10 BIODIVERSITY AND CONSERVATION

The term biodiversity, defined as the variability amongst living organisms and the ecological complexes in which these organisms occur, encompasses different levels of biological organization, including genes, individual organisms, populations, species, communities and landscapes (Noss 1990, Franklin 1993). Ecological processes are also included in the term biodiversity (Scott *et al*. 1995). The different levels of biological organisation are fundamental to the definition of biodiversity, and are reflected in the goals of the White Paper on the Conservation and Sustainable Use of South Africa's Biological Diversity (Department of Environmental Affairs and Tourism 1997). The biodiversity policy commits SA to conserving 'the diversity of landscapes, ecosystems, habitats, communities, populations, species and genes in South Africa' (Pfab 2002). Species and genetic level considerations have dominated conventional conservation biology. It is imperative that future biodiversity conservation moves away from this species approach towards a new integrative approach, which additionally targets higher-level biodiversity (Pfab 2002).

Within the boundaries of the EMM, natural grasslands in various stages of degradation prevail on untransformed land; ridges are sparsely distributed in the centre of the EMM and the Klipriviersberg protrudes into the south-west section of the EMM. Wetlands and water bodies (both natural and man-made) abound within the metropolitan area. Bird and frog species of conservation importance are concentrated in the wet areas, while Red Data listed plants and invertebrates are concentrated mainly on the ridges.

Based on the location of the EMM within the Gauteng Province, in close proximity to all the industrial and economic activities that generate the country's income, the biological diversity and natural ecosystems in this area are increasingly threatened by a wide range of pressures.

The core indicators for the biodiversity reporting theme include:

- Presence of and number of threatened species per taxonomic group, known to occur in the EMM;
- Population trends of selected key species;
- Distribution of selected exotic species;
- Levels of resource use: medicinal plants;
- Areas of conservation importance.

10.1 PRESSURES ON BIODIVERSITY

The driving forces generate a number of pressures on the natural environment. The major pressures relating to each driving force are identified below. The pressures arise from both current and past driving forces, since there is often a time lag between human actions and environmental responses. However, it is not very meaningful to separate out the driving forces and pressures in this manner, since the driving forces act in concert and pressures are linked to each other in complex networks; the relationships between them are not linear.

10.1.1 Human settlements, societal development, informal sector, spatial development plan and land reform

The growth of the economic sector within the EMM has attracted people in search of employment, so that, according to NLC (2000), 27% of the metropolitan surface area is covered by urban structures. In addition, with 64% of the population living in township areas, particular pressures on the natural environment are exerted. The human settlement factor associated with urban densities, accompanied by societal development, and the informal sector in addition to activities associated with the SDP and land reform all affect the environment in the following ways:

- Elimination/transformation and fragmentation of natural habitats to create urban landscapes: the Rocky Highveld Grassland and Moist Cool Highveld Grassland have been fragmented by the conversion of natural habitats into man-made structures; pans in the EMM have been filled in for urban development, and wetlands and surface water bodies have become isolated. These pressures all lead to losses of ecosystem function and biodiversity. Fences and walls on the edges or across pans also prevent natural migration of adult and juvenile Giant Bullfrog species between foraging areas and suitable breeding sites.
- Poor services in impoverished settlements lead to sewage pollution (no proper sanitation), litter and solid waste pollution (no/poor waste collection services) and deteriorating water quality in surface water bodies. The informal settlements in the Daveyton area are contributing to the deterioration of the RAMSAR Site on the Blesbokspruit by these mechanisms.
- Increased demand for resources and unsustainable resource use practises: The affordability and accessibility of basic primary health care, education, employment opportunities and the economic climate all act as drivers that place pressure on the environment due to over-harvesting of natural resources (specifically medicinal plants) and motivates people to become involved in the medicinal plant trade as either consumers, traditional healers, shop traders, street traders and/or commercial gatherers. Poverty and under-development often force people to disregard resource management practices (Smuts & Hobbs 1991). Plant resources provide a buffer for rural communities against poverty and unemployment during cyclic economic depression (Cunningham 1991) and an employment prospect where formal education-reliant opportunities are lacking. From a study conducted in 1994 by Williams *et al.* (1997) 20% (of 244) of herbal traders within Gauteng were located in the former East Rand (EMM). Giant Bullfrogs are also caught illegally and for the international pet trade.
- While habitat fragmentation and destruction may lead to loss of biodiversity, other settlement related disturbances also directly cause loss of a particular species. Formal residential suburbs surround the Bill Stewart Nature Reserve, Korsman Bird Sanctuary, D Meyer Bird Sanctuary and D Meyer Municipal Nature Reserve. A section of the formal township part of the Thokoza-Katlehong-Vosloorus settlement is encroaching on the north-western side of the Rondebult Bird Sanctuary. Excluding the D Meyer Bird Sanctuary and Nature Reserve the other protected areas all support populations of Greater & Lesser Flamingos and Grass Owls.

10.1.2 Mining

A large number of the existing mines within the EMM are no longer operational and most of the mining footprint in the area (3.8%) is made up of mine tailings and waste dumps. Surface based mining activities comprise only 0.6% of the EMM surface area, with underground mining activities comprising even less (0.1%).

Mining acts as a driver that exerts pressure on natural habitat and biological diversity, in the following ways:

- Open cast mining and quarrying, require the complete clearance of vegetation, they change surface topography and the drainage characteristics of soils (even when reasonable rehabilitation is implemented), leading to the loss of habitats and of populations of plant and animal species, of particular importance being species that are endemic or threatened (rare, endangered or vulnerable).
- Underground mining causes surface subsidence, which leads to land degradation.
- The sector encourages an influx of job seekers, with the same consequences as for human settlement pressures.
- Large volumes of bulk waste products, in the form of tailings and waste rock dumps, require large areas of land for disposal, leading to habitat destruction;
- Water falling on these waste disposal sites leaches toxic substances into the soil, seepage of which contaminates ground and surface water, leading to poor water quality. This causes changes in species composition and loss of natural indigenous riverine biota. The Blesbokspruit has mine tailings and waste rock dumps located along considerable sections of its length.
- Underground mining dewaters aquifers and the excess water in the mines has to be pumped and disposed of into surface water bodies, thus increasing flows in such receiving water bodies; there are also water quality changes associated with mine water.
- Changes in water quality and quantity of surface and ground water exert pressure on the riparian vegetation and biota dependent on the natural water bodies and wetlands. This leads to loss of biodiversity, changes in species composition and numbers and, where contamination or toxicity is severe, to physiological deformities and even mortalities. Changes in water quality resulting from contaminated run-off increases the possibility of exotic invasion in wetlands.
- Invasion of exotic species: in the past many mines have encouraged the planting of exotic species, notably Eucalyptus spp, known to transpire water rapidly and so dry out soils. Eucalyptus trees have been planted on and around tailings dams all over EMM in an effort to prevent leaching of harmful substances into the surface and ground water bodies. However, these species pose a threat to ecosystem functioning since they reduce the amount of run-off that reaches rivers and streams and they out-compete many indigenous species, causing displacement of indigenous species. The invasion of exotic trees and shrubs, especially in riparian habitats, poses a severe threat to plant and animal diversity (Macdonald 1989). The invasion process has many ecological impacts that include alteration of soil nutrient cycling, reduction of run-off and subsequent stream flow, increased river bank erosion and altered fire intensity (Macdonald & Richardson 1986).

10.1.3 Industry/Manufacturing

The majority of industries are concentrated in the Southern SRD. The industrial sector comprises 5.4% of the EMM's land surface area. Light industry/transport comprises 3.2% of the EMM surface area while heavy industry/transport comprises 2.2%.

Similarly to mining, this economic sector places pressure on the natural environment in the following ways:

- Clearing of vegetation for the construction of industrial infrastructure causes habitat destruction and fragmentation.
- Increased generation of waste and pollution through the demand for products created by industry. Heavy industry is particularly concentrated along the northern banks of the Elsburgspruit River. The pollutants produced by this sector impact on the species composition of the rivers and wetlands in close proximity that experience a change in quality of water.
- Industrial effluents seep into nearby water bodies and wetlands affecting the riparian habitats and biota within these systems. Industrial emissions released into the atmosphere contribute to air pollution that affects the terrestrial and aquatic biota receiving rain from the polluted atmosphere. This further leads to loss of biodiversity and breakdown in ecosystem function.

10.1.4 Energy

Energy generation and consumption are the largest sources of carbon dioxide and sulphur emissions in SA (CSIR 1999). These gases cause smog and acidification of rainwater and soil. Carbon dioxide is also to the major driver of global climate change, the ecological consequences of which in SA remain uncertain.

- The loss of water quality, through acidification, exerts pressure on the biota living in or around water bodies. Smog and airborne pollutants threaten sensitive terrestrial species and ecosystem functioning.

10.1.5 Transport

The road transport sector places considerable pressure on terrestrial and aquatic environments through the high generation of nitric oxide (44%) and volatile organic carbon emissions (45%). The transport sector places pressure on the environment in the following ways:

- Pollution of the environment through the generation of "phyochemical smog" which contains ozone and other gases toxic to plants and animals (CSIR 1999). The fact that the EMM is linked to all major destinations in the country through its radial freeway network suggests that the pollution generated by the sector is significant. The SA new car market does not encourage the replacement of old cars, due to the high prices of new cars, further promoting the release of atmospheric pollutants such as carbon monoxide which are deposited back into the terrestrial environment and water bodies and wetlands through rainfall. This pollution places pressure on ecosystem processes within terrestrial and aquatic environments and threatens the biota occurring there. Transport networks, particularly roads, that run in close proximity or traverse wetlands or water bodies further contribute towards the pollution of

aquatic habitats through oil, grease and fuel spillages and leaks that seep into the surface and ground water bodies.

- In addition to generating pollutants, transport routes require the transformation of natural habitat for the creation of roads, railways, airports etc.
- The transformation of natural land is also necessary for the dumping of old vehicles that are withdrawn from use.
- Fragmentation of habitats: transport networks that transect or fragment interconnected water bodies/wetlands and/or natural grasslands create a barrier to the migration of species between similar resources of varying quality and increase the risk of population decline and possible extinction. Certain species that require aquatic and terrestrial habitats in close proximity for different stages of their life-cycle (e.g. Giant Bullfrog), have suffered major declines in population numbers due to fragmentation of habitats. Major road networks that bisect suitable breeding and foraging areas result in mass road fatalities of migrating adult and juvenile Giant Bullfrogs (Cook 2003).

