TECHNICAL REPORT FOR THE GAUTENG CONSERVATION PLAN (GAUTENG C-PLAN V3.3)

March 2014

GAUTENG DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT

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TECHNOLOGICAL SERVICES
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</tr>
</tbody>
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Citation

Dedication
In memory of Pieta Compaan.

Revision of the Technical Document
The technical document was revised by ECOSOL GIS: Dr Stephen Holness, Andrew Skowno and Deborah Vromans.
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EXECUTIVE SUMMARY

A systematic conservation plan for the Gauteng Province was undertaken by Gauteng Nature Conservation, a division within the Gauteng Department of Agriculture and Rural Development (GDARD). The Gauteng Conservation Plan Version 3.3 (Gauteng C-Plan v3.3) was released in February 2012. It was built on, and replaces C-Plan Version 2.1 (2007).

This document provides a technical explanation of the data used, and the systematic conservation planning approach and methodology applied in developing the Gauteng C-Plan v3.3. It is based on the initial technical report (GDARD, 2013).

Gauteng C-Plan v3.3 is based on the systematic conservation planning approach described by Margules & Pressey (2000). The key characteristics of a systematic conservation plan are representation, persistence, quantitative targets, and efficiency and conflict avoidance (DEAT, 2009).

The main aims of Gauteng Conservation Plan Version 3.3 are to:

- Serve as the basis for biodiversity inputs into land use planning processes in the province.
- Serve as the basis for biodiversity inputs into bioregional plans for municipalities within the province.
- Serve as the primary informant for the biodiversity component of the Basic Assessment and Environmental Impact Assessment (EIA) processes.
- Guide protected area expansion and biodiversity stewardship programmes in the province.

The Gauteng C-Plan v3.3 delineates on a map, commonly known as a Critical Biodiversity Areas Map, biodiversity priority areas called Critical Biodiversity Areas, Ecological Support Areas and Protected Areas. The map is designed to be used at approximately 1:50 000 scale.

The Critical Biodiversity Areas are comprised of key areas that are required to meet national biodiversity pattern and process targets. Ecological Support Areas are areas required to prevent the degradation of Critical Biodiversity Areas and Protected Areas.

Input layers into Gauteng C-Plan v3.3 included a new land cover map, a new vegetation map, a range of revised threatened species data, data on important aquatic features including pans, unique aquatic biodiversity features and best-condition quaternary catchments, and priority areas for climate change adaptation. The Ecological Support Areas included comprised of dolomite areas, aquatic features which were not includes as CBAs (rivers, floodplains, and wetlands), as well as additional areas important for climate change adaptation such as ridges. The analysis process avoided areas of high conflict with other land uses, and favoured inclusion of areas best aligned with local planning instruments (e.g. identified Metropolitan Open Space Systems).

Protection of the priority areas identified in Gauteng C-Plan v3.3 would sufficiently contribute (on a proportional basis to ecosystem extent in Gauteng Province) to meeting national biodiversity targets for the South African vegetation types. Further, although nationally identified Freshwater Ecosystem Priority Areas (Nel et al., 2011) are not included as features in the analysis, these areas are sufficiently represented in the CBA and ESA areas.

Although there are certain deviations from the planning process and definitions commonly used elsewhere in South Africa, the Gauteng C-Plan v3.3 meets the requirements of the "Guideline regarding the Determination of Bioregions and the Preparation and Publication of Bioregional Plans" (DEAT, 2009).
ABBREVIATIONS

CBA: Critical Biodiversity Area
DEA: Department of Environmental Affairs
DEAT: Department of Environmental Affairs and Tourism
ESA: Ecological Support Area
FEPA: Freshwater Ecosystem Priority Areas
Gauteng C-Plan v3.3: Gauteng Conservation Plan Version 3.3 (this conservation plan)
GDARD: Gauteng Department Agriculture and Rural Development
GIS: Geographic Information System
GTI: GeoTerra Image (GTI) Pty Ltd
ha: Hectare
IUCN: International Union for Conservation of Nature
LC09: Land cover 2009 dataset developed by GTI
PA: Protected Area
SABCA: South African Butterfly Conservation Assessment
SANBI: South African National Biodiversity Institute
1. INTRODUCTION AND OBJECTIVES

A systematic conservation plan for the Gauteng Province was undertaken by Gauteng Nature Conservation, a division within the Gauteng Department of Agriculture and Rural Development (GDARD). The Gauteng Conservation Plan Version 3.3 (Gauteng C-Plan v3.3) was released in February 2012. It was built on, and replaces C-Plan Version 2.1 (2007).

This document provides a technical explanation of the data used, and the systematic conservation planning approach and methodology applied in developing the Gauteng C-Plan v3.3. It is based on the initial technical report (GDARD, 2013).

The Gauteng C-Plan v3.3 delineates on a map, commonly known as a Critical Biodiversity Areas Map, biodiversity priority areas called Critical Biodiversity Areas, Ecological Support Areas and Protected Areas. The map is designed to be used at approximately 1:50 000 scale as the integrated biodiversity input into land use planning and decision making. Gauteng C-Plan v3.3 should be used as the key biodiversity informant in the compilation of bioregional plans, Environmental Management Frameworks and Municipal Spatial Development Frameworks, and should be a primary biodiversity consideration in Environmental Impact Assessments.

1.1. SYSTEMATIC CONSERVATION PLANNING

The Gauteng Conservation Plan Version 3.3 (Gauteng C-Plan v3.3) has been developed using a systematic conservation planning approach. Systematic conservation planning has become the standard approach to conservation planning in South Africa, due to its robust scientific approach and internationally recognized principles and methodologies. The key characteristics of a systematic conservation plan are:

1. The setting of quantitative biodiversity targets.
2. The principles of representation and persistence.
3. The principles of efficiency and conflict avoidance

**Biodiversity Targets:** Systematic conservation plans set quantitative thresholds for biodiversity features (e.g. vegetation types, wetlands, rivers and species), in terms of both pattern and process. For example, for terrestrial ecosystems, targets are set as a proportion of the original extent of an ecosystem that needs to be maintained in a natural state, and are the minimum proportion of ecosystem types required for the persistence of biodiversity.

**The principles of representation and persistence:** The planning approach is based on conserving a representative sample of biodiversity pattern (e.g. vegetation types, wetlands, rivers), including species (the principle of representation), as well as the ecological and evolutionary processes (e.g. hydrological processes, nutrient cycling, fire, pollination, species migration) that maintain biodiversity (the principle of persistence).

**The principles of efficiency and conflict avoidance:** The configuration of biodiversity priority areas identified in the planning process is designed to be spatially efficient (i.e. to meet targets as efficiently as possible in terms of the amount of land required) and, where possible, to avoid conflict with other existing land uses.

Refer to Section 6 describing the conservation planning approach adopted by the Gauteng C-Plan v3.3 and Section 7 for an explanation on how the Gauteng C-Plan v3.3 meets the systematic conservation planning criteria required in order for it to serve as the basis for a bioregional plan.
1.2. CRITICAL BIODIVERSITY AREAS, ECOLOGICAL SUPPORT AREAS AND PROTECTED AREAS

The final spatial outcome of the systematic conservation planning process is a map that delineates biodiversity priority areas for conservation and sustainable land use management. The map, which is commonly referred to as a Critical Biodiversity Areas or CBA Map, identifies biodiversity priority areas in a number of major categories:

1. Protected Areas
2. Critical Biodiversity Areas
3. Ecological Support Areas

**Protected Areas (PA):** Protected Areas are areas which have legal protection under relevant legislation or which are managed with a primary conservation objective. Importantly, the Protected Area definition used and the areas included in Gauteng C-Plan v3.3 deviate from those typically used in other South African conservation plans, as the key criteria used to guide inclusion or exclusion is the type of conservation management applied in an area rather than its legal status. For example, World Heritage Sites and Protected Environments are not considered to be Protected Areas while certain undeclared conservation areas are included. Refer to Section 4 for the detailed PA definitions.

**Critical Biodiversity Areas (CBAs):** CBAs include natural or near-natural terrestrial and aquatic features that were selected based on an areas biodiversity characteristics, spatial configuration and requirement for meeting both biodiversity pattern and ecological process targets. CBAs include irreplaceable sites where no other options exist for meeting targets for biodiversity features, as well as best-design sites which represent an efficient configuration of sites to meet targets in an ecologically sustainable way that is least conflicting with other land uses and activities. These areas need be maintained in the appropriate condition for their category. Some CBAs are degraded or irreversibly modified but are still required for achieving specific targets, such as cultivated lands for threatened species. Refer to Section 2 for the biodiversity features that represent the Critical Biodiversity Areas and Section 5.2.1 for a summary of the CBA criteria.

