*	**NT**	3.9				Nests in low scrub.
169	African Harrier-Hawk	*Polyboroides typus*		2.0				
170	Osprey	*Pandion haliaetus*		2.0				
172	Lanner Falcon	*Falco biarmicus*	**NT**	2.0				
181	Rock Kestrel	*Falco rupicolus*		5.9			***	
192	Red-winged Francolin	*Scleroptila levaillantii*		2.0				
198	Red-necked Spurfowl	*Pternistis afer*		31.4		***		
200	Common Quail	*Coturnix coturnix*		7.8			***	
203	Helmeted Guineafowl	*Numida meleagris*		35.3			***	
208	Blue Crane	*Anthropoides paradiseus*	**VU**	13.7		***		Vulnerable to collisions with transmission lines.
213	Black Crake	*Amaurornis flavirostris*		2.0				
226	Common Moorhen	*Gallinula chloropus*		11.8	Y			
228	Red-knobbed Coot	*Fulica cristata*		17.6	Y			
231	Denham's Bustard	*Neotis denhami*	**VU**	15.7			***	Species of grasslands and low scrub. Vulnerable to

								collisions with transmission lines and disturbance.
233	White-bellied Korhaan	*Eupodotis senegalensis*	**VU**	3.9				Grassland species.
240	African Jacana	*Actophilornis africanus*		2.0				
244	African Black Oystercatcher	*Haematopus moquini*	**NT**	35.3	Y	***		Coastal species.
245	Common Ringed Plover	*Charadrius hiaticula*		2.0				
246	White-fronted Plover	*Charadrius marginatus*		29.4		***		
248	Kittlitz's Plover	*Charadrius pecuarius*		11.8		***		
249	Three-banded Plover	*Charadrius tricollaris*		29.4	Y	***		
254	Grey Plover	*Pluvialis squatarola*		2.0				
255	Crowned Lapwing	*Vanellus coronatus*		52.9			***	
257	Black-winged Lapwing	*Vanellus melanopterus*	**NT**	19.6	Y			Grassland species.
258	Blacksmith Lapwing	*Vanellus armatus*		39.2		***	***	
262	Ruddy Turnstone	*Arenaria interpres*		3.9				
264	Common Sandpiper	*Actitis hypoleucos*		9.8				
266	Wood Sandpiper	*Tringa glareola*		9.8				
269	Marsh Sandpiper	*Tringa stagnatilis*		5.9				
270	Common Greenshank	*Tringa nebularia*		7.8				
272	Curlew Sandpiper	*Calidris ferruginea*		5.9				
274	Little Stint	*Calidris minuta*		3.9				
281	Sanderling	*Calidris alba*		5.9				
284	Ruff	*Philomachus pugnax*		3.9				
286	African Snipe	*Gallinago nigripennis*		2.0				
290	Common Whimbrel	*Numenius phaeopus*		3.9				
294	Pied Avocet	*Recurvirostra avosetta*		9.8				
295	Black-winged Stilt	*Himantopus himantopus*		7.8				
297	Spotted Thick-knee	*Burhinus capensis*		11.8		***		
298	Water Thick-knee	*Burhinus vermiculatus*		9.8		***		
300	Temminck's Courser	*Cursorius temminckii*		5.9				
312	Kelp Gull	*Larus dominicanus*		47.1		***		
322	Caspian Tern	*Sterna caspia*	**NT**	2.0				
324	Swift Tern	*Sterna bergii*		13.7		***		
326	Sandwich Tern	*Sterna sandvicensis*		17.6		***		
327	Common Tern	*Sterna hirundo*		17.6		***		
328	Arctic Tern	*Sterna paradisaea*		3.9				
339	White-winged Tern	*Chlidonias leucopterus*		2.0				

348	Rock Dove	*Columba livia*		9.8				
349	Speckled Pigeon	*Columba guinea*		52.9		***		
350	African Olive-Pigeon	*Columba arquatrix*		2.0				
352	Red-eyed Dove	*Streptopelia semitorquata*		56.9		***		
354	Cape Turtle-Dove	*Streptopelia capicola*		64.7		***	***	
355	Laughing Dove	*Streptopelia senegalensis*		25.5		***		
356	Namaqua Dove	*Oena capensis*		3.9				
358	Emerald-spotted Wood-Dove	*Turtur chalcospilos*		13.7				
359	Tambourine Dove	*Turtur tympanistria*		2.0				
370	Knysna Turaco	*Tauraco corythaix*		2.0				
377	Red-chested Cuckoo	*Cuculus solitarius*		2.0				
382	Jacobin Cuckoo	*Clamator jacobinus*		3.9				
385	Klaas's Cuckoo	*Chrysococcyx klaas*		2.0				
386	Diderick Cuckoo	*Chrysococcyx caprius*		3.9	Y			
391	Burchell's Coucal	*Centropus burchellii*		2.0		***		
392	Barn Owl	*Tyto alba*		2.0				
401	Spotted Eagle-Owl	*Bubo africanus*		2.0		***		
405	Fiery-necked Nightjar	*Caprimulgus pectoralis*		2.0		***	***	
412	African Black Swift	*Apus barbatus*		3.9				
415	White-rumped Swift	*Apus caffer*		25.5		***		
416	Horus Swift	*Apus horus*		2.0				
417	Little Swift	*Apus affinis*		5.9				
418	Alpine Swift	*Tachymarptis melba*		5.9		***		
424	Speckled Mousebird	*Colius striatus*		51.0		***		
426	Red-faced Mousebird	*Urocolius indicus*		3.9		***		
428	Pied Kingfisher	*Ceryle rudis*		19.6		***		
429	Giant Kingfisher	*Megaceryle maximus*		19.6		***		
430	Half-collared Kingfisher	*Alcedo semitorquata*	**NT**	5.9				Found at wetlands and rivers.
431	Malachite Kingfisher	*Alcedo cristata*		3.9				
435	Brown-hooded Kingfisher	*Halcyon albiventris*		19.6				
446	European Roller	*Coracias garrulus*		2.0				
451	African Hoopoe	*Upupa africana*		17.6		***		
480	Ground Woodpecker	*Geocolaptes olivaceus*		5.9				
484	Knysna Woodpecker	*Campethera notata*	**NT**					Not recorded during SABAP, but recently by M. Cunningham
494	Rufous-naped Lark	*Mirafra africana*		3.9				