10.1.6 Agricultural activities

The conversion of natural ecosystems for intensive agriculture, forestry or grazing purposes, have been identified as major pressures on plant diversity (Cowling & Hilton-Taylor 1994). Although agricultural activities only contribute 1% to the GGP and employment market, approximately 15% of EMM surface area is currently under cultivation. Agricultural activities place pressure on the environment in the following ways:

- Change in land use: natural grasslands containing a diversity of vertebrate and invertebrate fauna are converted to monocultures of one particular crop leading to considerable loss of biodiversity. Small tracts of indigenous grassland become surrounded by monocultures causing fragmentation of previously intact natural habitats. The remaining remnants of natural grassland are more susceptible to exotic invasion and degradation due to increased edge effects. Habitat fragmentation also eliminates corridors between similar undisturbed habitats. The fragmentation of interconnected pans from each other and their surrounding terrestrial environment threatens species that move between nearby pans and those that require intact terrestrial habitats in close proximity to pans or streams (e.g. Giant Bullfrog, Cook 2003). The Grass Owl makes a tunnel in long grass that leads towards its nest and then makes its nest within long, undisturbed grass. The Blesbokspruit north of Cowles Dam and the Rietvlei River both have large tracts of agricultural land on either side with most of the pans and dams in this area surrounded by cultivated land. The conversion of natural areas to agricultural lands has also resulted in a decline in pollinators worldwide.
- Pollution of aquatic habitats: Agricultural lands pollute nearby aquatic habitats through sediment loads and contamination caused by pesticides and fertilizers that reach the water through run-off or seepage. This causes a decline of indigenous species populations and increases the chance of exotic invasion.

10.1.7 Tourism & Recreation

There are 8 protected areas within the EMM, comprising 0.97% of the land area. Ekurhuleni contains a small portion of the northern section of Suikerbosrand Nature Reserve. The following nature reserves are included in the EMM: Marievale Bird Sanctuary Provincial Nature Reserve, Korsman Bird Sanctuary, Glen Austin Bird Sanctuary, D Meyer Bird Sanctuary, D Meyer Municipal Nature Reserve, Rondebult Bird Sanctuary, Bill Stewart Municipal Nature Reserve. Many of these bird sanctuaries are popular places for tourists and birders to visit.

- Areas set aside for wildlife tourism can reduce the pressures on biodiversity by increasing the range and number of species in an area and by restoring or maintaining natural habitat conditions.
- Conservation of natural habitats and biodiversity: protected areas that require an entrance fee may further reduce pressures on the environment by contributing financially towards the conservation of natural habitats and biodiversity.
- Overutilisation of resources: Where access to such areas is not restricted there may be the pressure of illegal trade in both plants and animals. Collectors who propagate species for later trade often obtain material illegally and reserves provide a good source of natural material. Reserves that are not well managed or maintained may place pressure on the environment in terms of exotic invasions, degradation of the land and loss of species diversity due to illegal collecting.

10.2 STATE AND IMPACTS

10.2.1 Species diversity

Table 10.1 summarises the percentage of Gauteng and the Grassland Biome's diversity that occurs within Ekurhuleni for each taxonomic group.

Table 10.1 Species values for Ekurhuleni per taxonomic group

Taxonomic group	Number of species in EMM	% of grassland total[1]	% of Gauteng total[2]
Plants[3]	1644	49%	54%
Mammals[4]	Unknown	Unknown	Unknown
Birds[5]	255	73%	78%
Amphibians[6]	14	38%	56%
Reptiles[7]	41	?	47%
Invertebrates	?	?	?

[1] The total number of species in the Grassland biome for each taxonomic group was obtained from le Roux (2002). In the case of plants this number was taken as 3370.
[2] The total number of species obtained for each taxonomic group in Gauteng was obtained from DACEL (1999).
[3] The number of plants occurring in Ekurhuleni was obtained by extracting plant species found in the EMM quarter degree grids from the PRECIS database.
[4] Information on total mammal species occurring in EMM was not available.
[5] The bird species identified for all protected areas in the EMM were taken as a good indication of the total species present in the EMM
[6] Bullfrog pan has been monitored between 1991-2003, the species sited at the pan during this period are considered to be a good indication of total frog species that occur in the EMM (Cook 2003)
[7] Reptile data was derived from Jacobsen (1995).

10.2.1.1 Threatened species per taxonomic group

This indicator reports on the number of species categorised according to the new IUCN categories and criteria (IUCN Species Survival Commission criteria Version 3.1 2000) as Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least concern (LC), Data Deficient (DD) per taxonomic group in EMM. The taxonomic groups included in this report are plants, mammals, birds, reptiles, amphibians and invertebrates. Species within each taxonomic group were obtained from various sources, as specified in the tables.

A table of the threatened species within each taxonomic group and their threatened status according to the new IUCN categories and criteria (IUCN Species Survival Commission 2000) as well as a map showing their distribution is provided.

10.2.1.1.1 Plants

Threatened plants for the EMM were obtained from Pfab & Victor (2002), who have updated the list of threatened plants in Gauteng according to the updated IUCN Species Survival Commission (2000) criteria (Table 10.2). The new system differs from the earlier approach in that it targets more specifically taxa that are in danger of going extinct rather than those that are simply rare, using quantitative methods of assessment (Pfab & Victor 2002). The five Red Data plant species that occur in the EMM are classified as follows: *Khadia beswickii* is Critically Endangered (CR), *Cineria longipes* and *Delospermum purpureum* is Endangered (EN), *Trachyandra erythrorhiza* is Vulnerable (VU), and *Habenaria bicolour* is Near Threatened (NT) (Pfab & Victor 2002). Both *Khadia beswickii* and *Delosperma purpureum* are ranked within the top five Red Data plant taxa in Gauteng (Pfab 2002).

Figure 10.1 shows the distribution map for threatened plants, indicating which areas are important for their conservation due to the occurrence of threatened plants or the presence of suitable habitat for these species. The data used to compile this map was sourced from the Gauteng Conservation Plan (version 1), an output of the Gauteng Biodiversity Gap Analysis Project. These areas will need to be updated as additional information becomes available. As is evident from the map most of the threatened plants are concentrated in the ridge areas and particularly in the Meyersdal area. According to Bredenkamp and Brown's 1998 study cited by DACEL (2001a) "the quartzite ridges of Gauteng, together with the Drakensberg Escarpment, should be regarded as one of the most important natural assets in the entire region of the northern provinces of SA. They are characterized by unique plant species composition that is found nowhere else in SA or the world." The Klipriviersberg in which these threatened plants occur comprises one of the five major ridge systems in Gauteng (DACEL 2001a). Landscapes composed of spatially heterogenous abiotic conditions provide a greater diversity of potential niches for plants and animals than do homogenous environments and ridges are characterised by high spatial heterogeneity (DACEL 2001a). Forty-two % of Gauteng's Red Data plant species are confined solely to ridge habitats (DACEL 2001a).

Table 10.2: Threatened plant species occurring in Ekurhuleni

Scientific name	IUCN Species Survival Commission (2000) threatened status
Khadia beswickii[8]	CR
Delospermum purpureum[9]	EN
Cineraria longipes[10]	EN
Trachyandra erythrorhiza[11]	VU
Boweia volubilis	NT
Calamagrostis epigyus var. capensis	NT
Habenaria bicolour	NT
Kniphofia typhoides	NT

Source: Pfab & Victor (2002)

Of the threatened species that occur in EMM: approximately 50% of the total known population of *Kadia beswickii* occurs in the EMM (M. Pfab *pers.comm*.), 30% of *Delospermum pupureum*, 25% of *Trachyandra erythrorhiza* and 20% of *Cineraria longipes* total populations also occur in EMM indicating the importance of this area for conservation of these threatened plant species, in particular *Khadia beswickii*.

Habitat destruction/transformation and fragmentation through urbanisation is the most serious threat posed to the survival of threatened plants of Gauteng (Pfab and Victor 2002). Thus stopping or reversing this habitat loss is essential. Development proposal that threatens Red Data plant species and their habitat needs to be evaluated. Such a policy is being developed by GDACEL. With management and monitoring, rare plant species are able to survive and persist in large urban areas, therefore urban open spaces play an important role in biodiversity conservation (Stalter *et al.* 1996 cited in Pfab and Victor 2002), provided such areas are appropriately managed.

[8] Khadia beswickii is endemic to Gauteng, where it grows in open areas on shallow soil over rocks in grassland. It is predominantly threatened by imminent informal urban settlement and related development but also b6y alien vegetation, mining and perhaps collectors (Pfab and Victor 2002)

[9] This succulent is confined to the Witwatersrand quartzitic ridges. The main threat to its survival is habitat tranmsformation and fragmentation through urbanisation (Pfab and Victor 2002)

[10] The former distribution range of this species has been fragmented by urbanisation. It still exists on the Klipriviersberg and southwards to approximately 10 km south of Suikersbosrand, on south facing slopes of basaltic koppies. This species is threatened by urban development, habitat fragmentation and transformation, mining and alien vegetation (Pfab and Victor 2002).

[11] This species grows in black turf marshes mainly in Gauteng but also the Free State and Mpumalanga. It is threatened by habitat transformation and fragmentation through urbanisation, agriculture and invasive plant species. It is conserved in the Suikerbosrand Nature Reserve (Pfab and Victor 2002).

Figure 10.1 Areas of conservation importance for plants

10.2.1.1.2 Birds

According to information provided by the Avian Demographic Unit (ADU) and C. Whittington-Jones (*pers.comm*.) a total of 21 threatened bird species occur in EMM. Of these seven species are Vulnerable (VU) and 14 species are Near Threatened (NT). Table 10.3 provides a full list of common and scientific names of species listed in Red Data lists according to the new IUCN categories and criteria (IUCN Species Survival Commission 2000). Figure 10.2 illustrates the modelled distribution of areas important for the conservation of threatened bird species due to either the presence of a threatened bird species or suitable habitat. However, the Bald Ibis, Black Coucal, Blackwinged Plover, Caspian Tern, Corncrake, Openbill Stork and Painted Snipe are only vagrants to Gauteng and cannot be realistically accommodated in the conservation planning efforts for EMM (C. Whittington-Jones *pers.comm*.). The data used to compile this map was sourced from the Gauteng Conservation Plan (version 1), an output of the Gauteng Biodiversity Gap Analysis Project. These areas will need to be updated as additional information becomes available.

Table 10.3: Threatened bird species within the EMM (shaded cells indicate bird species considered to be vagrants to EMM – C. Whittington-Jones *pers.comm*.).