**Ecological Support Areas (ESAs):** Natural, near-natural, degraded or heavily modified areas required to be maintained in an ecologically functional state to support Critical Biodiversity Areas and/or Protected Areas. ESAs maintain the ecological processes on which Critical Biodiversity Areas and Protected Areas depend. Some ESAs are irreversibly modified, but are still required as they still play an important role in supporting ecological processes. Refer to Section 3 for the biodiversity features that represent the Ecological Support Areas and Section 5.2.2 for a summary of the ESA criteria.

1.3. KEY OBJECTIVE AND LIMITATIONS OF THE GAUTENG C-PLAN V3.3

The Gauteng Conservation Plan Version 3.3 identifies those sites that are critical for maintaining biodiversity, enabling planners, environmental professionals, and land use managers to integrate biodiversity into land use planning and decision-making.

**The key objective of the Gauteng C-Plan v3.3 is to serve as the biodiversity informant to:**

2. Land use decision-making (i.e. Basic Assessments, Environmental Impact Assessments, town planning applications and agricultural activities).
3. Land use planning (i.e. Municipal Integrated Development Plans, Spatial Development Frameworks, Environmental Management Frameworks and Zoning Schemes).
4. Proactive conservation activities (i.e. guiding protected area expansion and stewardship programmes, improving land management through programmes such as the clearing of invasive alien plants or wetland rehabilitation.

In summary, Gauteng C-Plan v3.3 has produced a Critical Biodiversity Areas Map for the purpose of integrating biodiversity into land use planning and decision making. There are, however, some limitations to the Gauteng C-Plan v3.3.

Limitations of the Gauteng C-Plan v3.3:

1. The Gauteng C-Plan v3.3 does not replace the need for site assessments, particularly for Environmental Impact Assessments and Basic Assessment. Although it is based on a fine-scale systematic biodiversity plan, this does not remove the need for on-site verification of the identified Critical Biodiversity Areas;
2. The Gauteng C-Plan v3.3 is designed to be used at a scale of approximately 1:50 000. Although it can be used at a finer scale, this requires specialist interpretation of the specific features identified in the systematic biodiversity plan;
3. The Gauteng C-Plan v3.3 was developed using appropriate methods; and uses the best available data at the time of its development. However, current scientific knowledge of key aspects such as the distribution of certain threatened species remain incomplete.

Land use change in the province is rapid and on-going, and results in biodiversity losses. This may impact on the Critical Biodiversity Areas network identified in the Gauteng C-Plan v3.3 (Section 5, Figure 3). It is likely that additional areas would need to be designated as Critical Biodiversity Areas in future iterations of the conservation plan.

2. BIODIVERSITY FEATURES USED TO DEFINE CRITICAL BIODIVERSITY AREAS

As noted above, Critical Biodiversity Areas (CBAs) include irreplaceable sites where no other options exist for meeting targets for biodiversity features, as well as best-design sites which represent an efficient configuration of sites to meet targets in an ecologically sustainable way that is least conflicting with other land uses and activities. CBAs include both terrestrial and aquatic habitats, including threatened species and their habitat requirements, as well as important ecological process that ensure the persistence of biodiversity.

The key data layers developed for, and included in, the Gauteng Conservation Plan 3.3, to enable the identification of Critical Biodiversity Areas are:

1. Land Cover Map
2. Gauteng Vegetation Map
3. Threatened Species
4. Aquatic Features
5. Climate Change Related Features

The remainder of this section explains derivation of these layers.
2.1. LAND COVER MAP

Land cover data is a key informant required for the development of a systematic conservation plan. Land cover data enables conservation planners to identify ecologically intact areas of biodiversity, as well as land that is degraded or irreversibly modified (urban areas, intensive cultivation). This is fundamental in the process of mapping Critical Biodiversity Areas (and Ecological Support Areas). In most instances, only natural and semi-natural areas where biodiversity features have not been irreversibly modified were available for selection in Gauteng C-Plan v3.3. In some specific instances, irreversibly modified areas (e.g. cultivated areas) were selected as CBAs as these areas were required for meeting targets for certain threatened species.

A new land cover dataset was developed for the Gauteng C-Plan v3.3 from a combination of the following data:

1. SPOT5 10m resolution satellite imagery (acquired in 2008 and 2009).
2. 50 cm resolution aerial photography, covering the main urban centres of Pretoria and Johannesburg (acquired in 2009).

The SPOT5 and aerial photograph imagery was used by GeoTerralmage (GTI) Pty Ltd to develop a land cover map in 2009. All the digital aerial photography and the SPOT5 imagery was ortho-rectified using a combination of aerial photography and cadastre as the primary geographical reference, and a 20m Digital Elevation Model (DEM) for terrain height (GTI, 2009). In addition, the land cover dataset was manually updated using heads-up digitizing methods in areas where development occurred after the imagery was processed, or in areas where the remote sensing process did not appropriately identify modified land cover classes.

The land cover map is of extremely high resolution and is at least the equivalent of the best available elsewhere in South Africa, and is useable at a 1:30 000 scale. The key accuracy issue relates to the rapidly changing urban landscape within Gauteng, which results in the land cover dataset becoming out-dated very quickly.

Table 1: Summary of the Land Cover Classes in the Gauteng

<table>
<thead>
<tr>
<th>Land Cover Level 1</th>
<th>Level 2</th>
<th>Extent in Gauteng Province Hectares</th>
<th>% Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural and semi-natural landscapes</td>
<td>Natural - Terrestrial</td>
<td>951 308</td>
<td>52%</td>
</tr>
<tr>
<td></td>
<td>Natural - Aquatic</td>
<td>70 631</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Natural and semi-natural Sub-Total</strong></td>
<td></td>
<td><strong>1 021 939</strong></td>
<td><strong>56%</strong></td>
</tr>
<tr>
<td>Irreversible Modification</td>
<td>Cultivated lands</td>
<td>445 606</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>291 750</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>Mining</td>
<td>58 538</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Irreversible Modification Sub-Total</strong></td>
<td></td>
<td><strong>795 894</strong></td>
<td><strong>44%</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1 817 833</strong></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1: Summarized land cover classes from the Gauteng land cover map (1:30 000 scale).
2.1.1. Availability of Land Cover Classes for selection in Gauteng C-Plan v3.3

The land cover classes used in the Gauteng C-Plan v3.3 are shown in Table 2. Based on the suitability of a particular land cover class for supporting important biodiversity features, the classes were allocated to the categories ‘Available’ and ‘Excluded’.

1. **Available**: These included natural habitats, such as grasslands, wetlands and woodlands; and artificial habitat such as dams, vegetated old lands and currently cultivated land*. In other words, these areas were identified as having potential biodiversity value and could be selected as Critical Biodiversity Areas.

2. **Excluded**: These are land cover types, such as urban areas, industrial and mining areas and non-vegetated or degraded old lands. In other words, these areas are irreversibly modified, have little or no biodiversity value and could not be selected as Critical Biodiversity Areas.

### Table 2: Land Cover Classes used in Gauteng C-Plan v3.3 (Reclassification of GTI Land Cover 2009)

<table>
<thead>
<tr>
<th>Gridcode</th>
<th>LC09 No.</th>
<th>Land Cover Class</th>
<th>Inclusion in C-Plan v3.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Dense Trees / Bush</td>
<td>Available</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Woodland / Open Bush</td>
<td>Available</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Wooded Grassland</td>
<td>Available</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Grassland</td>
<td>Available</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>Natural Bare Rock</td>
<td>Available</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>Rocky Grass Matrix</td>
<td>Available</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>Urban Woodland</td>
<td>Available</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>Urban Grass</td>
<td>Available</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>Natural Water</td>
<td>Available</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>Man-made Water</td>
<td>Available</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>Wetland (non pan)</td>
<td>Available</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>Wetland Pans</td>
<td>Available</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>Smallholdings: Dense Trees / Bush</td>
<td>Available</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>Smallholdings: Woodland / Open Bush</td>
<td>Available</td>
</tr>
<tr>
<td>26</td>
<td>26</td>
<td>Smallholdings: Wooded Grassland</td>
<td>Available</td>
</tr>
<tr>
<td>27</td>
<td>27</td>
<td>Smallholdings: Grassland</td>
<td>Available</td>
</tr>
<tr>
<td>551</td>
<td></td>
<td>All cultivated lands. Cultivated Crops (17), Pasture (18), Cultivated Other (19), Smallholdings: Cultivated (29)</td>
<td>Available</td>
</tr>
<tr>
<td>9999</td>
<td></td>
<td>Degraded (5), Non-Vegetated / Bare(6), Plantation &amp; Woodlot (9), Urban Trees (10), Intensive Cattle Camps (20), Urban (21), Mines (22), Sports &amp; Recreation Grassland (23), Smallholdings: Degraded (28), Old Lands: Degraded (34), Old Lands: Non-Vegetated / Bare, Old Lands (topo): Degraded (40), Old Lands (topo): Non Vegetated / Bare (41).</td>
<td>Excluded</td>
</tr>
</tbody>
</table>
In addition to the classification of areas in terms of availability for inclusion into the conservation planning process (Table 2), the land cover data was also used to develop datasets of:

1. Natural habitat: Primary grasslands, woodlands and other vegetation.
2. Natural and semi-natural habitats: As above, but including secondary grasslands (Old lands).
3. Cultivated lands: All currently cultivated areas.