495	Cape Clapper Lark	*Mirafra apiata*		3.9				
500	Eastern Long-billed Lark	*Certhilauda curvirostris*		2.0				
507	Red-capped Lark	*Calandrella cinerea*		25.5			***	
518	Barn Swallow	*Hirundo rustica*		35.3				
520	White-throated Swallow	*Hirundo albigularis*		15.7				
523	Pearl-breasted Swallow	*Hirundo dimidiata*		2.0				
526	Greater Striped Swallow	*Hirundo cucullata*		33.3		***		
527	Lesser Striped Swallow	*Hirundo abyssinica*		5.9				
529	Rock Martin	*Hirundo fuligula*		27.5				
530	Common House-Martin	*Delichon urbicum*		5.9				
533	Brown-throated Martin	*Riparia paludicola*		7.8				
534	Banded Martin	*Riparia cincta*		3.9				
536	Black Saw-wing	*Psalidoprocne holomelaena*		9.8				
541	Fork-tailed Drongo	*Dicrurus adsimilis*		58.8		***		
545	Black-headed Oriole	*Oriolus larvatus*		3.9				
547	Cape Crow	*Corvus capensis*		62.7			***	
548	Pied Crow	*Corvus albus*		5.9				
550	White-necked Raven	*Corvus albicollis*		7.8				
566	Cape Bulbul	*Pycnonotus capensis*		54.9	Y	***	***	
569	Terrestrial Brownbul	*Phyllastrephus terrestris*		11.8		***		
572	Sombre Greenbul	*Andropadus importunus*		62.7		***	***	
577	Olive Thrush	*Turdus olivaceous*		13.7		***		
587	Capped Wheatear	*Oenanthe pileata*		2.0				
589	Familiar Chat	*Cercomela familiaris*		9.8				
596	African Stonechat	*Saxicola torquatus*		60.8	Y	***	***	
601	Cape Robin-Chat	*Cossypha caffra*		52.9	Y	***		
621	Chestnut-vented Tit-Babbler	*Parisoma subcaeruleum*		2.0				
631	African Reed-warbler	*Acrocephalus baeticatus*		_			***	
635	Lesser Swamp-Warbler	*Acrocephalus gracilirostris*		2.0			***	
638	Little Rush-Warbler	*Bradypterus baboecala*		7.8		***	***	
640	Knysna Warbler	*Bradypterus sylvaticus*	**VU**	2.0				In dense thickets at edge of forests.
643	Willow Warbler	*Phylloscopus trochilus*		3.9				
645	Bar-throated Apalis	*Apalis thoracica*		47.1	Y	***	***	
648	Yellow-breasted Apalis	*Apalis flavida*		2.0				
657	Green-backed	*Camaroptera brachyura*		3.9		***		

	Camaroptera					
661	Cape Grassbird	*Sphenoeacus afer*	21.6	Y	***	***
664	Zitting Cisticola	*Cisticola juncidis*	7.8			***
666	Cloud Cisticola	*Cisticola textrix*	3.9			
669	Grey-backed Cisticola	*Cisticola subruficapilla*	11.8			***
677	Levaillant's Cisticola	*Cisticola tinniens*	27.5	Y	***	***
681	Neddicky	*Cisticola fulvicapilla*	41.2		***	
686	Karoo Prinia	*Prinia maculosa*	45.1	Y	***	***
690	African Dusky Flycatcher	*Muscicapa adusta*	5.9		***	
698	Fiscal Flycatcher	*Sigelus silens*	45.1	Y	***	
700	Cape Batis	*Batis capensis*	15.7		***	
710	African Paradise-Flycatcher	*Terpsiphone viridis*	7.8			
711	African Pied Wagtail	*Motacilla aguimp*	3.9			
713	Cape Wagtail	*Motacilla capensis*	58.8	Y	***	***
716	African Pipit	*Anthus cinnamomeus*	29.4	Y		***
718	Plain-backed Pipit	*Anthus leucophrys*	7.8			
727	Cape Longclaw	*Macronyx capensis*	35.3	Y		***
732	Common Fiscal	*Lanius collaris*	80.4	Y	***	***
736	Southern Boubou	*Laniarius ferrugineus*	43.1		***	***
740	Black-backed Puffback	*Dryoscopus cubla*	9.8		***	
742	Southern Tchagra	*Tchagra tchagra*	5.9			
746	Bokmakierie	*Telophorus zeylonus*	51.0	Y	***	***
750	Olive Bush-Shrike	*Telophorus olivaceus*	9.8		***	
757	Common Starling	*Sturnus vulgaris*	56.9	Y		***
759	Pied Starling	*Spreo bicolor*	62.7	Y		
760	Wattled Starling	*Creatophora cinerea*	13.7			
764	Cape Glossy Starling	*Lamprotornis nitens*	23.5			
768	Black-bellied Starling	*Lamprotornis corruscus*	5.9			
769	Red-winged Starling	*Onychognathus morio*	37.3		***	
773	Cape Sugarbird	*Promerops cafer*	9.8			
775	Malachite Sunbird	*Nectarinia famosa*	19.6		***	
777	Orange-breasted Sunbird	*Anthobaphes violacea*	5.9			
785	Greater Double-collared Sunbird	*Cinnyris afer*	31.4		***	
792	Amethyst Sunbird	*Chalcomitra amethystina*	13.7		***	
793	Collared Sunbird	*Hedydipna collaris*	2.0			

796	Cape White-eye	*Zosterops capensis*	31.4		***	***
801	House Sparrow	*Passer domesticus*	37.3	Y	***	
803	Cape Sparrow	*Passer melanurus*	5.9			
804	Southern Grey-headed Sparrow	*Passer diffusus*	9.8			
810	Spectacled Weaver	*Ploceus ocularis*	5.9	Y		
811	Village Weaver	*Ploceus cucullatus*	2.0	Y		
813	Cape Weaver	*Ploceus capensis*	54.9	Y	***	
814	Southern Masked-Weaver	*Ploceus velatus*	7.8	Y		
824	Southern Red Bishop	*Euplectes orix*	11.8			***
827	Yellow Bishop	*Euplectes capensis*	47.1	Y	***	
832	Long-tailed Widowbird	*Euplectes progne*	2.0			
846	Common Waxbill	*Estrilda astrild*	35.3		***	
860	Pin-tailed Whydah	*Vidua macroura*	21.6		***	
872	Cape Canary	*Serinus canicollis*	43.1		***	
877	Brimstone Canary	*Crithagra sulphuratus*	45.1	Y	***	
879	White-throated Canary	*Crithagra albogularis*	2.0			
881	Streaky-headed Seedeater	*Crithagra gularis*	35.3			

APPENDIX 4

AN INTRODUCTION TO ECOLOGICAL CORRIDORS

This is a brief introduction to the concept of ecological corridors. The target audience includes landowners, developers, planners, engineers, EIA practitioners and evaluators.

The environmental consultant is aware of two categories of factors when evaluating a site. The first category involves the species and habitats that occur on site, and their spatial distribution on the site. These are referred to as "pattern" factors. The second category involves the ecological systems, processes and phenomena that sustain or threaten that pattern of species and habitats – things like fire, seasonal flooding, drainage, migration routes, interfaces and connections between habitat types, presence of alien species, harvesting of veld products, etc. Collectively, these are referred to as "process" factors. One of the ecological processes that sustains natural communities of plants and animals is the ability to move through a landscape. It is this process of movement that creates the need for ecological corridors.

A. The concept

In human societies and economies, the need for connections between communities and centres of production is accepted as fundamental to normal human activity and economic progress – hence our infrastructural networks of roads, rail, canals, etc. Strange then that we tend to overlook an analogous need for connectivity in the natural world, especially for mobile animals.

The concept of an ecological corridor is of a strip of natural habitat connecting two otherwise separated areas of natural habitat. The purpose of an ecological corridor is to provide an ecological connection between separate areas, and to permit ecological processes to occur across the connected areas. The most obvious of these processes is movement of individuals or their propagules (e.g., seeds) between areas, thus preventing isolation of populations.