Common name (aquatic/terrestrial)	Species	IUCN Species Survival Commission (2000) threatened status
African Marsh Harrier	*Circus ranivorus*	VU
Bald Ibis	*Geronticus calvus*	VU
Black Coucal	*Centropus bengalensis*	NT
Black stork	*Ciconia nigra*	NT
Blackwinged Plover	*Vanellus melanopterus*	NT
Blue Crane	*Anthropoides paradiseus*	VU
Blue Korhaan	*Eupodotis caerulescens*	NT
Caspian Tern	*Hydroprogne caspia*	NT
Corncrake	*Crex crex*	VU
Grass Owl	*Tyto capensis*	VU
Greater Flamingo	*Phoenicopterus ruber*	NT
Half-collared Kingfisher	*Alcedo semitorquata*	NT
Lanner Falcon	*Falco biarmicus*	NT
Lesser Flamingo	*Phoeniconaias minor*	NT
Lesser Kestrel	*Falco naumanii*	VU
Melodious Lark	*Mirafra cheniana*	NT
Openbill Stork	*Anastomus lamelligerus*	NT
Painted Snipe	*Rostratula benghalensis*	NT
Secretarybird	*Sagittarius serpentarius*	NT
Whitebellied Korhaan	*Eupodotis cafra*	VU
Yellowbill Stork	*Mycteria ibis*	NT

Source: Avian Demography Unit

10.2.1.1.3 Reptiles

The Striped Harlequin snake (*Homoroselaps dorsalis*), is the only threatened reptile species occurring in EMM. There are only two threatened species in Gauteng and the African Rock Python is not found in EMM. The Striped Harlequin snake is categorised as Rare according to the IUCN Species Survival Commission (2000) and prefers grassland habitats. It is endemic to the highveld of the Free State, KZN, Swaziland, Limpopo and Gauteng. It is listed as LR/nt according to the IUCN Species Survival Commission (2000). The distribution of threatened reptiles has not been mapped.

10.2.1.1.4 Mammals

The Rough-haired golden mole (*Amblysomus hottentotus*), which occurs in the EMM, is endemic to Southern Africa and is listed as vulnerable in both the SARDB and the IUCN Species Survival Commission (2000). As shown in Figure 10.3, there are two areas included that have been earmarked for mammal conservation in EMM according to Gauteng Conservation Plan (version 1). These areas will need to be updated as additional information becomes available. The data used to compile this map was sourced from the Gauteng Conservation Plan (version 1).

Figure 10.2 Areas of conservation importance for birds

Figure 10.3 Areas of conservation importance for mammals

10.2.1.1.5 Invertebrates

The conservation status of many invertebrates in Gauteng is still in the process of being established. A number of species that are not currently listed officially will be submitted for assessment and listing to the IUCN in the near future. The total number of priority invertebrates for conservation in EMM is 21 species (these species are considered important in GDACEL's conservation planning). Invertebrate species that are rare, threatened or of conservation concern belong to the following orders: Lepidoptera (butterflies), Arachnida (spiders and scorpions) and Coleoptera (beetles). Only three species of butterfly are listed in the South African Red Data Book (SARDB) for this area. According to the IUCN Species Survival Commission (2000) only two butterfly species are categorised as threatened (for Gauteng). Table 10.4 lists the threatened taxa and identifies their threatened status according to the SARDB and IUCN Species Survival Commission (2000) threatened status.

Areas that are considered important for the conservation of invertebrates are shown in Figure 10.4. These areas will need to be updated as additional information becomes available. Hills and koppies generally have more insects (both in terms of individuals and species) than the immediate surroundings (Samways & Hatton 2000 cited in DACEL 2001a). This is also the case for EMM.

Table 10.4: Invertebrate species within the EMM that are rare, of conservation concern or threatened.

Family	Species	Common name	Assessment status	SARDB Status	IUCN Status	Gauteng Endemic
Lepidoptera	*Metisella meninx*	Marsh Sylph	Extremely habitat sensitive. Restricted wetland species	Vulnerable	None	NWP, Gauteng & MP
	**Gegenes hottentota*	Marsh Hottentot Butterfly	Specialist Assessment: Very rare	None	None	Wetland species
	**Lepidochrysops praeterita*	Highveld Blue	Specialist Assessment: Rare High altitude grassland species, flies around rock ridges to mate	None	None	Gauteng & NWP
	Aloeides dentatis dentatis	Roodepoort Copper Butterfly	Only found in Protected areas. Rocky Highveld Grassland. Habitat restricted.	Endangered/CD	VUD2	Yes
	Chrysoritis aureus	Heidelberg Copper Butterfly	Only found in Protected areas. Rocky Highveld Grassland	Endangered/CD	LR/nt	Gauteng & MP
Arachnida	*Brachionopus pretoriae*	Baboon Trapdoor spider	Specialist Assessment: Rare. Grassland and woodland	None	None	Yes
	Calommata simoni	Purse Web spider	Specialist Assessment: Very Rare. Grassland & woodland	None	None	Gauteng & FS only
	**Galeosoma pilosum*	Shield Bum Trapdoor	Specialist Assessment:	None	None	Yes. Genus endemic to

Family	Species	Common name	Assessment status	SARDB Status	IUCN Status	Gauteng Endemic
		spider	Rare. Very localised in colonies in rocky grassland areas.			Gauteng
	Harpactira hamiltoni	Golden Starbust Baboon spider	Specialist Assesment: Rare. Grassland & woodland. Trade species	None Protected in Transvaal Nature Conservation Ordinance 1983 Schedule 7	None	Gauteng & OFS only
	Harpactirella flavipilosa	Lesser Baboon spider	Specialist assessment: relatively common. Grassland, Acacia veld, under stones. Trade species	None	None	Southern Africa
	Homostola pardalina	Wafer lid Trapdoor spider	Specialist Assessment: Rare. Grassland & woodland	None	None	Gauteng& MP
	Idiops fryi	Frony eyed Trapdoor spider	Specialist Assessment: Rare. Open grassland	None	None	Gauteng & FS only
	Pycnacantha tribulus	Hedgehog spider	Specialist Assessment: Rare. Grassland and Woodland.	None	None	Unknown
	**Stasimopus oculatus*	Cork lid trapdoor spider	Specialist: Rare. Sandy & rocky areas	None	None	FS, Gauteng & NCape
	**Stasimopus robertsi*	Cork lid trap door spider	Specailist Assessment: Rare. Grassland & woodland	None	None	Gauteng & NWP
Scorpion	*Hadogenes gunningi*	Rock Scorpion	Specialist Assessment: Threatened. Only in rocky areas and ridges. Trade species	None	None	Yes
	Opistophthalmus pugnax	Burrowing scorpion	Specialist Assessment: Endangered. Only in pristine rocky areas and ridges. Trade species	None	None	Gauteng & Nprov. Highveld endemic
Coleoptera	*Ichnestoma stobbiai*	Fruit Chafer beetle	Specialist Assessment: Endangered. Restricted to low koppies. Extremely habitat dependant. Trade species	None	None	Yes
	Trichocephala brincki	Fruit Chafer beetle	Specialist Assessment: Vulnerable. Restricted to koppies. Rare in Gauteng. Trade species	None	None	NWP, Gauteng& MP

Source: Roos and Henning 2003, verification of data by Marianne Forsyth (GDACEL).

** G. hottentota, L.praeterita, G.pilosum, S.oculatus, S. robertsi were not included in Version 1 of the Gauteng Conservation Plan and are therefore not reflected in Figure 10.4. They will however, most likely feature in future versions of the conservation plan and are thus retained in the above table.*

GDACEL is concerned about the status of all invertebrates listed in Table 10.4 and in particular, species *M meninx*, *C. aureus*, *A.dentatis*. The biggest threat to invertebrate species is destruction and fragmentation of habitats.

Figure 10.4 Areas of conservation importance for invertebrates

10.2.1.1.6 Amphibians

The Giant Bullfrog (*Pyxicephalus adspersus*) is classed as Near Threatened (NT) (IUCN Species Survival Commission 2000). The areas of importance for conservation of Giant Bullfrogs are shown in Figure 10.5. The data used to compile this map was sourced from the Gauteng Conservation Plan (version 1), an output of the Gauteng Biodiversity Gap Analysis Project. These areas will need to be updated as additional information becomes available. The protection of Giant Bullfrog populations at Bullfrog Pan and Glen Austin is considered crucial to the long-term conservation of this species in the Province.

GDACEL is in the process of identifying additional areas that are important for sustaining the breeding, foraging and migration requirements of this species and all pans are considered potential habitat. Thirteen frog species were recorded at Bullfrog pan during the period 1991–2003 (Table 10.5). Although Bullfrog Pan is only one example of a wetland type in EMM and cannot be assumed toa ccomodate all amphibian species occurring in the EMM; it is regarded as providing a good indication of the species in EMM. Once the Frog Atlas Data, produced by the Avian Demographic Unit, has been published reference should be made to this literature to confirm the total number of amphibian species occurring in EMM. In addition to the frog species observed at Bullfrog Pan, Weel's Running Frog (*Femnodactylus wealii*) is also anticipated to occur in EMM (Cook 2003). Four of these species (Common River Frog, Cape River Frog, Striped Stream Frog, Weel's Running Frog) are provincially restricted and their populations understood to be declining.

Table 10.5: Frog species recorded at Bullfrog Pan during the period 1991–2003

Common Name	Species	Breeding Requirements
Common River Frog	Afrana angolensis	Rivers and permanent water, artificial habitats (dams) or pans.
Common Platanna	Xenopus laevis	Permanent water, seasonal pans.
Cape River Frog	Afrana fuscigula	Permanent water, seasonal pans.
Natal Sand Frog	Tomopterna natalensis	Shallow permanent streams or vleis in grassland.
Tremolo Sand Frog	Tomopterna cryptotis	Temporary shallow pools/pan or large roadside pools.
Bubbling Kassina	Kassina senegalensis	Open vleis, pans, dams in grassland.
Common Caco	Cacosternum boettgeri	Marsh, vleis, inundated grassland pools.
Guttural Toad	Bufo gutturalis	Open vleis, pans, ponds, dams, slow streams. Dominates artificial habitats. Urban Exploiter
Raucous Toad	Bufo rangeri	Vegetated zones around pans or dams. Extremely rare in the Gauteng Province due to possible hybridisation with Guttural Toads, Bufo gutturalis.
Red Toad	Schismaderma carens	Emerging vegetation in deeper water (.30 cm) often around reed beds (Typha).
Giant Bullfrog	Pxyicephalus adspersus	Sedge and grass (hygrophytic) dominated seasonal pans or shallow depressions. May utilise artificial habitats such as dams, ponds. Limited numbers in urban environments. Urban avoider

Striped Stream Frog	Strongylopus fasciatus	Vegetated dams, pans and streams. Limited numbers in urban environments. Urban avoider
Snoring Puddle Frog	Phrynobatrachus natalensis	Seasonal pools, pans or around dams. Limited numbers in urban environments. Urban avoider

Source: Cook (2003)

10.2.1.2 Abundance of selected key species

10.2.1.2.1 Threatened Waterbirds

Long-term waterbird monitoring currently occurs at 20 pans and wetlands (approximately 10% of the total number of pans) in the EMM, forming part of a waterbird count programme run by the Avian Demography Unit in Cape Town. Of these 20 pans and wetlands only 14 have long-term waterbird monitoring data in place. The data are collected on the same dates every year, once during summer and once during winter. Table 10.6 summarises the threatened species, total number of species and total number of each threatened species over the survey period that occur at the pans and wetlands monitored.