* Recommendations for future iterations of Gauteng C-Plan:* Categorizing cultivated land as ‘Available’ for selection as Critical Biodiversity Area is a very different approach compared with most other South African systematic conservation plans (where irreversibly modified land cover classes are usually excluded). This issue was dealt with in the Bioregional Planning Process by placing irreplaceably modified areas which were identified as priorities (e.g. cultivated lands identified as priority areas for the conservation of threatened species) into a separate class within the Critical Biodiversity Areas. It is strongly recommended that the approach taken in Gauteng C-Plan v3.3 is not repeated in future iterations of the plan. Should irreversibly modified habitat be required for threatened species, this should be separately identified and included as in its own category. This is necessary to allow appropriate inclusion into Bioregional Plans, and facilitates the establishment of clear land use guidelines.
2.2. **GAUTENG VEGETATION MAP**

A new vegetation map was developed for Gauteng (Hoare and Pfab, in prep.; Hoare et al., in prep.). The mapping process developed environmental envelopes based on the conditions found at sample sites associated with specific vegetation types. The range of environmental attributes that were included in the vegetation models were:

1. Average topsoil clay content
2. Average soil depth
3. Terrain units
4. Mean rainfall
5. Maximum temperature
6. Minimum temperature
7. Land type
8. Geology
9. Slope
10. Altitude

Where there was no overlap of environmental attributes, an area was immediately allocated to a specific vegetation type. In areas with characteristics that fell within the environmental envelopes for more than one vegetation type, an area was assigned a vegetation type based on the vegetation type of nearby sample sites, or if an adjacent area had already been allocated to a vegetation type, then this type was assigned.

The resultant map described 12 vegetation types (Refer Table 3 and Figure 2). The main difference to the South African national vegetation map (Mucina and Rutherford, 2006) is the absence of Egoli Granite Grassland and Tsakane Clay Grassland. As these two vegetation types have subsequently been listed as threatened ecosystems, (DEAT, 2011), it is critical that the revised map is formally published to justify the deviation from the currently recognized list of threatened ecosystems.

**Table 3: Vegetation types and their targets included in Gauteng C-Plan v3.3**

<table>
<thead>
<tr>
<th>Vegetation Type (Habitat)</th>
<th>Total Vegetation (ha)</th>
<th>Remaining Primary Vegetation (ha)</th>
<th>Target (ha)</th>
<th>Target % of Total Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Sandy Bushveld</td>
<td>193 187</td>
<td>111 298</td>
<td>48 486</td>
<td>25</td>
</tr>
<tr>
<td>Clay Grassland</td>
<td>30 604</td>
<td>12 961</td>
<td>2 374</td>
<td>8</td>
</tr>
<tr>
<td>Gauteng Grassland</td>
<td>1 046 365</td>
<td>296 153</td>
<td>219 044</td>
<td>21</td>
</tr>
<tr>
<td>Loskop Mountain Bushveld</td>
<td>39 987</td>
<td>37 030</td>
<td>9 145</td>
<td>23</td>
</tr>
<tr>
<td>Magaliesberg Mountain Bushveld</td>
<td>23 822</td>
<td>19 888</td>
<td>5 383</td>
<td>23</td>
</tr>
<tr>
<td>Marikana Thornveld</td>
<td>89 778</td>
<td>32 359</td>
<td>18 750</td>
<td>21</td>
</tr>
<tr>
<td>Moot Plains Bushveld</td>
<td>48 750</td>
<td>21 589</td>
<td>10 913</td>
<td>22</td>
</tr>
</tbody>
</table>
The remaining extent of primary vegetation of each type was identified by removing all irreversibly modified land cover classes (e.g. cultivated lands, urban areas), as well as old lands. This layer of primary vegetation, which represents existing natural habitat, was used as a key input layer into the Gauteng C-Plan v3.3 (Figure 2).

Targets were calculated using a species area model, which resulted in targets for vegetation types varying from 8 to 27% of the original extent of habitat types. The targets were designed to identify the area required to represent 80% of the species present in that habitat type. This method, and the resultant targets, is comparable with that used in the National Biodiversity Assessment for setting targets (Driver et al., 2012). Only targets for Clay Grassland are lower than those used for similar habitats in the National Biodiversity Assessment, but the low target appears to be fully justified based on low species diversity in this habitat type. Refer to Section 8 which deals with how well the South African vegetation type targets have been incorporated in the Critical Biodiversity Areas network.
Figure 2: Remaining areas of primary vegetation.
2.3. THREATENED SPECIES

Habitat requirements for a number of threatened species were included in the conservation planning process and used to guide section of Critical Biodiversity Areas.

Plants, birds, mammals, reptiles, and invertebrates have been assessed and classified according to their potential for extinction in the near future. Species are listed in the Red Data Book and are classified as Extinct, Critically Endangered, Endangered, Vulnerable, Near Threatened or Least Concern. Threatened species are defined as Critically Endangered, Endangered, and Vulnerable, and it is typically these species which are included in systematic conservation plans in South Africa. In addition to these threatened species, Gauteng C-Plan v3.3 also includes Near Threatened and Rare species.

The threatened species groups included in the assessment of Critical Biodiversity Areas were plants, birds, mammals, invertebrates and reptiles. The methodology for each group is explained below.

2.3.1. Plants

Forty-five threatened plants species, derived from Gauteng’s 2009 red and orange listed plants, were prioritized according to a ranking scheme (Pfab, 2000) (Table 4). The ranking scheme prioritized threatened species based on:

1. **Endemism to South Africa (Criteria A):** A1 species being SA endemics and A2 species being found over a broader area.
2. **Localized distributions (Criteria B):** B1 species are found only in Gauteng, B2 species in Gauteng and one other province/country, and B3 species in Gauteng and two provinces or countries.