Effective ecological corridors have the following features:

1. **Corridors connect relatively large areas of natural habitat**. It is important that a corridor not be a dead end or *cul de sac* because it then has the potential to do more harm than good by encouraging animals to move away from their core habitats and home ranges and expose themselves to danger.
2. **Corridors comprise strips of natural habitat**. Natural habitats are necessary to provide the right kind of environment to allow species to survive in, and move through, a corridor. If unaltered natural habitat is not available, semi-natural habitats are better than nothing, and can be adequate for at least some species.
3. **Corridors are continuous, unbroken strips of habitat**. It is important to have unbroken continuity, because even small breaks in habitat can be a barrier to some species. However, if a break, such as a road, is unavoidable, a corridor can still have value for some relatively mobile species, e.g., flying insects and birds.
4. **Corridors are wide enough to minimize the impacts of disturbance.** Animals need to feel safe and unexposed when moving through a corridor, therefore there needs to be sufficient cover, but also not so dense that some animals are unable to move through it. Buffer zones on both sides of the corridor help to minimize the negative effects of disturbing activities occurring outside of the corridor.
5. **Corridors should be shaped to encourage use by animals.** In addition to point 4 (above), this means that they are (a) wide enough to include a range of relevant habitat types, to suit the range of animals that are expected to use the corridor, and (b) have relatively wide entrances to help animals to find the corridor, and to disperse safely from the corridor at the other end. Narrow entrances/exits tend to create situations where animals can be ambushed by predators or have to compete with conspecific individuals, and these circumstances can deter animals from using the corridor. Entrances can be equipped with

fences or walls to guide animals towards the corridor and away from neighbouring hazardous areas. (See diagram of corridor models.)

6. **Corridors are managed as integral parts of protected areas**. If corridors are to be useful to a wide range of plants and animals, they need to be managed as well as the protected natural habitats that they connect. Some small and slow-moving animals, and plants, may literally take generations to move through a corridor from one area to another. If the corridor is not sensitively managed, such slow ecological processes cannot be successfully completed.

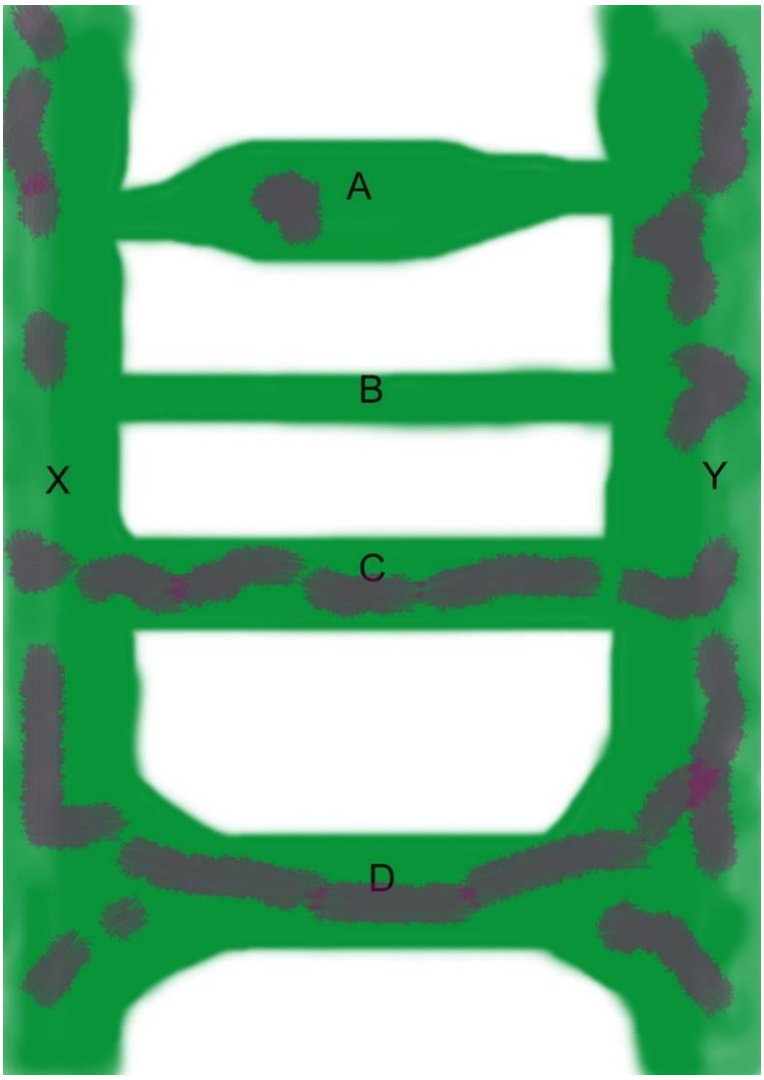


Figure 1: Models of corridors between conservation areas X and Y, across an inhospitable area (white). There are two natural habitat types present (green and purple). Model B is too narrow and does not include both habitat types. Model A has narrow entrances and has only a patch of the purple habitat in the centre, encouraging residency rather than movement through the corridor. Corridor C is a minimal adequate option, but its entrances are not ideal. Model D has additional width to minimize edge effects, and has wide entrances which make it easy for animals to find the corridor and to disperse safely from it.

B. The need

Given that individual organisms living in or moving through an ecological corridor are often exposed to greater risk that those living in more extensive natural habitats at either end of the corridor, what is the justification for encouraging such exposure? The arguments in favour of providing corridors include the following:

a) **Resources:** The areas connected by a corridor may contain different resources (food, water, shelter, potential mates), or differ in the seasonal availability of resources, so that there are important advantages to animals in being able to move between areas.

b) **Catastrophes:** Catastrophic events (e.g., fire, flood, disease) may wipe out the population of a species in one area. Unless there is an ecological connection to other populations in other areas, recolonization of the affected area would not be possible. In this way, corridors can help to prevent the local extinction of species.
c) **Inbreeding:** Small, isolated populations are vulnerable to the negative effects of inbreeding. Opportunities to mix with neighbouring populations can counteract this effect and promote a genetically healthy population.
d) **Migration:** Some animals need to migrate regularly between areas as part of their natural seasonal cycle (e.g., migration of toads to and from their wetlands breeding sites, or the altitudinal migration of many birds to exploit seasonal availability of food at different altitudes). Corridors assist such migratory movements.
e) **Dispersal:** The offspring of animals and plants have to find their own space in which to live. Amongst animals, parents will often aggressively drive their offspring out of their natal territories. Ecological corridors enhance the chances of offspring finding their own territories.
f) **Adaptation:** If there are long-term changes in habitats, as a result of climate change, for example, it may become difficult or impossible for a species to survive in its original distribution range. If there are no suitable neighbouring habitats, the species may become locally extinct. However, if there are ecological connections to more suitable habitats nearby, the species has the opportunity to move and to adapt over a long period of time. Ecological corridors can facilitate such long-term evolutionary processes.

C. The practice

The practice of creating ecological corridors is not an exact science because circumstances differ greatly from place to place, and the ecological requirements of the hundreds of affected species are all different. Added to these factors is the pressure on the environmental consultant to strike a compromise between the ecologically ideal scenario from a nature conservation perspective and the economically desirable scenario from the developer's perspective.