Figure 10.5 Areas of conservation importance for the Giant Bullfrog

Table 10.6: Threatened waterbird species abundance at the 20 pans and wetlands forming part of the waterbird count surveys.

Total species abundance throughout the count period is given in brackets. The percentage indicates the reporting rate i.e. what percentage of the counts included sitings of a particular species.

Pans and wetlands (count period)	Species Richness	% Threatened species	Threatened Bird Species						
			African Marsh Harrier	Grass Owl	Greater Flamingo	Lesser Flamingo	Painted Snipe	Yellowbill Stork	Black Stork
*Anglo Reserve (1999-2003) (n=8)	68	4.4%	(2) 25%		(245) 50%	(1) 12.5%			
*Apex Pan (2002-2003) (n=3)	22	0%							
*Blaaupan (2002-2003)	25	0%							
*Bonaero Park Pan (1999-2003)	53	5.6%			(198) 25%	(4) 12.5%			(3) 12.5%
*Bullfrog Pan (2002) (n=3)	38	7.8%		(16) 66%	(36) 66%	(28) 66%			
*Cowle's Dam (1993-2003)	78	3.8%	(5) 19%		(842) 52%	(298) 45%			
*Grootvallei Wetland Reserve (1999-2003) (n=8)	59	3.3%	(1) 12.5%		(24) 12.5%				
**Grootvallei on the Blesbokspruit (1994-2003) (n=20)	81	4.9%	(8) 20%		(30) 15%	(12) 10%		(2) 10%	
**Korsman Bird Sanctuary (1992-2003) (n=15)	90	3.3%		(14) 20%	(1047) 53%	(317) 47%			
*Lakefield Pan (2001-2003) (n=4)	26	0%							
**Leeupan (1992-2003) (n=19)	86	4.6%		(4) 5%	(1194) 79%	(393) 37%	(1) 5%		
**Marievale Bird Sanctuary (1993-2003) (n=21)	93	5.4%	(14) 29%	(2) 105	(117) 33%	(18) 10%		(13) 10%	
*Parkhaven Pan North	32	3.1%			(5) 25%				

Pans and wetlands (count period)	Species Richness	% Threatened species	Threatened Bird Species						
			African Marsh Harrier	Grass Owl	Greater Flamingo	Lesser Flamingo	Painted Snipe	Yellowbill Stork	Black Stork
(2001-2003) (n=4)									
*Parkhaven Pan South (2001-2003) (n=4)	30	0%							
**Rolfe's Pan (1993 –2003) (n=19)	59	1.7%			(16) 0.5%				
**Rondebult Bird Sanctuary (1993-2003) (n=15)	65	4.6%		(1) 0.75	(117) 40%	(72) 13%			
*Sandpan (2002 –2003) (n=2)	33	3%			(62) 50%				
**Stan Madden Bird **Sanctuary (1993 – 2003) (n=21)	76	3.9%			(2037) 38%	(1933) 33%		(4) 10%	
**Stewards Pan (1992 – 2003) (n=7)	50	6%		(7) 14%	(90) 14%	(17) 14%			
*Varkfontein Pan (2001-2003) (n=4)	31	3.2%		(30) 75%					

* These pans and wetlands have had data collected for less than 4 years.
** These pans and wetlands have had data collected over the past 9 to 11 years.
According to the data available the Corncrake, Whitebellied korhaan and Blue crane have been sited at the pans listed above over the specified siting periods.

Source: Avian Dempgraphy Unit

The water bird species richness for the pans and wetlands monitored indicates that Marievale Bird Sanctuary has the highest number of waterbirds species (93), while Korsman's Bird Sanctuary, Leeupan and Grootvaly on Blesbokspruit have all recorded over 80 different bird species (Table 10.6).

Threatened species were observed at 17 of the 20 pans and wetlands surveyed (85%) (Figure 10.6). The Greater and Lesser Flamingos were sited at 16 (80%) and 11 (55%) of these pans respectively; the Grass Owl at 7 (35%); the African Marsh Harrier at 5 (25%); the Yellowbilled Stork at 3 (15%); while the Painted Snipe was sited only at Leeupan and the Black Stork only at Bonaero Park Pan. The highest reporting rate for the African Marsh Harrier was at Marievale Bird Sanctuary (29%, n = 21). The highest reporting rate for the Grass Owl was at Varkfontein Pan (75%, n = 4). The highest reporting ratio for the Greater Flamingo was at Leeupan (79%, n = 15) and 35% (n =

7) for the Lesser Flamingo. The Yellow-billed Stork had exactly the same reporting ratio (1%) at all three locations.

Figure 10.7 summarises the species richness and threatened species for each of the protected areas in EMM. Species richness for the protected areas monitored indicated that Marievale Bird Sanctuary has the highest number of bird species (214), the highest number of threatened species and the greatest percentage endemism. Korsman's Bird Sanctuary and Rondebult Bird Sanctuary each had 167 and 178 species recorded respectively. For the protected areas monitored, a trend exists between the number of bird species recorded and the number of threatened species. The trends may be a related to size of pan or wetland, however no accurate data in this regard is available.

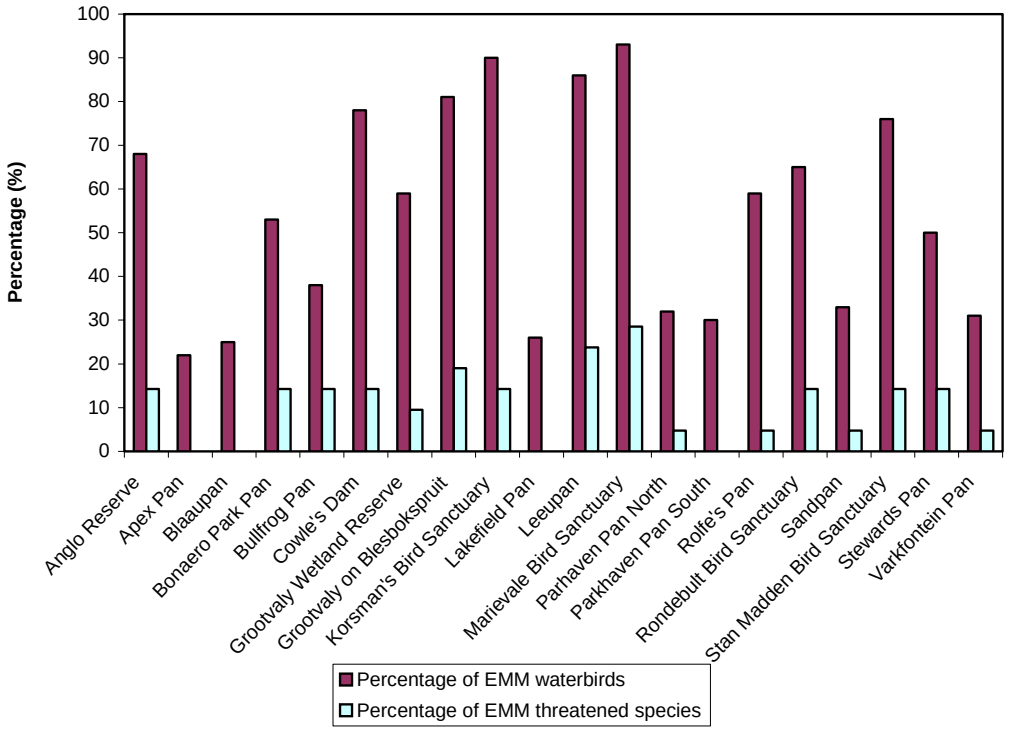

Figure 10.6: Summary of bird data for pans and wetlands in the EMM.

Source: Avian Demography Unit

The total number of water bird species was obtained by adding all the species for all the pans and wetlands surveyed. The number of water bird species and threatened species was then expressed as a percentage of the totals expected for EMM. Only water birds were considered for this data while all threatened species for SA were used in the percentage calculation of threatened species. A total of 155 water bird species is expected to occur in EMM. Over 85% of these species occur at each of the following pans and wetlands: Marievale Bird Sanctuary (93%), Korsman's Bird Sanctuary (90%) and Leeupan (86%). These three pans and wetlands also support the highest

percentage of threatened species. However, the network of wetlands in the EMM should be protected, not just those pans that are known to support threatened species.

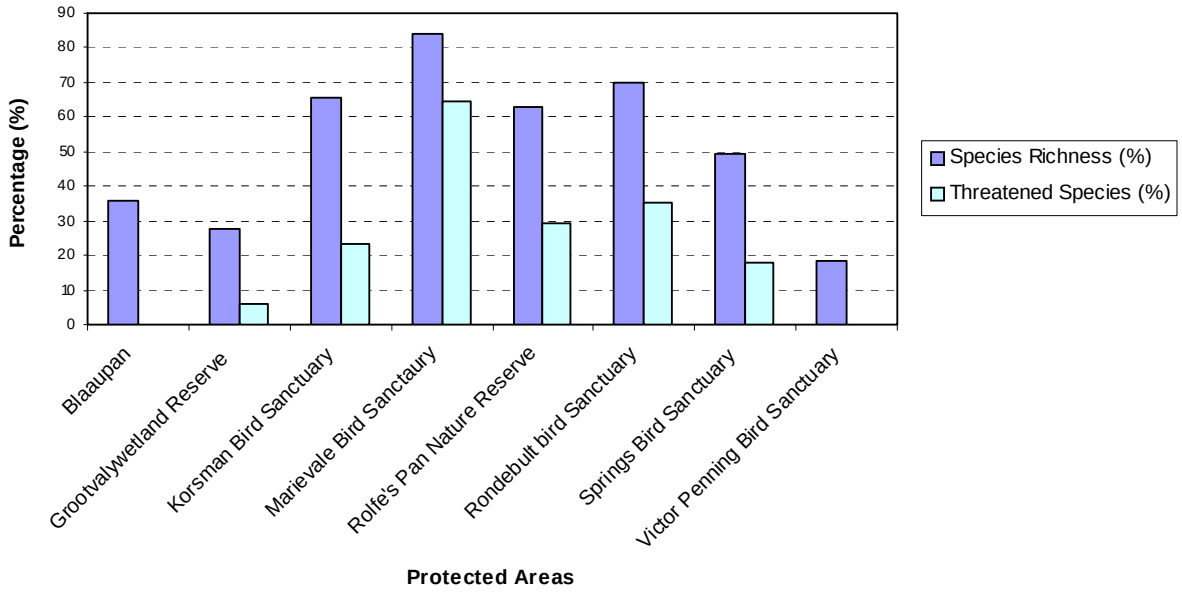

Figure 10.7: Summary of the percentage of the total bird species (species richness) found in EMM that occur protected areas and percentage of total threatened species found in EMM that occur in each of the protected areas.