<table>
<thead>
<tr>
<th>Species</th>
<th>Priority Grouping</th>
<th>Conservation Status</th>
<th>Confirmed habitat with 100% targets (ha)</th>
<th>Number of distinct populations &amp; targets set for these distinct populations</th>
<th>Total number of distinct populations</th>
<th>Target number of distinct populations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Adromischus umbraticola subsp. umbraticola</td>
<td>A2</td>
<td>Near Threatened$^1$</td>
<td>408</td>
<td>31</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>2. Alepidea attenuata</td>
<td>B</td>
<td>Near Threatened$^2$</td>
<td>18</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Aloe peglerae</td>
<td>A2</td>
<td>Endangered$^1$</td>
<td>2 918</td>
<td>7</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4. Argyrolobium campicola</td>
<td>A3</td>
<td>Near Threatened$^1$</td>
<td>7</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Argyrolobium megarrhizum</td>
<td>A3</td>
<td>Near Threatened$^1$</td>
<td>15</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Blepharis uniflora</td>
<td>A2</td>
<td>Rare$^1$</td>
<td>11</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Priority Grouping</td>
<td>Conservation Status</td>
<td>Confirmed habitat with 100% targets (ha)</td>
<td>Number of distinct populations &amp; targets set for these distinct populations</td>
<td>Total number of distinct populations</td>
<td>Target number of distinct populations</td>
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<td>----------------------------------------</td>
</tr>
<tr>
<td>7. Bowria volubilis subsp. volubilis</td>
<td>B</td>
<td>Vulnerable&lt;sup&gt;2&lt;/sup&gt;</td>
<td>4 180</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Brachycorythis conica subsp. transvaalensis</td>
<td>A3</td>
<td>Vulnerable&lt;sup&gt;1&lt;/sup&gt;</td>
<td>187</td>
<td>57</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>9. Brachystelma discoideum</td>
<td>B</td>
<td>Endangered&lt;sup&gt;3&lt;/sup&gt;</td>
<td>13</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Ceropegia decilua subsp. pretoriensis</td>
<td>A1</td>
<td>Vulnerable</td>
<td>868</td>
<td>75</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>11. Ceropegia turricula</td>
<td>A3</td>
<td>Near Threatened&lt;sup&gt;1&lt;/sup&gt;</td>
<td>25</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Cheilanthes deltoidea subsp. nov. Gauteng form</td>
<td>A2</td>
<td>Vulnerable&lt;sup&gt;1&lt;/sup&gt;</td>
<td>287</td>
<td>116</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>13. Cineraria austrotransvaalensis</td>
<td>A3</td>
<td>Near Threatened&lt;sup&gt;1&lt;/sup&gt;</td>
<td>24</td>
<td>95</td>
<td>29</td>
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<tr>
<td>14. Cineraria longipes</td>
<td>A1</td>
<td>Vulnerable</td>
<td>2 446</td>
<td>117</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>15. Cleome conrathii</td>
<td>A3</td>
<td>Near Threatened&lt;sup&gt;1&lt;/sup&gt;</td>
<td>296</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>16. Cucumis humifructus</td>
<td>B</td>
<td>Vulnerable&lt;sup&gt;2&lt;/sup&gt;</td>
<td>13</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Delosperma gautengense</td>
<td>A1</td>
<td>Vulnerable</td>
<td>153</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>18. Delosperma leendertziae</td>
<td>A2</td>
<td>Near Threatened&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1 453</td>
<td>4</td>
<td>1</td>
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<tr>
<td>19. Delosperma macellum</td>
<td>A2</td>
<td>Endangered&lt;sup&gt;1&lt;/sup&gt;</td>
<td>92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Delosperma purpureum</td>
<td>A1</td>
<td>Endangered&lt;sup&gt;1&lt;/sup&gt;</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Dioscorea sylvatica</td>
<td>B</td>
<td>Vulnerable&lt;sup&gt;2&lt;/sup&gt;</td>
<td>63</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Encephalartos lanatus</td>
<td>A2</td>
<td>Vulnerable&lt;sup&gt;1&lt;/sup&gt;</td>
<td>412</td>
<td>13</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>23. Encephalartos middelburgensis</td>
<td>A2</td>
<td>Vulnerable</td>
<td>1 960</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Eulophia coddii</td>
<td>A2</td>
<td>Vulnerable&lt;sup&gt;1&lt;/sup&gt;</td>
<td>72</td>
<td>24</td>
<td></td>
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<tr>
<td>25. Frithia humilis</td>
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<td>Vulnerable&lt;sup&gt;1&lt;/sup&gt;</td>
<td>573</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>26. Frithia pulchra</td>
<td>A2</td>
<td>Rare&lt;sup&gt;1&lt;/sup&gt;</td>
<td>97</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Priority Grouping</td>
<td>Conservation Status (1^{\text{st}}) global status; (2^{\text{nd}}) national status</td>
<td>Confirmed habitat with 100% targets (ha)</td>
<td>Number of distinct populations &amp; targets set for these distinct populations</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>Total number of distinct populations</td>
<td>Target number of distinct populations</td>
<td></td>
</tr>
<tr>
<td>27. <em>Gladiolus pole-evansii</em></td>
<td>A2</td>
<td>Rare-sparse(^1)</td>
<td>17</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. <em>Gladiolus robertsoniae</em></td>
<td>A3</td>
<td>Near Threatened(^1)</td>
<td>63</td>
<td>12</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>29. <em>Gnaphalium nelsonii</em></td>
<td>A2</td>
<td>Rare-sparse(^1)</td>
<td>33</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. <em>Habenaria barbertoni</em></td>
<td>A2</td>
<td>Near Threatened(^1)</td>
<td>83</td>
<td>55</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>31. <em>Habenaria bicolor</em></td>
<td>B</td>
<td>Near Threatened(^2)</td>
<td>100</td>
<td>27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. <em>Habenaria kraenzliniana</em></td>
<td>A3</td>
<td>Near Threatened(^1)</td>
<td>78</td>
<td>161</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>33. <em>Habenaria mossii</em></td>
<td>A1</td>
<td>Endangered(^1)</td>
<td>553</td>
<td>57</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>34. <em>Holothrix micrantha</em></td>
<td>A1</td>
<td>Endangered(^1)</td>
<td>24</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. <em>Holothrix randii</em></td>
<td>B</td>
<td>Near Threatened(^2)</td>
<td>474</td>
<td>126</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>36. <em>Khadia beswickii</em></td>
<td>A1</td>
<td>Vulnerable(^1)</td>
<td>1 759</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>37. <em>Kniphofia typhoides</em></td>
<td>A3</td>
<td>Near Threatened(^1)</td>
<td>779</td>
<td>39</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>38. <em>Lithops lesliei</em> subsp. <em>lesliei</em></td>
<td>B</td>
<td>Near Threatened(^3)</td>
<td>1 629</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39. <em>Lithops lesliei</em> subsp. <em>lesliei var. rubrobrunnea</em></td>
<td>A1</td>
<td>Endangered(^1)</td>
<td>258</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>40. <em>Melolobium subspicatum</em></td>
<td>A1</td>
<td>Vulnerable(^1)</td>
<td>1 748</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>41. <em>Nerine gracilis</em></td>
<td>A3</td>
<td>Near Threatened(^1)</td>
<td>277</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42. <em>Prunus africana</em></td>
<td>B</td>
<td>Vulnerable(^2)</td>
<td>11</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13
<table>
<thead>
<tr>
<th>Species</th>
<th>Priority Grouping</th>
<th>Conservation Status (^1) (\text{global status; national status)} )</th>
<th>Confirmed habitat with 100% targets (ha)</th>
<th>Number of distinct populations &amp; targets set for these distinct populations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total number of distinct populations</td>
<td>Target number of distinct populations</td>
</tr>
</tbody>
</table>

| 43. *Searsia gracillima* var. *gracillima* | A1 | Near Threatened \(^1\) | 126 | 22 | 8 |
| 44. *Stenostelma umbelluliferum* | A3 | Near Threatened \(^1\) | 169 | 89 | 19 |
| 45. *Trachyandra erythrorrhiza* | A3 | Near Threatened \(^1\) | 1,056 | 134 | 35 |

Point data was collated on the prioritized species (Table 4). This data comprised all known localities within Gauteng for each Red Data plant species.

Known locations of prioritized plant species in the GDARD plant database (7252 records as at the end of November 2010) were buffered according to their priority category and location:

1. 200m for all populations occurring within the urban edge
2. 600m for rural A1 populations
3. 500m for rural A2 populations
4. 400m for rural A3 populations
5. 300m for rural B populations

In addition, habitat and “meta-population models” were developed for selected species indicated by the presence of values in the right columns in Table 4 above. Habitat models were created where the current set of known species points was smaller than their historical distribution, while “meta-population models” were created where the historical distribution indicated a link to sites outside of Gauteng which were not covered by the buffered points. The modelling for habitat was based on minimum and maximum values for environmental parameters measured at the location of confirmed populations, which was then extended to the same set of environmental variable used for the habitat modelling. Resultant species models were limited to within the known historical distributions. For the “meta-population models” a similar modelling was undertaken but the extent was for all areas within a minimum convex polygon which included all known Gauteng populations, their historical range, and a linkage to the other province of occurrence. Suitable habitat patches were evaluated by size, with all patches smaller than the average of those containing confirmed populations were eliminated.

**Biodiversity Target:** The target for all confirmed sites for prioritized plant species was 100 % of the buffered area, except for *Bowiea volubilis* subsp. *volubilis* and *Lithops leslei* subsp. *Leslei*. The polygons for these two species were converted to centroid points, and 100 % target was set for these. The targeted number of distinct populations were generally set at between 25-35% of the total number of populations.
2.3.2. Birds

Eleven threatened bird species were prioritized for inclusion into the Gauteng C-Plan v3.3 (Table 5) based on:

1. Threat status (7 Vulnerable and 4 Near Threatened).
2. Whether the species was actually present, on a frequent basis, in the province. Vagrants, erratic visitors or erratic migrants to the province (Tarboton et al., 1987) have been excluded from the conservation plan.
3. Whether the threat was due to issues related to land use planning. Species which are impacted on mostly by threats such as poisoning were excluded.