The consultant's objective

In general, developments cause fragmentation of natural habitats and communities. In other words, instead of a natural landscape in which habitats are continuous and linked, a patchwork is created in which the patches are isolated from each other and organisms are not able to move freely from one patch to the next. The planning objective, therefore, should be to create connections that allow inter-patch movements to occur.

The environmental consultant will recommend the creation of ecological corridors that create such connections, and he will try to specify routes and dimensions for these corridors that he believes will be appropriate for the species that occur locally. He will recommend that the habitats in the corridors be managed so as to maintain the natural habitats within them.

Corridors and watercourses

Because watercourses and wetlands are important ecological features in all landscapes, it is often convenient and appropriate to create ecological corridors around the system of drainage lines that already exists in the landscape. When this approach is adopted, the consultant will usually recommend setting aside a buffer zone beyond the channel of the watercourse itself. The reasons for this are:

- Provision must be made for occasional floods. The 50-year flood line should be regarded as an absolute minimum, and the 100-year flood line as the preferred setback line.
- To function as an ecological corridor, the drainage channel alone cannot provide all the habitats necessary for all species, therefore sufficient adjacent dry-land habitats must be available.

- The impacts of disturbance on species within the corridor, including visual, auditory and physical disturbance, are reduced in proportion to the width of a buffer zone around the corridor.
- The edges of habitats are exposed to physical factors, e.g., wind, dehydration, dust, etc., that can reduce their vigour. Buffer zones are intended to ensure that such “edge effects” are not experienced throughout the whole width of a corridor.

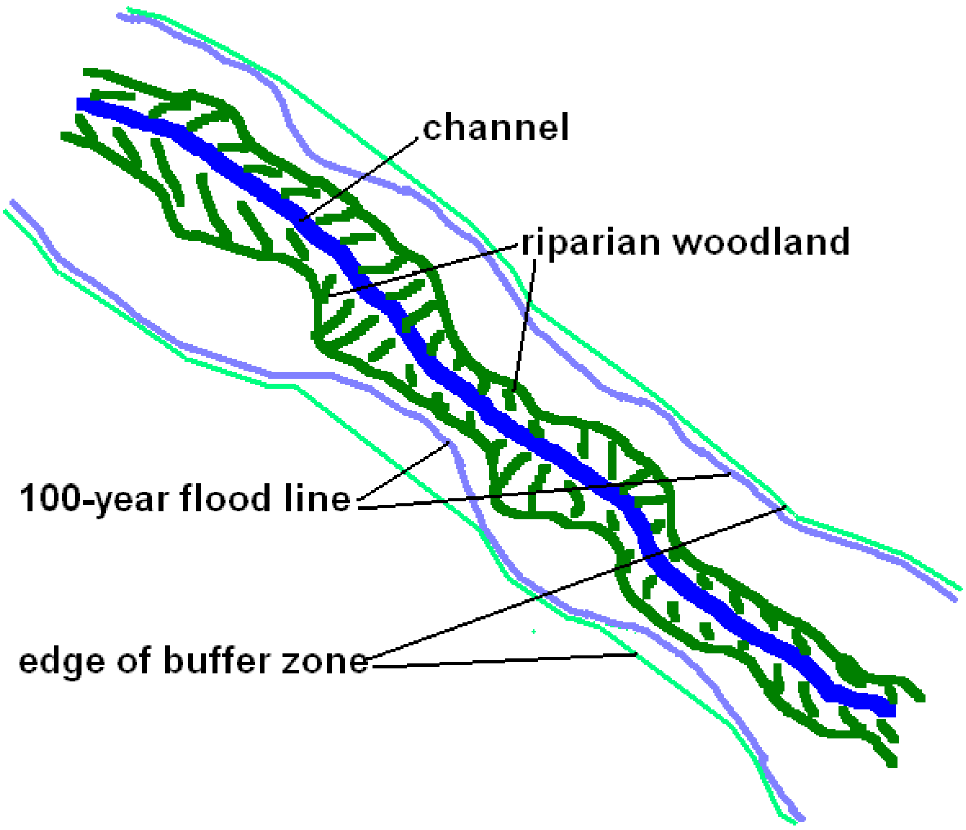


Figure4: Conceptual diagram of an ecological corridor along a watercourse. Note that the edge of the buffer zone can, for the most part, correspond to the 100-year flood line, but where this line does not allow for the recommended width of the corridor, the edge of the buffer zone should be beyond the flood line and allow a minimum corridor width of 100 m.

Corridors and multiple uses

If the width of ecological corridors is generous, potential for other uses of the land is enhanced. Such uses should be of a low-impact nature such that they do not interfere substantively with the primary ecological function of the corridor. Depending on corridor width and local circumstances, such additional uses may include:

- recreational trails for walking, hiking, jogging and birding
- recreational cycling trails
- recreational horse-riding trails
- educational facilities such as interpretive signage and centres, bird hides, viewing platforms
- sustainable harvesting of natural products, e.g., reeds and grasses
- routes for utilities, such as sewerage, water supply pipes and power lines (Such utilities should preferably be underground and habitats should be restored on the surface.)
- fire breaks
- storm water drainage.

Corridors and land value

By bringing green habitats into the heart of built environments, ecological corridors have the potential to add aesthetic value to properties and thereby boost their financial value. Developers and planners are increasingly aware of this very real potential.

James Harrison
Updated July 2009

APPENDIX 5

NOTES ON CULVERTS AND OVERPASSES

The objective is to provide wildlife with an alternative to crossing a busy road which poses a great danger to them as they move between habitats. Such movement is essential as conditions change from season to season, year to year, and with the progress of development. As species breed, their young offspring need to disperse to find territories of their own, and this also necessitates movement between areas.

Culverts

Culverts provide animals with an alternative route for crossing a road. Culverts intended for this purpose should have the following *minimum* characteristics:

- **High enough:** The culvert should accommodate the tallest animal likely to use it, without being cramped. In this case, the tallest animal is likely to be a small antelope, therefore a height of 1.5 m should be adequate.
- **Wide enough:** The culvert should be as wide as possible – the wider the better. A width of 3 m should be regarded as a minimum.
- **Flat-bottomed:** The floor of the culvert should be flat, therefore box-culverts are the most suitable. Pipe culverts can be used if the diameter is very large – at least 1.5 m – and the bottom of the pipe is covered with soil to provide a flat surface.
- **Natural substrate:** The floor of the culvert should have natural soil covering it to minimize the "strangeness" of the interior of the culvert. If the bottom of the culvert is 2-3 cm lower than ground level, soil will naturally fall into the culvert and be spread along its length by wind and water.
- **Easy access:** The approach to the culvert, at both ends, should be level and clear of any obstructions. Any step up or step down to the floor of the culvert will be a severe deterrent to its use, especially by small creatures. Similarly, dense growth of shrubs and grass, or accumulated debris, will tend to prevent animals from using the culvert. Dense growth around the entrances will provide cover for predators which will deter prey species from using that route.
- **Sufficient alternatives:** The more culverts the better because they will provide alternative routes with slightly different features which are likely to be more or less attractive to different species.