A total of 255 bird species are expected to occur in EMM (based on the cumulative number of bird species sited in all the protected areas). Over 80% of these species occur in Marievale Bird Sanctuary this reserve also boasts the highest number of threatened and endemic species (Figure 10.7). *The EMM pans and wetlands form the biggest breeding nuclei for greyheaded gulls (D Harebottle *pers.comm*.) Marievale is very important for Spurwing Geese and ducks that use this site as a moult refuge during winter (D Harebottle *pers.comm*.).

One of the RAMSAR criteria for waterbirds is that if 1% of the global (and more recently sub-regional) population of a particular species is found to occur at a particular site, this site is considered to be of international importance. For the Flamingos this would mean either 7600 individuals on a regular basis or 760 000 individuals in total. The Stan Madden Bird Sanctuary does record these high numbers for both Lesser and Greater Flamingos, but not on a consistent basis. If the summer maximum numbers of flamingo individuals are considered for the EMM, this area as a whole could easily support 1-2% of the Southern African population. The pans in EMM that support threatened species form a crucial networking function and should be protected as habitats for the threatened species that use them.

Impacts: Urban development has had a negative impact on grassland bird species diversity. Grassland bird species were negatively correlated with improved grasslands; highlighting a need to conserve natural wild grasslands, rather than modified habitats (DACEL 1998). Although

threatened species appear to have adapted to modified grasslands, being more dependant on vegetation structure than species composition (C. Whittington-Jones *pers.comm*.). The diversity of grassland species is low in Gauteng compared to the grassland biome as a whole. Protecting existing natural grasslands will help maintain populations of grassland Red Data species such as the Secretarybird, Lesser Kestrel, Eastern Redfooted Kestrel and Melodious Lark.

10.2.1.2.2 Bullfrogs

The Giant Bullfrog (*Pyxicephalus adspersus*) is a grassland species that is classed as Near Threatened (NT) by the IUCN Species Survival Commission (2000); it is suspected that the transformation of natural grassland for residential, commercial and industrial land uses (prevalent in Gauteng) may have contributed to its decline (DACEL 1998). Giant Bullfrogs require large areas of open grassland for foraging and migration and shallow margins of temporary rain-filled depressions to breed successfully (Cook 2003). A dramatic decline in bullfrog populations has occurred especially in Gauteng (80%). The major causes of their decline are habitat destruction, habitat degradation, habitat fragmentation, human persecution and illegal collection for the pet trade (Cook 2003).

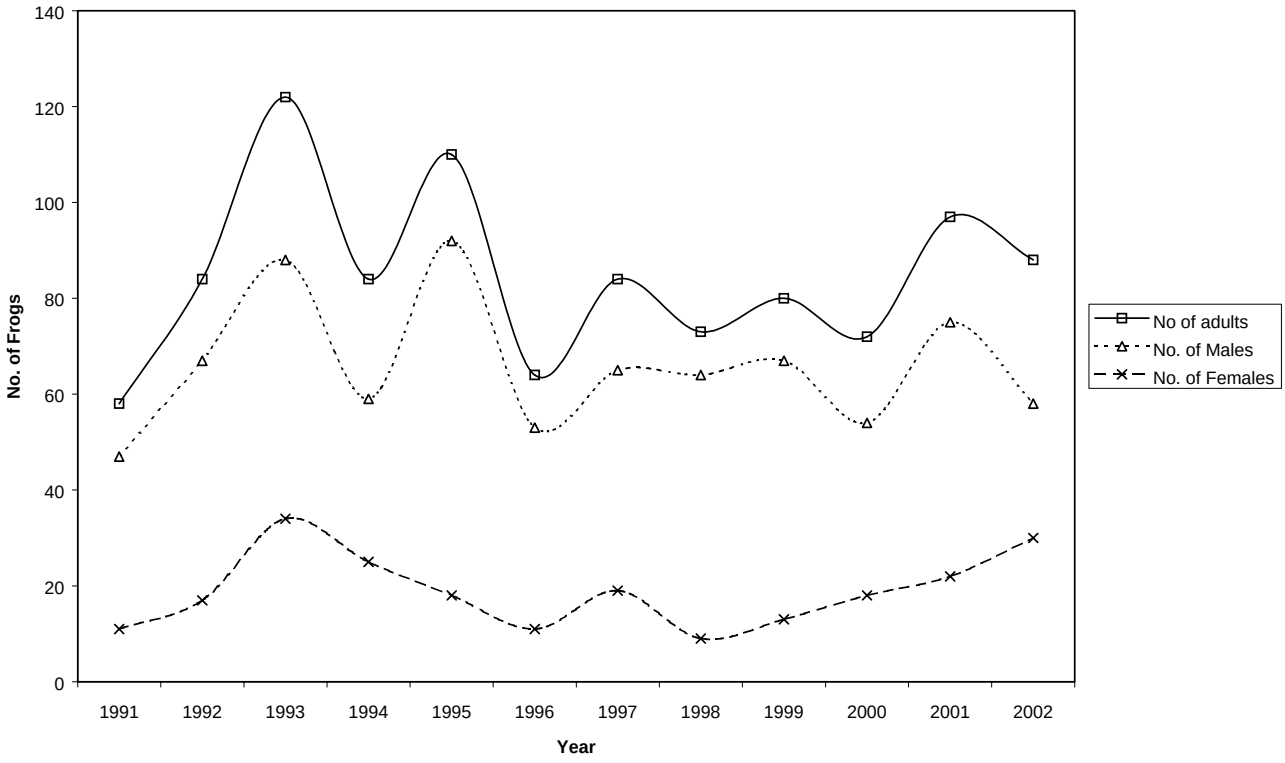

Figure 10.8: Summary of observations of Giant Bullfrogs at Bullfrog pan and specimens collected off nearby roads.

Source: Cook (2003)

Bullfrog pan is situated in an urban environment in the suburb of Rynfield (Figure 10.5). Small agricultural and residential holdings, houses and a school encircle the pan. Continual deterioration

in water quality has resulted in the deterioration of available breeding habitat and extremely limited reproductive success.

The results of monitoring at Bullfrog Pan (Cook 2003), over the past 12 years do not show a decline in either male or female numbers (Figure 10.8). However, Bullfrog Pan was previously regarded as one of the largest breeding sites for the Giant Bullfrog in Southern Africa. Anecdotal historical records describe populations exceeding several thousands (Cook 2003). Data available from earlier may support the widely held belief that the population numbers have declined remarkably at this pan. This pan is one of the last remaining breeding areas for the Giant Bullfrog on the Highveld; according to Cook's (2003) monitoring at the pan no successful breeding activity (resulting in the emergence of juveniles from tadpole cohorts > 10 clutches) has been recorded for Bullfrog pan since 1997 (Cook 2003). Current impacts on the site include:

- A municipal dump on the western boundary of the pan that continues to seep into the pan during the wet season and restricts the growth of the pan;
- Drainage canals and embanked areas that have altered the flow regime;
- Primary and secondary access roads surround the pan restricting migrating adult and juvenile frogs and natural pan expansion;
- Residential house constructed in the pan;
- Large scale dumping of solid and organic refuge (this has been cleared but forms part of an ongoing problem);
- Alien vegetation surrounds the pan (*Eucalyptus grandis*);
- Cutting (mowing) and burning of surrounding grassland;
- Fencing (concrete and wire) around the entire pan area disrupts natural migratory routes;
- Unfavourable climatic conditions such as insufficient rainfall and hot conditions that result in limited emergences with no major breeding events.

Continual destruction and deterioration of suitable breeding and foraging areas will result in the disappearance of Giant Bullfrog populations throughout Southern Africa, especially on the Highveld in the Gauteng Province (Cook 2003).

The protection of wetlands is vital to the conservation of amphibians. Many species need water to reproduce, and for the tadpoles to develop. Increasing demand for land for agriculture and development is threatening many wetlands, and the enormous diversity of animals and plants they support. In order to maintain amphibian diversity and population sizes it is necessary to minimise habitat loss, through controls on development, and to optimise the number and distribution of wetlands, through protective legislature (DACEL 1997). These wetlands also require areas of natural grasslands in close proximity, particularly where conservation of the Giant Bullfrog is concerned.

Impact: Loss of populations of species or biodiversity

Dispersal to new sites and re-colonization of sites is impeded/ prevented by fragmentation of habitats. Plants reliant on pollinators, that require considerable areas of natural vegetation, may suffer reduced pollination or seed set if their pollinators are unable to traverse severely fragmented habitats. This may result in a decline in population numbers of a species. Smaller creatures such

as frogs and insects may become trapped in areas surrounded by transformed land and may suffer subsequent population decline. Since birds are able to fly greater distances they are less sensitive to the effects of fragmentation than certain less mobile animals, however they are nonetheless impacted by habitat fragmentation.

Many invertebrates, and particularly butterflies, function as metapopulations. Fragmentation may isolate these metapopulations from one another, causing inbreeding and possible decline in population numbers.

The Grass Owl prefers habitats of long grass usually near water, vleis or marshes. Residential formal suburbs have encroached on many of the pans and wetlands. The absence of both aquatic and pristine grassland habitat in close proximity may restrict the Grass Owl distribution within the EMM. The limited distribution of the Grass Owl at the pans currently monitored and in the protected areas suggests that habitat fragmentation may be impacting on this species.

Anthropogenic activities in close proximity to a particular pan can may impact on population numbers and distribution of “near-threatened” species, such as the Greater Flamingo, known to be highly sensitive to disturbance, and may cause populations to shift away from an area if all the pans suffer disturbance due to human activities, vehicles, dumping of waste at the pan etc. Both Korsman’s and Rondebult Pans have had very limited numbers of flamingos sited there between 1995 and 2002 (Avian Demographic Unit).

10.2.1.3 Distribution of alien invasive species

Invading alien plants are a serious threat to biodiversity through alteration of habitat or disruption of ecosystem processes. Despite this, there is a lack of data on the distribution of alien invasives in the area. This indicator reports on the exotic invasive species occurring in the EMM and their distribution. ARC-Institute of Soil, Climate and Water (ISCW) mapped the geographical distribution of alien woody vegetation by means of remote sensing (using Landsat TM data). In Gauteng, wattle (mainly *Acacia dealbata* and *A.mearnsii*) and blue gum trees (*Eucalyptus* sp.) are the most widespread woody exotic (Henderson 1995).

Table 10.7 provides the areas of each of the map classes within Gauteng. Approximately 6040 ha (3 %) of the EMM is covered by exotic trees (that are not on steep slopes and are therefore very likely pure stands of invader vegetation). This area calculation is however a slight underestimation, since exotic stands smaller than three contiguous Landsat pixels were eliminated from the vector product.