**Table 5: Threatened Bird Species and Their Targets**

<table>
<thead>
<tr>
<th>Bird Species</th>
<th>Common Name</th>
<th>Status</th>
<th>Total Habitat Area (ha)</th>
<th>Target (ha)</th>
<th>Target (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>Alcedo semitorquata</em></td>
<td>Half-Collared Kingfisher</td>
<td>Near Threatened</td>
<td>11 863</td>
<td>11 863</td>
<td>100</td>
</tr>
<tr>
<td>2. <em>Anthropoides paradiseus</em></td>
<td>Blue Crane</td>
<td>Vulnerable</td>
<td>6 158</td>
<td>6 158</td>
<td>100</td>
</tr>
<tr>
<td><em>Anthropoides paradiseus</em></td>
<td>Blue Crane</td>
<td>Vulnerable</td>
<td>9 624</td>
<td>9 624</td>
<td>100</td>
</tr>
<tr>
<td><em>Circus ranivorus</em></td>
<td>African Marsh-Harrier</td>
<td>Vulnerable</td>
<td>23 357</td>
<td>10 000</td>
<td>43</td>
</tr>
<tr>
<td>4. <em>Eupodotis caerulescens</em></td>
<td>Blue Korhaan</td>
<td>Near Threatened</td>
<td>14 937</td>
<td>10 000</td>
<td>67</td>
</tr>
<tr>
<td>5. <em>Eupodotis senegalensis</em></td>
<td>White-bellied Korhaan</td>
<td>Vulnerable</td>
<td>21 337</td>
<td>14 400</td>
<td>67</td>
</tr>
<tr>
<td>6. <em>Gorsachius leuconotus</em></td>
<td>White-backed Night-Heron</td>
<td>Vulnerable</td>
<td>5 112</td>
<td>5 112</td>
<td>100</td>
</tr>
<tr>
<td>7. <em>Gyps coprotheres</em></td>
<td>Cape Vulture</td>
<td>Vulnerable</td>
<td>3 496</td>
<td>3 496</td>
<td>100</td>
</tr>
<tr>
<td>8. <em>Mirafra cheniana</em></td>
<td>Melodious Lark</td>
<td>Near Threatened</td>
<td>16 556</td>
<td>640</td>
<td>4</td>
</tr>
<tr>
<td>10. <em>Sagittarius serpentarius</em></td>
<td>Secretarybird</td>
<td>Near Threatened</td>
<td>226 962</td>
<td>94 500</td>
<td>42</td>
</tr>
</tbody>
</table>

*Recommendations for future iterations of Gauteng C-Plan:* It should be noted that compared to other South African conservation plans, the targets used are high for Vulnerable species, and particularly high for Near Threatened species (as these species are not regarded as threatened would commonly not be included in conservation plans which typically focus on threatened species only). This is particular the case where targets are set for modelled (rather than confirmed) distributions of Near Threatened species. However, as these species have been prioritized by GDARD using a formal and documented method (Pfab, 2000), and are required to be included into environmental impact assessments, it is appropriate that these species are included in the conservation plan. Further, as the area requirements for most of these species are limited in the context of the whole Gauteng Province, it is not a significant issue that these additional species are included in the plan.
The species included and targets set are detailed below:

**African Finfoot (Podica senegalensis)**

This species is listed as Least Concern internationally but is seen as locally Vulnerable (Ekstrom & Butchart, 2004; Barnes, 2000). Rivers with confirmed current and historical occurrences were mapped, and all habitat within a 100m (outside urban areas) and 32m (inside urban edges) along these rivers was included in the modelled habitat. For the Vaal River, remaining suitable stretches of habitat were mapped. Areas that were excluded from the model, as these river stretches are considered unsuitable, included: The Pienaars upstream of Roodeplaat, the Sesmyspruit (tributary of the Hennops) upstream of Rietvlei Nature Reserve and the Bronkhorstspruit River (tributary of the Wilge), south from the dam.

**Biodiversity Target:** 11 292ha or 100 % of suitable habitat.

**African Marsh-Harrier (Circus ranivorus)**

The African Marsh Harrier is listed as Least Concern internationally, but is seen as locally Vulnerable (Ekstrom & Butchart, 2004). It occurs widely, but patchily within the province and is typically associated with large wetlands on which it is dependant for breeding. Wetlands (including those too small for breeding), watercourses and to a lesser extent adjacent grassland areas may be used for foraging. Aquatic habitat for which the species has been confirmed was buffered by 350m of terrestrial habitat both to protect the wetland resource and to provide for the persistence of prey species. Unsuitable habitat (e.g. ridges and permanently modified areas) were excluded from the buffered area. Remnant habitat patches < 100ha were excluded, unless linked directly to a wetland/stream.

Targets were set to contain habitat for 10 breeding pairs, which is the estimated maximum population of African Marsh-Harrier now remain in the province (Tarboton *et al.*, 1987). An area requirement of 1 000ha was set based on observations of area required for a breeding pair in the province, though it should be recognized that Tarboton & Allan (1984) found that most Highveld wetlands larger than 100ha supported a breeding pair of African Marsh Harriers, while Simmons (1997) reports breeding densities of 8 pairs per 1 000ha, which suggests that the area targets are high.

**Biodiversity Target:** 10 000ha which equates to 43 % of 23 357ha of suitable habitat. Calculated to support 10 breeding pairs.

**African Grass-Owl (Tyto capensis)**

The species is listed as Least Concern internationally, but is seen as locally Vulnerable (Ekstrom & Butchart, 2004; Barnes, 2000). Following the recommendation of Pfab *et al.* (2011) that all Vulnerable populations must be conserved in situ, and targets should be calculated to ensure that any area contributes in proportion to its share of the species population range, a targeted population of 150 breeding pairs was set. Data on the foraging range requirements of this species is not available, but an interim estimate by GDARD specialists suggest that 130ha may be sufficient for a pair, but that an equivalent area of unoccupied habitat is likely to be required as a refuge for when habitat patches are rendered temporarily unsuitable e.g. as a result of grazing pressure and/or fire which are essential tools in the management of their habitat. Therefore the requirement was doubled to 260ha per pair, or a total of 39 000ha.

Habitat was modelled based on confirmed records (point data), buffered by 1 500 m, and which was used to select suitable quaternary catchments. Within these catchments, all rivers and wetlands were buffered by 1500m. Finally,
areas within the urban edge and permanently modified areas (transformed) were excluded, as were any habitat patches of under 100ha in size.

**Biodiversity Target:** 39 000ha which equates to 11 % of 369 310ha of suitable habitat. Calculated to support 150 breeding pairs.

**Blue Crane** (*Anthropoides paradiseus*)

This near endemic species is listed locally and internationally as Vulnerable (Ekstrom & Butchart, 2004). All suitable breeding habitat around the nine known breeding sites in Gauteng was targeted. Breeding habitat was defined by known nest sites, with a mapped adjacent suitable foraging habitat. In addition, an identified over-wintering area for a non-breeding flock of about 300 birds, which routinely over-winters on the border between SE Gauteng and Mpumalanga, was included. A minimum convex polygon of observed points was used to define the over-wintering area. Much of this area consists of cultivated lands. The entire area was included in the target.

**Biodiversity Target:** 6 158ha or 100 % of breeding habitat and 100 % of 9 624ha of overwintering area.

**Blue Korhaan** (*Eupodotis caeruleascens*)

The Blue Korhaan is a near endemic species listed locally as Near Threatened (Barnes, 2000b). A habitat model was developed by including all continuous land patches over 100ha outside of the urban edge which include confirmed records. The target was set at 100 breeding pairs, which at an estimated requirement of 100ha per pair gives a target of 10 000ha. This was based on the recommendation of Pfab et al. (2011) for Near Threatened species that at least 10 000 mature individuals must be conserved in situ, thereby avoiding a Vulnerable listing under the C criterion, in the event that the species is subject to a decline or extreme fluctuations. Gauteng’s proportional allocation of breeding birds combined with a density of 1 bird per 50ha (Tarboton et al., 1987), gives the target specified.

**Biodiversity Target:** 10 000ha or 67 % of 14 937ha of suitable habitat. Calculated to support 100 breeding pairs.

**Cape Vulture** (*Gyps coprotheres*)

This Southern African endemic species is listed locally and internationally as Vulnerable (Butchart & Pilgrim, 2006; Anderson, 2000). There is one breeding colony of 118 birds present in Gauteng. For Vulnerable species listed under the IUCN Red List Criteria of B, C or D; Pfab et al. (2011) recommend that all populations must be conserved in situ, and therefore the colony as a whole was targeted. The colony was defined as the full extent of the two farms on which the colony is located, in order to provide an ecological buffer from disturbance.