Other features: There are additional features which will improve the effectiveness of culverts as alternative routes for animals to cross roads. While these features will add to the cost and effort required to install culverts, they should be regarded as essential in situations where a serious effort is to be made to conserve local wildlife:

- **Guiding walls:** Low walls on either side of the entrance to a culvert will help to guide small creature towards the culvert, and prevent them from crossing the surface of the road. Such walls can be "Vibracrete" walls, one or two slats high. They should be angled slightly inward towards the entrance, and should be at least 25 m in length, on either side.
- **Skylights:** Many animals will not enter a small, confined space, especially if it is not open to the sky. In addition, some animals use the sky to navigate, and

therefore will not go where they cannot see the sky. For these reasons, the ceiling of the culverts should preferably be transparent. The best way to achieve this is by using a steel grid as the roof of the culvert. If it is not practical to use such a grid for the whole length of the culvert, shorter grids can be placed at intervals along its length.

- **Raised shelves:** In situations where the floor of a culvert is likely to be flooded for extended periods, raised shelves on the side walls should be installed to provide a dry route for animals that will not be able to swim through the culvert.
- **Security fences:** If the culverts are considered to present a security risk, it may be necessary to fit the entrances with security fencing. Naturally, this is undesirable from the point of view of the animals, but it may be unavoidable for security reasons.

<u>Overpasses</u>

It should be noted that an alternative to culverts is overpasses. These are essentially bridges which have their surfaces covered with soil and natural vegetation such that animals are encouraged to use them to cross a road. Overpasses are preferable to culverts in many ways, but are also much more expensive and visually intrusive.

PLEASE VIEW THE FOLLOWING ILLUSTRATIONS AND READ THE CAPTIONS.

http://www.fhwa.dot.gov/environment/wildlifeprotection/

When small mammals and amphibians are moving along a stream and come up to a culvert, they have to crawl up the road fill and cross the highway to get around the culvert. Often, they're killed as they try to cross the highway. At numerous highway-stream crossings throughout Oregon - for example, an unnamed tributary of the Siuslaw River west of Eugene - the Oregon Department of Transportation is creating a way for these small animals to go through the culvert rather than around it. Along one side of a culvert spanning the width of the stream, contractors are building a natural rock ledge that's wide enough for both small and medium-sized animals. They're using rock because it's "natural," close to the culvert, and doesn't need to be attached to the culvert wall. Shrews and raccoons have been observed on the ledges, and bobcats, tree frogs, western pond turtles, and other species may also be using them to move up and down the stream corridor. They stay dry as they move along the ledge or only get a little wet - and they don't run the risk of a collision with a vehicle on the highway above.

www.umt.edu/urelations/ vision/2004/18tunnels.htm
A shelf-outfitted culvert.

www.redland.qld.gov.au/ plans/Hilliards_Creek_...
Busy roads kill animals moving across the landscape; culverts and overpasses create some opportunities for animals to move along creek corridors in safety.

Bridges can be constructed so as to leave the bamks of watercourses intact as an ecological corridor. (Kruidering A.M, G. Veenbaas, R. Kleijberg, G, Koot, Y. Rosloot, E. van Jaarsveld 2005. Leidraad faunavoorzieningen bij wegen. Delft, Rijkswaterstaat, Dienst Weg- en Waterbouwkunde.)

www.wildlifeandroads.org/ search/search_result...

Copeland South Box Culvert: This wildlife passage was installed in 2005-2006 under US Route 95 in Northern Idaho. Named the Copeland passages, these three box culverts are 4 m tall, 7 m wide, and approximately 43 m long. The three box culverts are within 1.5 miles of each other. As of summer 2007, Wayne Wankinnen of Idaho Fish and Game reports many mammals species photographed using these culverts, including bear and moose. The notable exception is Rocky Mountain elk. They have been photographed within 25 meters of a passage but never has one been photographed using one, or the tracks of elk found in the passages. Photo credit: Patricia Cramer

Figure 14. Arch culvert on German Highway B-30, with rail for amphibians and fence for larger wildlife.

international.fhwa.dot.gov/ wildlife_web.htm

Figure 12. French box culvert overpass (3 m high and 6 m wide).

international.fhwa.dot.gov/ wildlife_web.htm

Figure 23. Dutch box culvert modified with ledge for wildlife.

international.fhwa.dot.gov/ wildlife_web.htm

www.forester.net/ ecm_0311_new.html

This open-bottom box across a seasonal wetland is founded on the ground and not embedded. This box value engineered to replace a concrete structure that was to be embedded 5 ft. into the soft soils.

www.massaudubon.org/.../ restoration.html
This restrictive culvert at Argilla Rd. in Ipswich has now been replaced by a much bigger box culvert,allowing the natural flow of the tide.

www.floridahabitat.org/.../ view
Often submerged - here is the Paynes Prairie ecopassage. When photographed in February 2007 it was dry. A fence on the west side seems to complicate animal passage. Also viewable is the overhanging lip above the passage that is to limit movement of animals onto the road.

www.g8legacy.gc.ca/ english/legacyRundle_how.html
Three examples of successful wildlife underpasses found in the area.

Small-scale underpass for reptiles and amphibians. Note grid construction to admit natural light and encourage use by animals.

www.utexas.edu/.../ wildlife_crossings.html

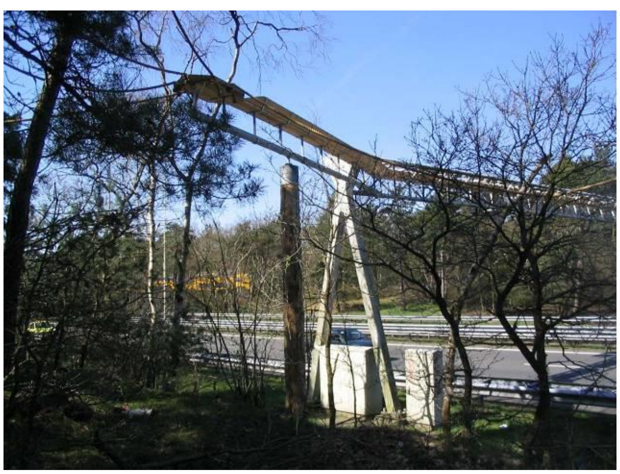
Overpass/ecoduct: Wildlife crossing on the 26 Motorway in the Hardt Forest in Germany. photo: Javier Martinez de Castilla

Ecoduct across highway in the Netherlands. (Kruidering A.M, G. Veenbaas, R. Kleijberg, G, Koot, Y. Rosloot, E. van Jaarsveld 2005. Leidraad faunavoorzieningen bij wegen. Delft, Rijkswaterstaat, Dienst Weg- en Waterbouwkunde.)

Ecoduct across highway in the Netherlands. (Kruidering A.M, G. Veenbaas, R. Kleijberg, G, Koot, Y. Rosloot, E. van Jaarsveld 2005. Leidraad faunavoorzieningen bij wegen. Delft, Rijkswaterstaat, Dienst Weg- en Waterbouwkunde.)


Ecoduct with side walls to screen out visual and noise disturbance.


Small-scale overpass for terrestrial mammals, with a grid to prevent use by people.


Overpass for arboreal mammals.

J.A. Harrison
September 2009

APPENDIX 6

NOTES ON FENCES AND WILDLIFE

Fencing and wildlife is a large and complex topic which will not be comprehensively covered in this appendix. Some of the dangers of fencing to wildlife will be presented, followed by a relatively detailed discussion of security fencing. In South Africa, the challenge for most developments lies in reducing the conflict between the need for security and the need to allow wildlife to move freely in and out of an area.