Table 10.7 Area of each map class calculated from the north & south exotic woody vegetation product

Description	Hectares	% of EMM Area
Exotic trees no slope	6042.20	3.14
Exotics/Gardens Urban	3652.93	1.89
Exotics/Indigenous Urban slope	138.88	0.07
Exotics/Indigenous on slopes	105.09	0.05
No exotic trees	182447.7	94.83
Total EMM Area	192386.83	

Source: Wessels et al. (2002)

The following quarternary catchments were identified for the EMM: A21A, A21B, A21C, B20B, C21D, C22B, C22C, C21F, C21E, C22D. Table 10.8 shows which of the quartenary catchments occurring within the EMM boundary are prioritised for the clearing of exotics, according to a recent study conducted by SRK (2003). The B20B catchment is given a medium priority ranking while C21E, C21F, C22C are all given a low priority ranking in terms of exotic clearing programmes.

Table 10.8: Exotic invasive species identified within the quarternary catchments within the EMM

Quarternary catchment	Priority	Genus/Species	Density	Landscape Distribution
B20B	2[12]	*Lantana*	Low	Midslope
	2	*Populus sp.*	Moderate	River
	2	*Solanum mauritanum*	Low	Midslope
	2	*Wattle*	Low	Midslope
C21E	3[13]	*Blugum*	Moderate	
	3	*Wattle sp.*	Moderate	
C21F	3	*Bluegum*	Moderate	
	3	*Wattle sp*	Moderate	
C22C	3	*Bluegum*	Moderate	
	3	*Wattle sp*	Moderate	

Source: SRK 2003

10.2.2 Resource value – medicinal plants

The Witwatersrand is SA's second largest market for medicinal plants after the markets in KwaZulu-Natal, and the ethnic diversity of the region's traders, healers and gatherers is influential in determining the floristic diversity and sources of plants in trade (Williams *et al*. 2000). Traders in the traditional medicine market are differentiated into two sectors, namely formal businesses and

[12] 2 = medium priority
[13] 3 = low priority

informal markets (Williams *et al*. 1997). The formal sector is represented by herb traders, including traditional healers, trading from premises called *muthi* shops (herbal chemists). Transient commercial gatherers and traders selling plants from pavements and open-air markets, on the other hand, represent the informal sector i.e. Faraday Street market.

The list of species that occur in the 8 grid cells included in the EMM boundary was obtained from the PRECIS database. The number of species listed here may thus be an over-estimate since only portions of some of these grid cells are found within the EMM. Plants having medicinal uses, according to the PRECIS database, were extracted from 109 different references, giving a good indication of which plants are potentially useful for medicinal purposes. These plants are not necessarily in trade as they may be freely available to resource users.

According to the PRECIS database, 64 plant taxa occurring in the EMM have potential medicinal use. Four of these taxa are also cited as being actually traded by Williams (2003). *Khadia beswickii*, a threatened plant, is also cited as used for medicinal purposes.

Table 10.9: PRECIS list of medicinal plants in the EMM area. Species shown in bold are threatened according to IUCN 2002.

Taxa occurring in the EMM cited as having potential medicinal uses	**Used medicinally according to Williams (2003)**
Aloe greatheadii Schönland *var. davyana* (Schönland) Glen & D.S.Hardy	
*Asclepias emin*ens (Harv.) Schltr.	
Asclepias fallax (Schltr.) Schltr.	
Barleria macrostegia Nees	
Bonatea speciosa (L.f.) Willd. *var. speciosa*	
Bowiea volubilis Harv. ex Hook.f. *subsp. volubilis*	Y
Calamagrostis epigejos (L.) Roth *var. capensis* Stapf	
Callilepis leptophylla Harv.	
Ceropegia decidua E.A.Bruce *subsp. pretoriensis* R.A.Dyer	
Cleome macrophylla (Klotzsch) Briq. var. macrophylla	
Cleome maculata (Sond.) Szyszyl.	
*Cotyledon o*rbiculata L. var. oblonga (Haw.) DC.	
Crassula arborescens (Mill.) Willd. subsp. undulatifolia Toelken	
Craterostigma plantagineum Hochst.	
Cyathea dregei Kunze	
*Cynanchum vi*rens D.Dietr.	
Delosperma leendertziae N.E.Br.	
Dianthus mooiensis F.N.Williams *subsp. kirkii* (Burtt Davy) Hooper	
Dierama pulcherrimum (Hook.f.) Baker	
Disa woodii Schltr.	
Dombeya rotundifolia (Hochst.) Planch. *var. rotundifolia*	
Duvernoia aconitiflora A.Meeuse	
Encephalartos senticosus Vorster	
Eragrostis patens Oliv.	
Erica jasminiflora Salisb.	
Eucomis autumnalis (Mill.) Chitt. *subsp. clavata* (Baker) Reyneke	Y
Eulophia coddii A.V.Hall	Y
Eulophia cooperi Rchb.f.	Y

Taxa occurring in the EMM cited as having potential medicinal uses	**Used medicinally according to Williams (2003)**
Freylinia tropica S.Moore	
Gladiolus pretoriensis Kuntze	
Gladiolus robertsoniae F.Bolus	
Habenaria bicolor Conrath & Kraenzl.	
Habenaria kraenzliniana Schltr.	
Habenaria mossii (G.Will.) J.C.Manning	
Holothrix randii Rendle	
Hyparrhenia nyassae (Rendle) Stapf	
***Khadia beswickii* (L.Bolus) N.E.Br.**	
Kniphofia typhoides Codd	
Kniphofia typhoides Codd	
Leucadendron tradouwense I.Williams	
Leucospermum saxosum S.Moore	
Lobelia erinus L.	
Lophacme digitata Stapf	
Lotononis wilmsii Dummer	
Mossia intervallaris (L.Bolus) N.E.Br.	
Nemesia fruticans (Thunb.) Benth.	
Nerine bowdenii Watson	
Nervilia kotschyi (Rchb.f.) Schltr. *var. purpurata* (Rchb.f. & Sond.) Börge Pett.	
Otholobium polyphyllum (Eckl. & Zeyh.) C.H.Stirt.	
Parapodium costatum E.Mey.	
Pavetta zeyheri Sond.	
Protea roupelliae Meisn. *subsp. roupelliae*	
Protea subvestita N.E.Br.	
Protea welwitschii Engl. *subsp. welwitschii*	
Rhynchosia nitens Benth.	
Schizochilus zeyheri Sond.	
Schoenoxiphium lehmannii (Nees) Steud.	
Stapelia gigantea N.E.Br.	
Thuranthos basuticum (E.Phillips) Oberm.	
Trachyandra erythrorrhiza (Conrath) Oberm.	
Tristachya biseriata Stapf	
Urginea modesta Baker	
Wahlenbergia androsacea A.DC.	
Zantedeschia pentlandii (Watson) Wittm.	

Source: PRECIS database

In 1994 Vivienne Williams commenced a study to examine the commercial market for medicinal plants in the *muthi* shops of the Witwatersrand (Williams *et al*. 1997, 2000). The study focussed on the formal sector traders since the informal sector was small, developing transient and less formalised. Results indicated that there were at least 500 species in trade (Williams *et al*. 2001) mainly harvested from KZN (42%) and Gauteng (15%). The Farady street market represented 31% of the suppliers to the *muthi* shops on the Witwatersrand. The growth in the medicinal plant and Faraday market since that earlier study, coupled with the increasing challenge of rural unemployment and the growing number of species threatened by the national trade in medicinal plants justified a comprehensive investigation of the Faraday street market and traders. According to Williams' (2003) study, seventy-six plant taxa that occur in EMM (according to PRECIS), are

recorded as being traded for their medicinal use (Appendix G). It is unknown whether these plants were collected for EMM however the possibility exists that they are sourced from natural populations found in the EMM.

From a recent survey of traders at Faraday market, conducted by Williams (2003), 63% of customers earned less than R800 per month and 26% of customers earned less than R400 per month. Seventy percent of traders in the Faraday market were women, usually single and/or widowed, who are often the sole breadwinners within their family.

Of the total 1644 plant taxa occurring in EMM, 171 are traded medicinally (Williams 2003). Ten of these species are indicators of over-exploitation, harvesting results in plant mortality and current levels of harvest are not sustainable. These species should be propagated in nurseries and alternatives are urgently needed. Twenty-three species were classified as C2. These species have the potential to be harvested according to site and species specific quotas. Reserach is needed to set quotas and harvesting levels according to prevailing environmental conditions.

Impact: Loss of livelihood/ source of income

The unsustainable utilisation of medicinal plants has a number of impacts on both the natural and human environment. Populations of certain species that are harvested unsustainably may decline in number to the extent where a certain species may become threatened or even extinct. The loss of certain popular medicinal plants can impact on the people who rely on these plants as a source of income.

10.2.2.1 Areas of conservation importance/Protected areas

Historically southern African nature reserves were not established with biodiversity criteria under consideration. Protected areas were often established for the sole purpose of conserving larger mammal species, while the socio-economic and political history of SA also played a role in the decisions made (Preston *et al.* 1995). South African nature conservation authorities have subsequently been criticized for lacking a holistic overview of biodiversity, the representativeness of nature reserves being poorly understood (Preston *et al.* 1995). The designation and delimitation of reserves is often not based on systematic conservation planning and new reserves have often been located in areas that do not contribute to the representation of the local/regional biodiversity (Margules and Pressey 2000).

The Highveld Grassland of South Africa has been identified as being inadequately protected within the present protected area system (DEAT 1997). Only 0.97 % of the EMM currently falls within protected areas (Figure 10.9), falling far short of the internationally accepted, recommended 10%. However, 42.7% of the EMM surface area remains as more or less natural habitat.

The focus of conservation action, in terms of biodiversity protection, has shifted from protecting individual species to conserving habitats and ecosystems. The current pattern of species distribution within a landscape cannot be conserved without ensuring that the processes responsible for that pattern are not threatened. By aiming conservation at the ecosystem and landscape level there is a far higher chance of keeping the important processes intact.

This indicator identifies areas of high conservation value based on the existence of rare taxa or habitat that supports such taxa. This indicator provides useful information for strategic conservation planning within the EMM and Gauteng, as it focuses attention on those regions that are of high value but are not formally protected. According to the Gauteng Conservation Plan (version 1) the area that needs to be conserved covers 9.79% of the EMM area.

10.2.3 Aquatic and hydrophilic habitats

Wetlands – the broadest definition of which includes rivers, lakes, pans and vleis - play a vital role in the provision of water. Wetlands are defined by saturation, distinctive plants and modified soils although the plants and soils may be dry. Various wetland studies in SA suggest that 35 - 60% of our wetlands have been lost. The general perception of wetlands is that they are valueless wastelands and as a result they have undergone extensive drainage and conversion. Wetlands are the 'previously disadvantaged' ecosystems.