**Biodiversity Target:** 3 496ha or 100 % of the only breeding colony in Gauteng.

**Half-Collared Kingfisher** (*Alcedo semitorquata*)

This species is internationally seen to be of Least Concern and locally as Near Threatened (Ekstrom & Butchart 2004, Allan 2000). The Half-collared Kingfisher occurs along perennial rivers and streams where suitable cover of wooded margins or over-hanging vegetation exists (Tarboton et al., 1987). It is widely, but patchily distributed in the province. Rivers for which the species has been confirmed were mapped. For the Vaal River, remaining suitable stretches were identified. Unsuitable habitat was excluded. A buffer including the riparian zone and 100m (outside the urban edge) or the riparian zone and 32m (inside the urban edge) was used to define the modelled habitat.

For Near-Threatened species, Pfab et al. (2010) recommended that at least 10 000 mature individuals must be conserved in situ, thereby avoiding a Vulnerable listing under the C criterion. A proportional allocation of the
estimated national population resulted in the target being set at the habitat requirements of 240 breeding pairs. Pairs require at least 1 km of suitable riverine habitat for breeding (Clancey, 1992, in Allan, 2000), but densities may be as low as 1 bird/9km even in prime habitat (Allan, 2000). While densities are expected to vary among rivers, as a very rough estimate, approximately 240 - 2160 km of suitable riverine habitat would be required to support 240 pairs. Therefore the planners set the target at 100 % of suitable habitat.

**Biodiversity Target:** 11 863 ha or 100 % of suitable riverine habitat.

**Melodious Lark (Mirafra cheniavana)**

This Southern African endemic is listed locally and internationally as Near Threatened (Ekstrom & Butchart, 2004; Barnes, 2000c). Suitable habitat was based on remnant patches of suitable natural habitat where this species has been observed in the last decade. Areas within the urban edge, small areas under 100ha, and unsuitable areas such as ridges were excluded. For Near-Threatened species, Pfab et al. (2011) recommend that at least 10 000 mature individuals must be conserved in situ, thereby avoiding a Vulnerable listing under the C criterion, in the event that the species is subject to a decline or extreme fluctuations. A proportional calculation of the national population gave a suggested target of 320 pairs, which, combined with local estimates of density at 2ha per pair, gave a requirement of 640ha of suitable habitat.

**Biodiversity Target:** 640ha of suitable habitat, or 4 % of 16 556ha (320 breeding pairs).

**Secretarybird (Saggitarius serpentarius)**

This species is internationally listed as Least Concern and is locally seen to be Near Threatened (Ekstrom & Butchart, 2004; Barnes, 2000d). Based on observations of habitat use in Gauteng, all records were buffered by 5 600 m. All land within the urban edge, agricultural holdings, actively cultivated fields and habitat fragments < 100ha were excluded from the model. For Near-Threatened species, Pfab et al. (2010) recommend that at least 10 000 mature individuals must be conserved in situ, thereby avoiding a Vulnerable listing under the C criterion, in the event that the species is subject to a decline or extreme fluctuations. Although a proportional allocation of the South African breeding population suggests Gauteng should support 60 breeding pairs, records suggest that 30 pairs is a more realistic estimate. Therefore the 30 pairs, combined with a territory size of 3 150ha, was used as the basis for the target which was set at 94 500ha.

**Biodiversity Target:** 94 500ha or 42 % of 226 962ha of suitable habitat. The target is designed to ensure sufficient habitat for 30 breeding pairs.

**White-bellied Korhaan (Eupodotis senegalensis)**

This species is internationally listed as Least Concern and is locally seen to be Vulnerable (Ekstrom & Butchart, 2004; Barnes, 2000e). The White-bellied Korhaan occurs in grassland and open woodland (Tarboton et al., 1987). Habitat was modelled as un-fragmented suitable habitat associated with clusters of confirmed White-bellied Korhaan records. All unsuitable habitat including agricultural holdings, actively cultivated fields, and fragments of suitable habitat < 100ha were excluded. For Vulnerable species listed under the IUCN Red List Criteria of B, C or D; Pfab et al. (2011) recommend that all populations must conserved in situ. Gauteng's proportional contribution to the national target would be 120 breeding pairs. Estimates based on species forage requirements and densities suggest a requirement of 120ha per pair, which gives a total target of 14 400ha.

**Biodiversity Target:** 14 400ha or 67 % of 21 337ha (120 breeding pairs).

**White-backed Night-Heron (Gorsachius leuconotus)**
This species is internationally listed as Least Concern and is locally seen to be Vulnerable (Ekstrom & Butchart, 2004; Barnes & Parker, 2000). The White-backed Night-Heron occurs patchily within the province and is found along both large rivers and small streams where suitable cover of wooded margins or over-hanging vegetation occurs (Tarboton et al., 1987; Barnes & Parker 2000). Rivers for which the species has been confirmed (either in recent surveys or historically according to Tarboton et al. 1987) were mapped. For the Vaal River, remaining suitable stretches of habitat were mapped. Unsuitable river stretches were excluded, namely: the Blesbokspruit, which is marginal habitat for this species, the Pienaars upstream of Roodeplaat and the Sesmypspruit (a tributary of the Hennops River) upstream of Rietvlei Nature Reserve. For Vulnerable species listed under the IUCN Red List Criteria of B, C or D; Pfab et al. (2011) recommend that all populations must conserved in situ. Due to the linear connectivity of their habitat, impacts such as destruction of overhanging trees and increased water turbidity, resulting from erosion (Martin, 1997), have consequences not only at the point of impact, but downstream too. Consequently, the full extent of suitable modelled habitat along each identified river (except the Vaal) needs to be conserved if the integrity of this species habitat is to be maintained. The Vaal River is highly impacted on and thus only remnant patches of mapped suitable habitat were included in the target.

**Biodiversity Target:** 5 112ha or 100 % of suitable riverine habitat mapped for the conservation plan.

* **Recommendations for future iterations of Gauteng C-Plan:** For future iterations of Gauteng C-Plan, it is recommended that the target setting process is re-evaluated. It is recognized that as these species are identified species of concern in Gauteng Province, it is reasonable that they are strongly included in the provincial conservation plan. However, this complicates the development of a Bioregional Plan which ideally should be built on a conservation plan which more strongly targets spatial efficiency in identifying the minimum required area to support viable populations of threatened species. This is quite different to the approach taken in the current plan where generally all suitable habitat for priority species is included. This is particularly an issue for modelled habitat for Vulnerable and Near-Threatened species. However, as the habitat requirements for most species are fairly limited, often overlap with each other, and include other key habitats and process areas such as rivers and wetlands, the inclusion of these species at these high target levels is unlikely to result in large additional areas being unnecessarily included.

### 2.3.3. Invertebrates

Four invertebrate species, three butterflies and one beetle, were prioritized for inclusion into the Gauteng C-Plan v3.3 based on threat status. Four confirmed Vulnerable species were included (Table 6).
Table 6: Threatened invertebrate species and their targets. Note targets were set for the full extent of confirmed habitat, and that additional targets were set for specified numbers of distinct modelled populations.

<table>
<thead>
<tr>
<th>Invertebrate Species</th>
<th>Common Name</th>
<th>Status</th>
<th>Confirmed habitat with 100% targets (ha)</th>
<th>Additional modelled habitat and targets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Aloeides dentatis</td>
<td>Roodepoort Copper Butterfly</td>
<td>Vulnerable</td>
<td>2,438</td>
<td>2,438</td>
</tr>
<tr>
<td>2. Chrysoritis aureus</td>
<td>Heidelberg Copper Butterfly</td>
<td>Vulnerable</td>
<td>3</td>
<td>9,873</td>
</tr>
<tr>
<td>3. Ichnestoma stobbiai</td>
<td>Stobbia’s Fruit Chafer Beetle</td>
<td>Vulnerable</td>
<td>319</td>
<td>12,806</td>
</tr>
<tr>
<td>4. Lepidochrysops praeterita</td>
<td>Highveld Blue Butterfly</td>
<td>Vulnerable</td>
<td>152</td>
<td>13,803</td>
</tr>
</tbody>
</table>

The species included and targets set are detailed below:

(1) Highveld Blue Butterfly (*Lepidochrysops praeterita*)

Although the species is classified as Vulnerable, it is proposed for Endangered (Henning *et al.*, 2009), based on a limited distribution and the extent of mining and agricultural activities within its range. It is largely endemic to Gauteng, but extends into the Potchefstroom area in the North West. Known localities were buffered by 500m and the full extent of this area was included as a target. Modelling for the species was based on South African Butterfly Conservation Assessment (SABCA) atlas and data from site visits. The model refined the basic distribution by incorporating slope and aspect, and removed unsuitable land cover classes and areas smaller than the smallest known patch of habitat occupied by the species.