Fencing and dangers to wildlife

Direct threats: Fencing presents direct threats to wildlife through the dangers of collision and entanglement.

Collisions occur when animals fail to see a fence while running or flying. Visibility is especially problematic for nocturnal flying animals such as owls and bats. Collisions can be immediately fatal, or can lead to injuries or entanglements that are ultimately fatal.

Entanglements occur when animals attempt to jump over or through wire-strand fences, especially barbed-wire fences, or when an animal collides with such a fence. Entanglements tend to cause especially prolonged and agonizing deaths.

When a deer jumps the fence if the hind feet go between the top two wires they will loop over the fence and trap the deer to die a slow death. The answer is to use fence stays between the posts. This is simply a twisted piece of steel wire that keeps the strands of wire at an even distance apart and prevents them from trapping deer. They can be purchased at most fencing supply stores.
http://wildedtx.blogspot.com/2009/02/texas-wildlife-suffer-in-drought.html

Fencing poses many dangers to wildlife in the Macedon Ranges. Kangaroo 'fencehanging' as pictured above is horrific. Sadly it is extremely common in our region, being the second most frequent callout that MRWN rescuers receive.
http://www.mrwn.org.au/v2/index.php?option=com_content&view

A swan entangled in a fence.
http://www.jhwildlife.org/index.php/power_line_marking

An eagle owl entangled in a barbed-wire fence.
http://photo.net/nature-photography-forum/00L7u7

Electrified fences present a real threat to small terrestrial animals that come into contact with low electrified strands of wire.

A mating pair of Western Leopard Toads (Endangered) electrocuted on the bottom wire of an electrified fence. The discolouration, especially of the male, is a result of being "cooked" by the electricity. (Photo by Clifford Dorse.)

An electrocuted python. Note its attempt to defend itself against the "attacker", resulting in its being electrocuted in the mouth. http://www.safetyphoto.co.uk/photo1/electrical_socket/death_by_electrocution.htm

Mitigation of direct threats: Mitigation of direct threats depends largely on improving visibility of wire strands, especially the top strand, and also on design features which help to keep strands apart. In the case of electrified fences, bottom strands of wire should NOT be electrified.

Visibility of fencing can be improved using either plastic or aluminium tags or other types of flagging. Flags should be spaced no wider than 30cm. Note that if you use plastic flagging, these will deteriorate over time and need to be replaced. http://www.mrwn.org.au/v2/index.php?option=com_content&view

Recycled CD's to flag fencing and warn wildlife. http://www.mrwn.org.au/v2/index.php?option=com_content&view

Split poly pipe over fencing wire improves the visibility of the fencing and makes the wire less dangerous. http://www.mrwn.org.au/v2/index.php?option=com_content&view

White electric fence tape, or white plastic-coated wire for fending, improves visibility significantly. http://www.mrwn.org.au/v2/index.php?option=com_content&view

Removing the bottom strands of fencing allows animals to go under the fence rather than over. This is particularly helpful to smaller animals. If you cannot do this for the whole fence-line, even removing the bottom strands at the point where wildlife most commonly crosses the fence will reduce the danger. http://www.mrwn.org.au/v2/index.php?option=com_content&view

Indirect threats: Fencing also presents indirect threats by constraining or altering the movements of animals. Many animals need to cover large areas to forage, find mates and establish new territories away from the territories of their parents. Some animals also carry out regular migrations between their breeding and non-breeding ranges. Fences often make all of these types of movement difficult or impossible or potentially dangerous for animals, leading to disruption of their ecology and reduction of the size and vigour of their local populations.

Security barriers

In South Africa, there is usually a need for a security barrier around the perimeter of erven or secure estates. The threats to wildlife presented by these barriers are mainly of the indirect type, i.e., the disruption of animal movements and ecology, and the long-term effects this has on local populations.

The objective of a security barrier should be to stop human intruders while allowing as much unhindered movement of animals as possible. Several factors will help stop intruders, but height and strength of the barrier are especially important. For animals, the critical factors are visibility and an absence of obstruction at ground level.

Walls: Walls are generally impermeable to wildlife, and therefore unsuitable. However, if apertures/holes are created at ground level, these can provide a way through for small animals. Such apertures should be at least 100 mm x 100 mm, and there should be at least one aperture per 3 m of wall.

"Invisible" walls: Invisible walls/fences are a specialized form of mesh fencing designed for low visibility, and are therefore likely to cause collisions and fatalities. They are also not permeable at ground level. For these reasons, these structures cannot be recommended in situations where movement of wildlife needs, or is likely, to happen.

Mesh fencing: Most of the problems mentioned for "invisible fences" are also applicable to mesh fences. However, if the mesh is large enough, and visibility is mitigated with flags, mesh fences can be acceptably permeable to small animals. Unfortunately, mesh fences are not likely to provide sufficient security because they are easily cut.

Palisade fencing: Palisade fences are generally suitable because they are visible to animals, not easily breached by intruders, but also reasonably permeable to small animals. However, it is important that certain design details are not overlooked:

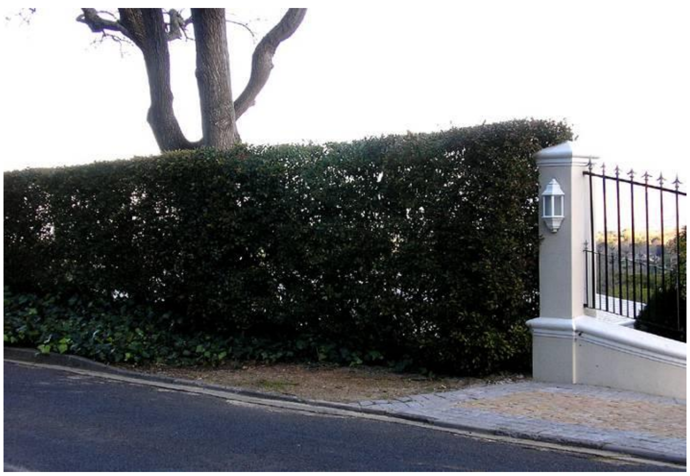
- The fence should not be erected on top of a wall, not even a low one. Even very low walls will divert the movements of some animals, such as frogs and tortoises.
- The gaps between the bars of the palisade fence should be as wide as possible, without undermining their security function (100-120 mm). In other words, narrow enough to prevent humans from squeezing through, but wide enough to allow small animals to move through with relative ease.
- The bottom of the fence should preferably be 100-120 mm clear of the ground so that small animals can run under, and larger animals can squeeze through.
- Unfortunately, determined intruders can also dig! If this is an important security consideration, a concrete barrier can be laid in the ground below the bottom of the fence, but this should NOT protrude above ground level. (If the barrier does protrude slightly in places, this is not a problem as long as it is underground in most places.) Alternatively, the vertical bars can extend below ground.
- The fence should NOT be electrified near ground level.

This palisade fence would be good if the concrete wall at the bottom were flush with the ground.

The palisade fence is OK, but the electrified wires at the top are not visible enough and therefore pose a threat to birds.