Figure 10.9 Areas of conservation importance and protected areas

The aquatic and hydrophilic habitats within the EMM include rivers (perennial and non-perennial), wetland areas and water bodies (natural, enoreic pans and man-made dams). Wetlands and waterbodies comprise 6.7% of the EMM surface area. The most noteworthy wetlands are situated along the RAMSAR site of the Blesbokspruit, stretching north-south along the eastern boundary of the EMM. Wetlands are also located along the Natalspruit in the south-west of the EMM and the Kaalspruit in the north-western corner of the EMM. The remaining waterbodies are pans, dams and man-made lakes scattered throughout the area.

The Natalspruit (a permanent stream) flows northwards into the Elsburgspruit in the south-western part of the EMM. The south-eastern boundary is flanked by the Blesbokspruit, which flows in a north-east direction on the eastern side of the EMM. The Rietvlei River extends southwards into the EMM from the Rietvlei Dam outside the EMM boundary.

Endoreic pans, such as Bullfrog pan, are a very sensitive and highly threatened wetland type that is poorly protected in the Gauteng province. These habitats are of considerable importance to a diversity of bird and amphibian species.

As part of an ongoing survey and monitoring programme conducted by Dr C.A. Whittington-Jones of GDACEL the current state and conservation potential of a sample of pans within the area has been included in this report. The EMM contains in excess of 190 pans, the majority of these within the Benoni (2628AB) quarter degree square. To date, 26 (approximately 14%) of these pans have been surveyed and the preliminary findings constitute the current state of these pans.

Only four pans in the EMM i.e. Westdene Pan (Korsman's Bird Sanctuary), Carlos Rolfes Pan, Blaauwpan (Pamula Park Nature Reserve) and Glen Austin Pan are formally protected. Of these, only Korsman's Bird Sanctuary appears to be adequately managed for biodiversity. Residents around Bullfrog Pan have voluntarily established a conservancy in an attempt to secure the long-term survival of this important site and similar initiatives are currently being pursued at Sandpan and Glen Austin Pan.

Of the 26 sites surveyed, 11 (42%) were found to have high conservation potential, three (11.5%) medium conservation potential, four (15.4%) low conservation potential, one (3.9%) no conservation potential and seven (26.9%) were of unknown conservation potential. Five (19%) pans supported threatened species (Greater Flamingoes, Lesser Flamingoes, Grass Owls and/ or Giant Bullfrogs), five (19%) pans supported high waterbird diversity and seven (27%) pans supported high waterbird abundance (i.e. more than 500 waterbirds).

Based on the following definitions an assessment was made of the status of the surveyed pans

- Not obviously impacted: Pan and catchment apparently unaffected by human activities.
- Minimally impacted: One or more threats/ disturbances affect the perimeter of the catchment only.
- Moderately impacted: One or more threats/ disturbances affect < 25% of catchment outside of the 100 m buffer zone.
- Severely impacted: One or more threats/disturbances affect > 25% of the catchment outside of the 100 m buffer zone.

- Very severely impacted: One or more threats/disturbances affect the pan and/or the 100 m buffer zone.
- Destroyed: Wetland 100% transformed by human activities and no longer constitutes a wetland.

Table 10.10: Percentage of pans surveyed in the EMM that have been impacted by human activities.

Extent of impact	Number	Percentage of pans surveyed (%)
Not obviously impacted	0	0
Minimally impacted	0	0
Moderately impacted	0	0
Severely impacted	0	0
Very severely impacted	25	96
Destroyed	1	4

Source: Whittington-Jones (2003)

According to Table 10.10, 96% of the pans surveyed had been severely impacted by human activities. The activities impacting on the pans are summarised in Figure 10.10.

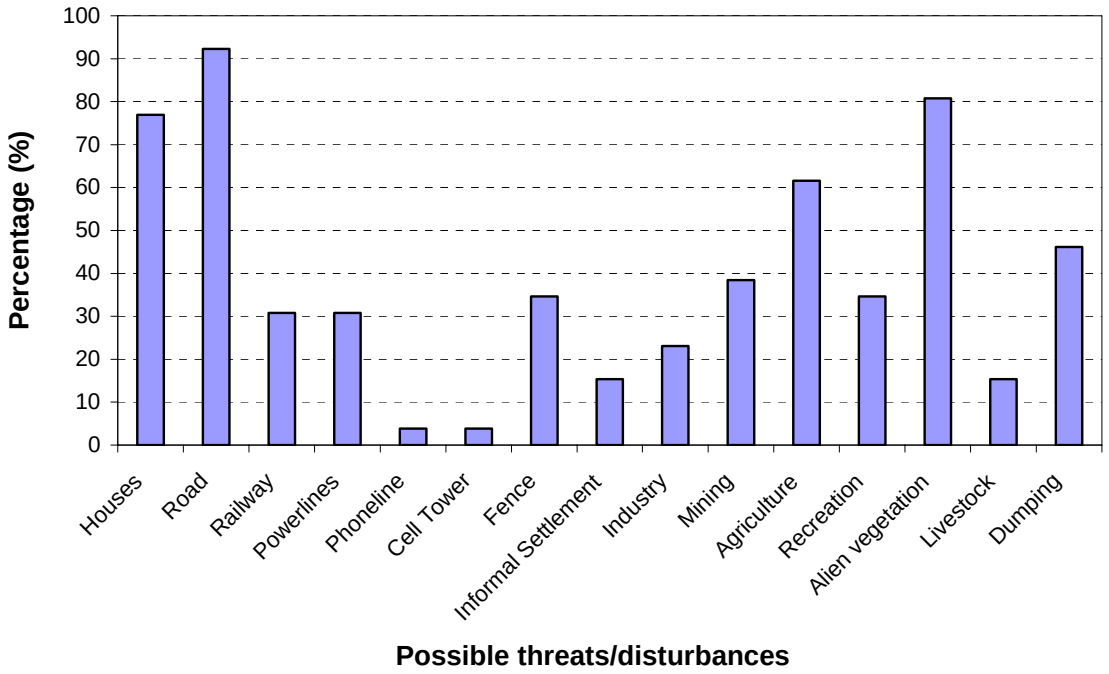

Figure 10.10 Quantifiable threats to pans surveyed in EMM.

Source: Whittington-Jones (2003)

The biggest threat (impact) on the pans surveyed are roads, houses and alien vegetation (Whittington-Jones 2003).

10.2.3.1.1 Wetlands

SA currently has 17 wetlands designated as having international importance in terms of the RAMSAR Convention. Of these only six are inland freshwater wetlands, the Blesbokspruit within the EMM being one of them. Within the Blesbokspruit are the Grootvaly Wetland Reserve (Blesbokspruit Wetland Reserve - 350 ha) and the Marievale Bird Sanctuary. The boundaries of the RAMSAR Site have never been clearly defined.

The Blesbokspruit wetland is a high conservation priority as it forms an important component of one of the tributaries of the Vaal River that provides water to the Gauteng Province. This wetland is permanently inundated and reed dominated (*Typha* and *Phragmites*). It is permanently flooded due to artificial inputs of water (e.g. from mines and sewage treatment works) and the reedbeds are probably supported by the eutrophic status of the water. Approximately 45% of the catchment is urbanised while the remaining land is utilized for agricultural, mining and industrial activities. This wetland supports a variety of noteworthy fauna and flora species.

A summary of the ecological state of the Klip River, Natalspruit and Blesbokspruit is provided in Table 10.11, with definitions for the river health indicators and categories below. According to the River Health Programme (RHP) the three rivers that have been monitored in EMM, namely the Klip River, Natalspruit and Blesbokspruit, have all been impacted to some degree by human activities in the area. The three river systems generally have habitats that are in fair condition, the condition of aquatic invertebrates and fish populations is poor. The riparian vegetation differs between the three river systems: the Blesbokspruit has good riparian vegetation while the Natalspruit riparian vegetation is classified as fair and the Klip River as poor. Water quality for the Natalspruit and Blesbokspruit is poor while it is fair for the Klip River. For the Blesbokspruit the poor water quality is largely due to artificial inputs from mines (gold and open-cast coal mines), sewage treatment works and other industrial activities (i.e. point source discharges), the water quality is influenced by the total dissolved solids in these effluents.

Table 10.11: Ecological state of the Klip River, Natalspruit and Blesbokspruit

River Health Indicator	Upper Klip River	Natalspruit	Lower Klip River	Upper Blesbokspruit	Mid Blesbokspruit	Lower Blesbokspruit
Habitat	Good	Fair	Fair	Poor	Fair	Fair
Aquatic Invertebrates	Poor	Poor	Poor	Poor	Poor	Fair
Fish Populations	Poor	Poor	Poor	Poor	Poor	Poor
Riparian Vegetation	Fair	Fair	Poor	Poor	Good	Poor
Water Quality	Poor	Poor	Fair	Poor	Poor	Poor

Source: River Health Programme 2003

Definitions:

	River Health Indicators
Habitat:	*Instream availability and habitat diversity*
Aquatic Invertebrates:	*A variety of organisms (snails, insect larvae, crabs & worms) requires specific habitat typesand water quality for part of hteir life cycle*
Fish populations:	*Fish are good indicators of the longer term influences on a river reach and general habitat conditions*
Riparian vegetation:	*Healthy riverbanks maintain the form of the river channel, provide habitat for species (aquatic and terrestrial) and filter sediment minerals and light*
Water quality:	*The chemical, physical and bacteriological properties of water determine its suitability for use*
	River Health Category
Natural:	*No negligible modification of habitat and biota*
Good:	*Some human-related impact; biodiversity largely intact*
Fair:	*Significant pressure from development and land use; sensitive species may be lost*
Poor:	*Natural functioning disrupted; extensive use of river ecosystem*

10.3 RESPONSES

10.3.1 Policy

Draft Development Guidelines for Ridges (DACEL 2001a)

Ridges provide an important habitat for Red Data and/ or threatened species of plants and animals. The Ridges in Gauteng act as refuges for a number of plant, mammal, bird, reptile, amphibian and invertebrate species, many of which are restricted to ridge habitats. Ridges act as corridors between habitat patches and are important in ecosystem functioning; they are also less likely to be impacted by climate change. As such they are considered to be no-go areas for development and their conservation is vital. This policy has classified the ridges in Gauteng depending on the percentage of the ridge that has been transformed. Suikerbosrand Ridge in EMM is classified as a class 1 ridge (0-5% transformed) with no further development permitted. The Klipriviersberg is classified as class 2 (5-35% transformed), a no-go development policy is encouraged for this area with no further subdivisions allowed and consolidation of subdivisions encouraged.

Draft Red Data Policy for Environmental Impact Evaluations (DACEL 2001b)

This policy has developed a priority ranking of Red Data plants species for the Gauteng Province based on a set of selected criteria. This policy is based on the following principles: conservation of all populations and associated ecological processes of threatened and endemic plant species to Gauteng; conservation of pollinators associated with these species. The policy discourages the translocation of Red Data species and encourages the conservation of areas adjacent to Red Data plant populations and the creation of buffer zones.

This policy also deals with buffer zones[14]. The minimum buffer zone set for Red Data plant populations in grassland is 200 m.