**Biodiversity Target:** 2,661ha or 20% of 13,803ha modelled habitat.

(2) Heidelberg Copper Butterfly (*Chrysoritis aureus*)

This butterfly is proposed for Endangered (Henning *et al.*, 2009), based on limited distribution, as it is host specific and known from a handful of localities on the Heidelberg-Balfour-Greylingstad ridge system. It is possible that the species is under-recorded. Known localities were buffered by 500m and the full extent of this area was included as a target. Modelling for the species was based on SABCA atlas and data from site visits, and this resulted in the development of a model which reflected the high altitude ridge systems which host the species.

**Biodiversity Target:** 1,975ha or 20% of 9,873ha modelled habitat.
(3) **Roodepoort Copper Butterfly (Aloeides dentatis dentatis)**

This butterfly is proposed for Endangered (Henning et al., 2009), based on its limited distribution. Suitable habitat around known localities was mapped off satellite imagery. A 100% target was set for these areas, though it is worth noting that all of this area is within existing Protected Areas, and hence does not influence the outcome of the Gauteng C-Plan v3.3.

**Biodiversity Target:** 2 438ha or 100% of known habitat localities.

(4) **Stobbia’s Fruit Chafer Beetle (Ichnestoma stobbiai)**

Although not listed, it appears that this species of beetle would qualify as Vulnerable under the IUCN Red List criteria. An expert driven mapping approach was used for the species to map the area likely to be occupied by the beetle at known localities. All suitable, untransformed habitat in the vicinity of known records were mapped as suitable, occupied habitat for the species. No attempt was made to predict the occurrence of additional populations in other areas. A 100% of the confirmed habitat and the extended mapped suitable habitat were targeted.

**Biodiversity Target:** 12 806ha or 100% of known habitat localities.

**2.3.4. Mammals**

Ten mammal species, seven of which are bats, were prioritized for inclusion into the Gauteng C-Plan v3.3 (Table 7). The prioritization was based on threat status, with Endangered, Vulnerable and Near Threatened species being included.

**Table 7: Threatened Mammals and their targets. Note targets were set for the full extent of confirmed habitat, and that additional targets were set for specified numbers of distinct modelled populations.**

<table>
<thead>
<tr>
<th>Mammal Species</th>
<th>Common Name</th>
<th>Status</th>
<th>Confirmed habitat with 100% targets (ha)</th>
<th>Additional modelled habitat and targets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Habitat Target %</td>
</tr>
<tr>
<td>1. Atelerix frontalis</td>
<td>Southern African Hedgehog</td>
<td>Near Threatened</td>
<td>7 391</td>
<td>41</td>
</tr>
<tr>
<td>2. Lutra maculicollis</td>
<td>Spotted-Necked Otter</td>
<td>Near Threatened</td>
<td>53 689</td>
<td>38</td>
</tr>
<tr>
<td>3. Mystromys albicaudatus</td>
<td>White Tailed Mouse</td>
<td>Endangered</td>
<td>6 015</td>
<td>33</td>
</tr>
<tr>
<td>4. Neamblysomus julianae</td>
<td>Juliana’s Golden Mole</td>
<td>Vulnerable</td>
<td>5 336</td>
<td></td>
</tr>
<tr>
<td>BATS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Mammal Species

<table>
<thead>
<tr>
<th>Mammal Species</th>
<th>Common Name</th>
<th>Status</th>
<th>Confirmed habitat with 100% targets (ha)</th>
<th>Additional modelled habitat and targets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Habitat (ha)</td>
</tr>
<tr>
<td>5. <em>Miniopterus schreibersii</em></td>
<td>Scheiber’s Long-Fingered Bat</td>
<td>Near Threatened</td>
<td>784</td>
<td>694</td>
</tr>
<tr>
<td>7. <em>Rhinolophus blasii</em></td>
<td>Blasius’s/Peak-Saddle Horseshoe Bat</td>
<td>Vulnerable</td>
<td>473</td>
<td></td>
</tr>
<tr>
<td>8. <em>Rhinolophus clivosus</em></td>
<td>Horseshoe Bat</td>
<td>Near Threatened</td>
<td>388</td>
<td>694</td>
</tr>
<tr>
<td>9. <em>Rhinolophus darlingi</em></td>
<td>Darling’s Horseshoe Bat</td>
<td>Near Threatened</td>
<td>237</td>
<td></td>
</tr>
<tr>
<td>10. <em>Rhinolophus hildebrandtii</em></td>
<td>Hildebrandt’s Horseshoe Bat</td>
<td>Near Threatened</td>
<td>79</td>
<td></td>
</tr>
</tbody>
</table>

The species included and targets set are detailed below:

1. **Juliana’s Golden Mole (Bronberg sub-population) (*Neamblysomus julianae*)**

   The species is endemic to South Africa and is listed as Vulnerable, with the Bronberg sub-population listed as Critically Endangered (Bronner, 2008). Three (and probably only two) geographically isolated populations of this species are known. A habitat model for the Bronberg area was developed based on known locations and environmental parameters (altitude, soil type and depth, geology). Permanently modified areas (e.g. mines and urban areas) were excluded.

   **Biodiversity Target:** 5 336ha or 100 % of modelled habitat. This target is high for a Vulnerable species, but is justified if the population is indeed distinct and Critically Endangered.

2. **Southern African Hedgehog (*Atelerix frontalis*)**

   The southern African hedgehog is listed as Near Threatened by the South African Red Data Book for mammals, and listed as a Protected Species in the Threatened or Protected Species (TOPS) regulations of the National Biodiversity Act. It occurs in such a wide variety of habitats, that it is a challenge to assess their habitat requirements. In Gauteng, they are confined in the grassland biome. Known locations were buffered by 3 090m to give an area of 3 000ha. Unsuitable habitat was removed from the model to give a modelled habitat of 7 391ha. The target was set at 3 000ha (representing 1 population), which was identified based on Gauteng’s proportional contribution to meeting targets for this species.

   **Biodiversity Target:** 3 000ha or 41 % of 7 391ha modelled habitat (1 population).
Spotted-Necked Otter (*Lutra maculicollis*)

This widespread species is listed as Near Threatened by the South African Red Data Book and is a Protected Species in the TOPS regulations. The species is dependent on clean water sources. Perennial rivers and wetlands were buffered by 100m outside the urban edge and 32m within the urban edge. Waterbodies like Rietvlei Dam and Roodplaat were not buffered, but were included. Based on a proportional contribution to meeting the national target (Pfab *et al.*, 2010) of 10 000 individuals, to avoid a Vulnerable listing, a targeted population of 150 individuals requiring 20 300ha was set.

**Biodiversity Target:** 20 300ha or 38 % of 53 689ha (150 individuals).

White Tailed Mouse (*Mystromys albicaudutus*)

The white-tailed mouse, which is mostly found in grasslands, is endemic to South Africa and is currently listed as Endangered. A distribution model was developed based on buffering known localities to give a 4 000ha circle, from which unsuitable habitat and small patches under 100ha were excluded. Only a small proportion of the species’ natural distribution range falls within Gauteng (approximately 10 %) and one viable population of 1 000 individuals is therefore considered adequate to meet the national target for the species. This is a low density species and; at an estimated ratio of 1 individual per 2 hectares, 2 000 hectares of untransformed grassland was used as the target.

**Biodiversity Target:** 2 000ha of untransformed grassland or 33 % of 6 015ha (1 000 individuals).

Bats: Blasius’s/Peak-Saddle Horseshoe Bat (*Rhinolophus blasii*), Darling’s Horseshoe Bat (*Rhinolophus darlingi*), Geffroy’s Horseshoe Bat (*Rhinolophus clivosus*), Hildebrandt’s Horseshoe Bat (*Rhinolophus hildebrandtii*), Scheiber’s Long-Fingered Bat (*Miniopterus schreibersii*), Temminck’s Hairy Bat (*Myotis tricolo*)

With the exception of *R. blasii*, which is listed as Vulnerable, these bats are all listed as Near Threatened by the South African Red Data Book for mammals (in Skinner & Chimimba, 2005). The species are considered to be highly sensitive to disturbance due to their specific cave roosting requirements. Known locations for each species were buffered by 500 m, and the full area set as the target. Although a 100 % target is high for Vulnerable and Near Threatened species, it is justified based on the limited extent of the roosts for these species and the fact that they are an umbrella species for broader cave ecosystems, which are not included in the habitat map.