Photos of US-Mexico border fences taken in July 2006. (a) Border fence located east of San Diego, CA. (b) Recently built "permeable" border barrier located south of San Diego will allow migration of smaller species, but proposed double-barrier impermeable fencing may not.
http://www.terradaily.com/reports/Ecology_In_An_Era_Of_Globalization_999.html

Hedges: Hedges, either alone or in combination with a palisade fence, can provide a good long-term solution which is also aesthetically pleasing. Hedges themselves also provide habitat for small animals. The most important conservation consideration is the choice of plants – invasive alien species should never be used.



This hedge is permeable to small animals and is aesthetically pleasing.

Electrified fencing: Electrified fencing can be a suitable solution, provided that the current is not so high as to seriously injure larger animals, and provided that there are no electrified strands within 250 mm of the ground. Tortoises are especially vulnerable to low wires because they try to protect themselves by retreating into their shells, instead of moving away, and therefore get shocked repeatedly and die.


This type of electrified fence is an unmitigated disaster! Note the small gaps between strands and the many electrified strands near ground level.

J.A. Harrison
March 2009

APPENDIX 7

AN INTRODUCTION TO BIODIVERSITY

The term "biodiversity" has become a key concept in the discourse on nature conservation and "green" issues in general. The preservation of biodiversity is given pride of place as a principal aim of the conservation movement, and a critical measure of success in evaluating conservation actions. It is frequently used as a "buzz word", but its proper meaning is not always understood. This document defines biodiversity, and introduces some of the issues that interact with and inform the concept.

THE CONCEPT

Biodiversity can be simply defined as ***the sum total of all living things, as well as their genes and their ecology, within a defined area***, or on Earth as a whole. However, it is informative to flesh out this simple definition in terms of the different levels of organization at which biodiversity exists and functions. The three principal levels of organization are species, ecosystems and genes.

Biodiversity as species

Most people have a fairly good grasp of biodiversity as species. Everyone is familiar with different types of plants and animals, and that we call these different types, "species". A list of all the species that occur within an area is one way of describing the biodiversity of that area. However, it is important to realize that a list of species, even if it is complete – which species lists never are – is only a measure of "species richness", not a complete nor a satisfactory description of the biodiversity of that area. Species richness is only the most obvious and easily measured level of biodiversity. Nevertheless, species richness is an easily understood "handle" on biodiversity and a means of comparing the biodiversity of different places, or the biodiversity of the same place at different times.

Conservation actions have, in the past, traditionally been focussed on the needs of species. For example, actions were taken in South Africa to save the White Rhino from extinction, and these actions were successful. This was conservation of a single species, but it had spin-off benefits for the broader conservation of biodiversity, because it also involved the preservation of the habitats of the White Rhino. This brings us to the next level of biodiversity organization, the ecosystem.

Biodiversity as ecosystems

An ecosystem is made up of a community of living things living within a physical environment (e.g., the air, soil and water), and interacting with each other and that physical environment. Therefore, while a species is made up of individuals, an ecosystem is made up of populations of many species, and the relationships between them. The way in which a species interacts with and survives in an environment, is called its "ecology", hence an "ecosystem" is a complex of populations of species and their ecology. An ecosystem can be thought of as the "macro" expression of biodiversity.

Species do not live in isolation; all species are dependent, to varying degrees, on the existence of other species. The White Rhino, for example, depends on several species of grass for food. Species live together in complex communities in which there are innumerable interactions between species. These interactions are, themselves, a vital aspect of biodiversity.

A species of butterfly and a species of flowering plant coexist in an ecosystem. The adult butterfly feeds on nectar from the flowers, and its caterpillar larvae feed off the leaves of the same plant. Not only that, but the butterfly carries pollen from one flower to another, thereby bringing about pollination and the reproduction of the plant. From this simple example, it can be seen that listing the species of plant and the species of butterfly tells one nothing about the relationship between them, nor does it explain how that relationship contributes to their survival. In other words, the relationship between the plant and the butterfly is something that is not described at the species level, but only at the ecological level of organization.

But the complexity does not end there. Neighbouring areas may be so different in their ecology that the same species of plant and butterfly do not occur at all, but are replaced by different species. Alternatively, some or all of the same species may occur, but the relationships between them may not be the same. For example, our butterfly species may use different food plants, and our flowering plant may have a different pollinator. In other words, ecosystems differ widely from one another, not only in their species composition, but also in the relationships between species.

From this discussion it is clear that, if we wish to preserve the full range of living things, i.e., biodiversity, we also need to preserve the ecological relationships which sustain species, and this means that we need to preserve ecosystems as fully functional entities. This is one of the reasons why biodiversity can never be adequately preserved in zoos.

It is not possible to put neat boundaries around ecosystems because neighbouring ecosystems interact and form larger ecosystems, such that the largest ecosystem is the biosphere of the Earth itself. This leads to some practical difficulties in deciding what ecosystems to prioritize for conservation action. In South Africa, vegetation types (e.g., Mucina & Rutherford 2006) are often used as surrogates for ecosystems. In other words, it is assumed that a particular vegetation type is approximately uniform in both its species composition and ecology, and therefore it can be viewed as an ecosystem. For an ecosystem to survive as a functional unit, a reasonably large, connected fraction of its total area needs to be kept intact and untransformed (see below).

Biodiversity as genes

If ecosystems are the macro expression of biodiversity, then genes are the “micro” expression, and probably the least widely understood level of biodiversity. We tend to think of species as precisely defined entities, and of the individuals within species as interchangeable examples of that entity. In other words, a lion is a lion is a lion – all the same. However, the fallaciousness of this view is clear when we consider that domestic dogs, of all breeds, belong to one species, *Canus vulgaris*. Those different breeds, and even the individuals within a particular breed, vary so much that, if we want to preserve the diversity of dogs, we would need to preserve a great many individuals of every different breed and a fair sample of mongrels!

Wild populations may appear more uniform than artificially bred populations, but they also contain considerable genetic variation, as has been proven by genetic analysis. This variation is vitally important because it is the raw material of evolution. Evolution happens precisely because individuals are not all genetically identical. Those individuals which carry genes that make them better adapted to survive under current conditions, are those individuals that are more likely to survive and pass on their advantageous genes to the next generation. This is the process of natural selection. Through chance mutations of the genetic material and the process of natural selection, species change over time; in other words, they evolve. If species are not able to evolve, they are also not able to adapt to change, and they are likely to become extinct.

In today's world we have become very aware of the fact that things change – even the global climate is changing. If species are to survive in the long term, they will need to evolve. This will only be possible if the genetic variation within populations is maintained. The practical means of achieving this is to conserve populations that are relatively large and therefore contain sufficient genetic variation to ensure the vigour of the population. Where this cannot be achieved within a single protected area, as is the case with some large animals, translocation of individuals between areas may be necessary to introduce new genes into populations. This is done, for example, with populations of Cheetah.

Which type of biodiversity is most important?

Ultimately, it is genes that perpetuate life and provide the basis for the future evolution of life, so it is the genes that are most fundamentally important. However, sperm banks, seed banks and gene banks notwithstanding, genes are of little use in practical conservation, because they are not the usual units of conservation management.