Draft Policy for regulating the Export of Indigenous Plant Species from the province of Gauteng to International Destinations (DACEL 2001c).
This policy places certain restrictions on the collection, propagation and sale of wild plant species and requires permits for each of these activities. Commercial activities involving indigenous plants are also restricted and controlled.

Draft Policy for Rehabilitation of indigenous Wildlife (DACEL 2001d)
This policy document sets out the goals, principles, code of ethics for wildlife rehabilitation and the profile and skills of a rehabilitator. Wildlife rehabilitation will also be regulated by the legislation listed below.

10.3.2 Legislation

10.3.2.1 International Law

There are several international treaties dealing either entirely or partly with biodiversity. The most important is the Convention on Biodiversity. Other international agreements include the Convention on International Trade in Endangered Species of Fauna and Flora (CITES), the Convention on Wetlands of International Importance (RAMSAR), the Convention on the Protection of World Cultural and Natural Heritage Sites, the African Convention on Conservation of Nature and Natural Resources and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn).

The Convention on Biological Diversity
The convention aims to promote sustainable use of living natural resources worldwide through fair and equitable sharing of the benefits arising from the utilization of natural resources. It also promotes the following:

- Protection of ecosystems, habitats and species;
- Sustainable use of wetlands;
- Rehabilitation of degraded ecosystems;
- An ecosystem approach

The RAMSAR Convention (1971 Convention on Wetlands of International Importance especially as Waterfowl Habitat)
This convention promotes the following principles:

- The conservation of listed wetlands;
- The wise (sustainable) use of wetlands;
- International co-operation; and
- The creation of wetland reserves.

[14] A buffer zone is a collar of land that filters out inappropriate influences from surrounding activities (Shafer 1999 cited by DACEL 2001b), also known as edge effects, including the effects of invasive plant and animal species, physical damage and soil compaction caused through trampling and harvesting, abiotic habitat alterations and pollution (DACEL 2001b).

The NEPAD environmental initiative

This promotes the following:

- Training & capacity building;
- Communication;
- Rehabilitation; and
- International cooperation.

10.3.2.2 National Legislation

The Environment Conservation Act (Act No. 73 of 1989)

In terms of this act, Environmental Impact Assessments (EIAs) are required for a range of developments. The legislative significance given to environmental conservation within this act, subjects any proposed land-use change or development to an EIA. The prior determination of negative environmental impacts through the EIA process ensures a more sustainable approach to terrestrial resource usage. Moreover the Act can be applied to most of the terrestrial resources and will positively impact on their long-term sustainability in Gauteng. The act is administered by GDACEL.

World Heritage Draft Bill, 1999

This bill will enable the identification and promulgation of world heritage sites in the country. The Bill is administered by the National DEAT. The Bill promulgates the conservation and sustainable management of those sites which would be regarded as world heritage sites. The Bill gives effect to promoting conservation of terrestrial environments such as national parks, historic sites, geological sites of cultural or scientific importance.

Sectoral legislation that aims to ensure the sustainable utilisation and protection of terrestrial resources are:

Tourism Act (Act No. 72 of 1993)

The Tourism Act will influence any tourism development as it deals with the setting of certain standards for resort activities. The construction of game reserves, lodges and other such projects will mean that all environmental impacts will have to be considered and the standards as laid down by the act will have to be adhered to.

Conservation of Agricultural Resources Act (Act No. 43 of 1983)

Control of the utilization and protection of wetlands, soil conservation and all matters relating thereto; control and prevention of veld fires, control of weeds and invader plants, the prevention of water pollution resulting from farming practices and losses in biodiversity.

The National Evironmental Management Act (NEMA) (Act No. 107 of 1998)

This Act embraces all three fields of environmental concern namely: resource conservation and exploitation; pollution control and waste management; and land-use planning and development. The environmental management principles include the duty of care for wetlands and special attention is given to management and planning procedures.

The Gauteng Nature Conservation Ordinance (Ordinance No. 12 of 1983)
This ordinance deals with the conservation of wild animals, fresh water fish and the conservation and protection of flora. Animals and plants are both listed in the schedules with different degrees of protection afforded to each.

The Criminal Procedures Act (Act No. 51 of 1989)
Deals with the breaching of certain duties relating to the protection of the environment. The relevant section of the NEM headed “Private Prosecution” builds on the general provisions of this Act.

The Fertilisers, Farm Feeds, Agricultural Remedies and Crop Remedies Act (Act No. 36 of 1947)
This Act places prohibitions on the acquisition, disposal, sale and use of certain agricultural remedies in certain areas.

The Animal Protection Act (Act No. 71 of 1962)
The objective of this Act is to prevent cruelty to animals. The core provision contains extensive prohibitions on the maltreatment of animals and makes such action a criminal offence subject to a fine and/or imprisonment.

Ordinance: Transvaal Nature Conservation Ordinance 12, 1983.
This lists the familes, genera and species that are protected within the Province. The whole Ordinance will be revised and made into one Act once the Biodiversity Bill has been enacted.

The Biodiversity Bill

- Lists ecosystems that are threatened or in need of national protection
- Links to Integrated Environmental Management process
- Must be taken into account in EMP and IDPs
- The Minister may make regulations to reduce the threats to listed ecosystems.

The National Water Act (Act No. 36 of 1998)
This act is unique and ground breaking as it refers to ‘Ecological Reserves’. It includes the protection of aquatic and associated ecosystems and biodiversity and the regulation of water use and activities in wetlands, rivers and lakes.

10.3.3 Programmes and initiatives

The **WfW**, which is aimed at both job creation and gaining some measure of control over alien invasive plants, is a programme that will positively impact on both terrestrial and aquatic environments. The removal of alien plants will significantly promote the sustainability of biodiversity in SA. Furthermore the programme will enhance existing conservation programmes that are currently in place. There is however currently no WfW activity in the EMM.

An Interim **Blesbokspruit Management Committee** was formed to discuss objectives for the Blesbokspruit site. GDACEL has undertaken management of the provincial Marievale Nature Reserve. A staff member has been allocated to the reserve and a variety of infrastructure developments have added to the services offered and appeal of the reserve.

An **Environmental Sensitivity Analysis** is currently being undertaken for Inyoni Park, located in Extension 37 of Vosloorus along the Natalspruit River. The objective of the study is to: identify environmentally sensitive areas; set development zones according to environmental sensitivity; provide a framework for future development.

The **National Wetland Inventory** aims to determine the extent of the distribution and diversity for each wetland required before they can be properly conserved and prioritised for rehabilitation. This is being conducted in conjunction with the national baseline wetland mapping through the National Land Cover 2000 (Green Trust, NORAD). GDACEL are currently verifying in the field, the preliminary NLC wetland data.

Working for Wetlands (WfW, DEAT, DWAF, National Department of Agriculture, Mondi) this project uses wetland rehabilitation to achieve other goals such as job creation.

GDACEL are currently busy with the **Gauteng Biodiversity Gap Analysis** that will result in important areas for the conservation of biodiversity (at all levels) being delineated and set aside in order to meet 10% protected area coverage. Preliminary data from this analysis have been used in this report.

There are various activities, initiatives and projects underway in which members of the local public are involved.

10.4 MONITORING

10.4.1 Information and data gaps

The nature and functioning of corridors between aquatic habitats (rivers, wetlands, dams and pans) has not been studied.

There have never been any detailed invertebrate studies done for Gauteng or the EMM area. Surveys carried out have been fragmented and concentrated only in Nature Reserves and only partial specialist studies done in conservancies so we can only draw data from these results. The other distribution data is obtained from Collections and Publications and is not always valid in terms of identification, place or locality descriptions. In addition historical records dating back more than 10-20 years are questionable due to land reformation and changes in land use. The continual distribution, dispersal and migration processes that take place in invertebrate species needs to be monitored. Much information is contained in unpublished records that are difficult to obtain.

The following are considered to be limitations of the Draft NLC data used in this study:

- Limited accuracy: the estimated accuracy is 50% of wetlands between 1-2 ha and 60-70% of wetlands between 2-5ha. There is thus an under-representation of small narrow transformed wetlands and the classification system is ambiguous;
- The data used has not been ground truthed and subjected to an accuracy assessment.

Wetland monitoring: Research needs to look at the catchment scale and assess the health and functioning of wetlands and establish a link between rehabilitation and sustainable livelihoods.

Very little information exists on medicinal plant collection in the existing reserves in EMM. Investigations into actual resource use in the Meyersdal area, Suikerbosrand Nature Reserve and other reserves in the area are necessary for management reccommendations. The comparison of plant species lists is often problemmatic in that some databases are not updated frequently and identical species may have different names making them incomparable. A common limitation of obtaining information on plant species use is that this information is obtained in the indigenous language and then needs to be translated into species; there are often many species name for a single vernacular name. Bearing these limitations in mind: the information obtained on medicinal plant use requires comparisons with actual extraction of plants from the areas in the EMM.

Based on the recent declaration of the EMM, specialist taxonomic investigations (for invertebrates, plants and mammals) involving field surveys are essential for determining exactly which species occur in this metropolitan municipality area.

Population information on the Giant Bullfrog requires further long-term studies in the area, and especially around Bullfrog Pan.

10.4.2 Recommended future indicators

Most biodiversity indicators focus on the species level, since this level has the greatest amount of information available. This focus needs to shift to the population, landscape and ecosystem level to ensure that the processes that are maintaining species distribution patterns are conserved. By focussing on the processes forming the apparent pattern there is also a greater chance that species will be conserved even in the face of disturbances and climate change. Management needs to take into consideration these processes (including disturbances). Studies on movement of animals and insects need to be undertaken and the interconnectedness of plants and animals needs to be investigated ie conservation of a threatened plant in the absence of its relevant pollinator is futile. If sufficient data becomes available through additional monitoring a useful indicator would be population trends of selected species, in particular, threatened species.

Recommended future indicators include:

- A detailed survey and definition/description of natural habitats and open space resources in the EMM, followed by biannual monitoring of:
    - Ecological integrity of selected reserve/open space trail plots;
    - Species abundance of selected species in known localities;
    - Trends in species richness in trail plots in key habitat areas;

- Population trends in selected indicator species.

10.5 CONCLUSIONS

A considerable portion of the EMM's surface area still comprises untransformed grassland. This grassland forms an important habitat for a wealth of biota (including threatened species of plants, mammals, birds, reptiles, amphibians and invertebrates). While the conservation of these species is vital, the conservation of intact grassland habitat is critical to conserving current and future patterns of distribution and the processes that maintain these patterns. The current state of the EMM's biotic (terrestrial and aquatic) environment and the impacts on biodiversity and habitats suggests that additional grassland habitats need to be conserved in order to protect both threatened species occurring in the EMM and the processes associated with these species' survival. The recommendations, provided by GDACEL's Biodiversity GAP Analysis, need to be incorporated into any spatial planning in the EMM.

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