As mentioned above, species have been the focus of practical conservation in the past. However, ecological science has shown that it is not just the large, charismatic species, like rhinos, that are important to the maintenance of healthy environments, but mainly the small, unimpressive species, such as bacteria, worms and fungi. Also, it is clear that one cannot hope to conserve species without conserving their habitats.

For these reasons, the emphasis has shifted towards ecosystems. By conserving an ecosystem one preserves the diversity of species within it, their genes, the relationships between the species, as well as the "goods and services" that the ecosystem provides, such as clean air and water and biological raw materials. Ecosystems, although large and complex, can be conserved and, indeed, *must* be conserved if biodiversity conservation is to succeed. There are good reasons, therefore, for saying that ecosystems are the most important level of biodiversity, both in theory and in practice.

Are humans part of biodiversity?

Homo sapiens, as a living species, has been around for tens of thousands of years, and hominids for millions of years. There can, therefore, be no question that humans are part of biodiversity and an important part of ecosystems. However, in historical times, humans have come to view themselves as separate from the rest of the living world, and have exploited that world with little regard for its long-term health or sustainability. This is especially true of recent history with its technological sophistication and exponential human population growth.

It is now a fact, virtually beyond debate, that the twenty-first century is the period in history during which humanity will face its impacts on the natural world, including biodiversity, and will be compelled to find solutions to the precipitous decline in species richness and health of ecosystems. While humanity is a part of biodiversity, it simultaneously holds a special responsibility as custodian of that same biodiversity.

THE VALUE OF BIODIVERSITY

Defining the value of biodiversity is almost as nonsensical as defining the value of the Earth – it is all we have and we cannot survive without it. Nevertheless, one can break the value down into a variety of identifiable categories for the sake of the modern city-dweller who has lost his direct connection to the source of his culture, his economy and his humanity.

- **Aesthetic, spiritual and recreational value:** Humanity evolved and came into being as part of a bio-diverse ecosystem. Humanity developed technology, religion and art in response to biodiversity. Humans instinctively feel the value of biodiversity when they are given the chance to experience it. Diminishing biodiversity diminishes our human heritage and our opportunities to continue learning from nature.
- **Consumable resources:** Even today, humankind needs the consumable resources that wild nature has to offer. Fish is just one obvious example. Through wise husbandry of natural systems, as in the better forms of game farming, biodiversity can offer a sustainable harvest of products from the wild.
- **Medicines:** Medicines are a special category of consumable resources. Most effective medicines have their origins in wild plants, and we can confidently expect to discover many more, especially with the help of traditional systems of knowledge.
- **Foods:** As with medicines, foods originate in the wild, and new domestic crops and animals may still emerge from the vast store of potential in the wild. In addition, genes for the modification and improvement of present crops are available among wild genomes. Biodiversity provides an insurance against collapse of current food resources.
- **Non-consumable resources:** The inherent beauty and fascination of wild biodiversity has always lured the traveller. Recently this has become formalized into a new category of tourism: ecotourism. Especially biodiverse countries, such as South Africa, have great potential for the development of this lucrative industry.
- **Ecosystems services:** the biodiversity of ecosystems allows these systems to provide us with services, for free:
    - *Nutrient recycling:* the decomposition of dead material and release of nutrients is achieved by a variety of animals, fungi, and micro-organisms.
    - *Regulation of gases:* the composition of the atmosphere is buffered and maintained primarily by plants.
    - *Provision of freshwater:* rain is generated, retained, filtered and gradually released by healthy, naturally vegetated ecosystems.
    - *Flood attenuation:* ecosystems with healthy catchments and watercourses, with diverse terrestrial, semi-aquatic and aquatic vegetation, are more likely to prevent damaging floods.

- *Prevention of soil erosion:* ecosystems with healthy and diverse plant cover are less likely to lose soil.
- *Improvement of soil quality:* the quality of soil is dependent on the micro-organisms, plants and animals that live in it. The greater the biodiversity of soil organisms, the better the quality of the soil.
- *Neutralizing pollution:* some organisms, especially certain micro-organisms, are able to take up and neutralize toxic pollutants.
- *Productivity:* biodiverse ecosystems are more productive of goods and services, including all those mentioned above.
- *Resilience:* biodiverse ecosystems, as opposed to monocultures or degraded systems, are better able to withstand perturbations, such as climate change, without a collapse of ecosystem services. Ecosystems that have lost species display unforeseen undesirable – sometimes catastrophic – consequences in their ecology.

THREATS TO BIODIVERSITY

The threats to biodiversity are multitudinous, but most fall within a relatively small number of categories:

- **Habitat destruction:** The transformation of natural habitats into agricultural, urban and industrial landscapes is the single greatest threat to biodiversity. Such ongoing transformation is directly linked to a growing human population and to economies based on unsustainable growth and unsustainable standards of living.
- **Habitat degradation:** Habitats can be degraded without completely destroying them, e.g., by over-grazing, and degradation can lead to loss of biodiversity. Some degrading factors are mentioned below.
- **Habitat fragmentation:** Fragmentation is a particular type of habitat degradation which results from partial destruction. When fragments of natural habitat are isolated from each other, the probability of extinction of species within fragments increases, causing a loss of biodiversity within each fragment.
- **Unsustainable exploitation:** Many species are exploited directly for food, medicines or other products. This need not be a problem if carried out sustainably, but levels of exploitation are often unsustainable. Among the best current examples of unsustainable exploitation are to be found in the marine environment and in tropical forests.
- **Invasion by alien species:** Humans have deliberately and accidentally introduced alien species – both plant and animal species – into natural ecosystems, often with dire consequences. The spread of invasive alien species leads to the degradation of ecosystems and the loss of biodiversity.
- **Pollution:** The release of organic and inorganic wastes and agrochemicals into the natural environment leads to disruption of ecological processes and the degradation of ecosystems, with resulting loss of biodiversity. Pollution is almost always avoidable, but requires commitment and investment to combat.
- **Poor governance and lack of political will:** The central importance of biodiversity to human welfare is not yet sufficiently appreciated in political structures and among electorates, with the result that suitable legislation is often not in place, or is inadequately enforced. The private sector contributes to problems through similar ignorance and through corruption.

HOW TO PRESERVE BIODIVERSITY

The preservation of biodiversity is a complex subject. The simple list below is intended only as a stimulus to further investigation.

- Conserve ecosystems holistically because this approach will preserve the greatest fraction of biodiversity.
- Maintain connectivity within and between ecosystems, i.e., connect fragments by means of ecological corridors so that movement of individuals and propagules can take place between fragments.
- Pay special attention to sparsely distributed ecological resources, e.g., wetlands, riparian habitats, rocky outcrops, mineral deposits, etc.
- Protect ecological transition zones, e.g., altitudinal gradients and coastal zones, because these are critical to long-term adaptation to changing conditions.
- Focus on the maintenance of ecosystem processes, such as drainage, fire, plant succession, predator/prey relationships, migration, etc., to promote ecosystem health and sustainable functioning.
- Monitor species richness and the status of populations as key indicators of effective conservation action.
- Promote sustainable utilization of biodiversity resources, especially among local communities, so as to grow a sense of value in biodiversity, and support for conservation efforts.
- Provide incentives to private landowners to conserve the biodiversity on their land. This can be achieved through a combination of relevant information/education, enforcement of legislation, and financial incentives, such as tax relief.

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