**Biodiversity Target:** 100 % of known locations (with 500m buffers).

2.3.5. Reptiles

One snake was included in the Gauteng C-Plan v3.3 based on its Near Threatened status (Table 8).

**Table 8: The threatened Striped Harlequin Snake and associated target**

<table>
<thead>
<tr>
<th>Reptile Species</th>
<th>Common Name</th>
<th>Status</th>
<th>Total area (ha)</th>
<th>Target (ha)</th>
<th>Target %</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Homoroselaps dorsalis</em></td>
<td>Striped Harlequin Snake</td>
<td>Near Threatened</td>
<td>10 865</td>
<td>10 865</td>
<td>100</td>
</tr>
</tbody>
</table>
The species included and target set is detailed below:

**Striped Harlequin Snake (Homoroselaps dorsalis)**

The Striped Harlequin Snake (*Homoroselaps dorsalis*) is distributed from Limpopo through Mpumalanga, Gauteng, the Free State, KwaZulu-Natal and Swaziland. The species was listed as Rare in Branch (1988) and will probably be listed as Near Threatened in the revision of the red list (Burger, in press). A habitat model was developed based on the specific land type associated with this species at Suikerbosrand. Although the target was set very high, at 100% of suitable habitat, this will not impact the outcome of the Gauteng C-Plan v3.3, as the protection of *H. dorsalis* in Suikerbosrand Nature Reserve (Sedibeng District Municipality) will meet the conservation targets for the species in Gauteng.

**Biodiversity Target:** 10 865ha or 100% of modelled habitat.

### 2.4. IMPORTANT AQUATIC FEATURES

The aquatic features that were selected as Critical Biodiversity Areas in the Gauteng C-Plan v3.3 are divided into two categories, namely:

1. Unique Features and Pan Clusters (Table 9).
2. Near-pristine Quaternary Catchments (Table 10).

Wetland (pan) systems and near-pristine catchment areas are important hydrological process areas and play a major role in controlling the hydrology of the region.

#### TABLE 9: IMPORTANT AQUATIC FEATURES (UNIQUE FEATURES AND PANS) AND THEIR TARGETS

<table>
<thead>
<tr>
<th>Aquatic feature</th>
<th>Total area (ha)</th>
<th>Target (ha)</th>
<th>Target %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maloney’s Eye sub Catchment: Unique fish, diverse invertebrate species and unique habitats</td>
<td>1 061</td>
<td>1 061</td>
<td>100</td>
</tr>
<tr>
<td>Pan cluster, good quality</td>
<td>10 382</td>
<td>10 382</td>
<td>100</td>
</tr>
<tr>
<td>Pan cluster within near-pristine Quaternary Catchment</td>
<td>22 256</td>
<td>22 256</td>
<td>100</td>
</tr>
</tbody>
</table>

#### TABLE 10: NEAR-PRISTINE QUATERNARY CATCHMENTS AND THEIR TARGETS

<table>
<thead>
<tr>
<th>Quaternary Catchment</th>
<th>Ecological State of Rivers</th>
<th>Total Area (ha)</th>
<th>Target (ha)</th>
<th>Target (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elands Quaternary Catchment</td>
<td>B</td>
<td>68 766</td>
<td>40 572</td>
<td>59</td>
</tr>
<tr>
<td>Skeerpoort Quaternary Catchment</td>
<td>B</td>
<td>11 055</td>
<td>6 522</td>
<td>59</td>
</tr>
<tr>
<td>Upper Suikerbosrant Quaternary Catchment</td>
<td>C</td>
<td>74 910</td>
<td>34 459</td>
<td>46</td>
</tr>
<tr>
<td>Wilge Quaternary Catchment</td>
<td>B</td>
<td>77 267</td>
<td>45 588</td>
<td>59</td>
</tr>
</tbody>
</table>
The features included and targets set are detailed below:

### 2.4.1. Unique Features and Pans

**The Maloney’s Eye sub-catchment**

The Maloney’s Eye sub-catchment contains an assemblage of three unique fish species inhabiting the rivers of Gauteng Province, namely: Lowveld Largescale Yellowfish (*Labeobarbus marequensis*), Bushveld Smallscale Yellowfish (*Labeobarbus polylepis*), and Mountain Catfish (*Amphilius uranoscopus*). These species are naturally intolerant to changes in flow.

In addition, the area has a high diversity of invertebrate species and contains unique habitats. The entire sub-catchment needs to be appropriately managed to support these species. Maloney’s Eye sub-catchment was digitized on-screen, as well as three streams where indigenous fish species occur. The target was set at 100 %. The target is justified given the uniqueness of the site.

**Biodiversity Target:** 1 061ha or 100 % of Maloney’s Eye sub-catchment.

**Pans within near-pristine quaternary catchments and good quality pan clusters**

Pans occurring within near-pristine quaternary catchments (Refer section below and Table 9) were buffered by 1km. The full extent of these features was included with a target of 100 %. Pans were buffered by 1 km to develop the input layer for good quality pans. The buffered areas were combined to identify continuous pan clusters. Each cluster was evaluated against a 40 % threshold of permanently modified habitat to identify good quality pan clusters. Note that old lands were not considered to impact on pans, and therefore this land cover class was considered as ‘natural’ in the calculation.

**Biodiversity Target:** Good quality pan clusters (10 382ha) and pans within near-pristine quaternary catchment (22 256ha) were included with a 100 % target. All other pans were defined as Ecological Support Areas (Refer Section 3 below).

### 2.4.2. Near-Pristine Quaternary Catchment

Four near-pristine quaternary catchments were included as part of the Critical Biodiversity Areas. These areas are important hydrological (ecological) process areas. The best quality (i.e. near natural cover) catchments in the province were prioritized, and included:

1. Wilge Quaternary Catchment.
2. Skeerpoort Quaternary Catchment.
3. Upper Suikerbosrant Quaternary Catchment.
4. Elands River Quaternary Catchment.

Rivers in a Class B ecological state are defined as “Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged”, whereas Class C
rivers are defined as: “Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged” (Kleynhans & Louw, 2008).

**Biodiversity Target:** Class B river catchments were given a target of 59 %, whereas the target was set at 46 % for Class C river catchments. The specific rationale for these targets needs to be clarified in future iterations of the Gauteng Conservation Plan. However, given the highly impacted nature of Gauteng’s rivers, it appears justifiable to set these high targets for the few remaining intact types.

### 2.5. CLIMATE CHANGE RELATED FEATURES

In order to ensure long term capacity to adapt to climate change impacts, it was important that the conservation plan included areas representing the full range of bioclimatic variables present in the province. In addition, key habitats for mitigating climate change impacts were (Table 11).

**Table 11: Summary of the Climate Change Related Features and Their Targets**

<table>
<thead>
<tr>
<th>Climate Change Features</th>
<th>Total area (ha)</th>
<th>Target (ha)</th>
<th>Target %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change: Priority Areas to Represent Bioclimatic zones</td>
<td>78 586</td>
<td>70 727</td>
<td>90</td>
</tr>
<tr>
<td>Carbon Sequestration Woodlands</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Dinokeng Scarp Woodland</td>
<td>43</td>
<td>43</td>
<td>100</td>
</tr>
<tr>
<td>2. Magaliesberg Scarp Woodland</td>
<td>1 908</td>
<td>1 908</td>
<td>100</td>
</tr>
<tr>
<td>3. Suikerbosrand Mesic Woodland</td>
<td>346</td>
<td>346</td>
<td>100</td>
</tr>
<tr>
<td>4. Wilge Scarp Woodland</td>
<td>232</td>
<td>232</td>
<td>100</td>
</tr>
</tbody>
</table>

The features included and targets set are detailed below:

#### 2.5.1. Priority Areas to Represent All Bioclimatic Zones

Gauteng C-Plan 3.3 aimed to include some representation of all distinct combinations of bioclimatic variables in the province. A total of 992 distinct bioclimatic zones were identified based on the following environmental parameters:

- Altitude (200m class intervals were used).
- Slope (four classes were used).
- Aspect (the four primary direction and flat areas were used).
- Geology (21 unique types).

**Analysis Methodology**

The bioclimatic zone layer was analysed by Dr Stephen Holness (Nelson Mandela Metropolitan University) using MARXAN software to identify a spatially efficient set of areas for inclusion into Gauteng C-Plan 3.3. The MARXAN
models were calibrated to ensure that the appropriate technical parameters were used, and that a spatially efficient outcome was achieved. Impacted landscapes were strongly avoided by incorporating costs surfaces which allocated transformed areas a cost of 100 times higher than natural areas. At the end of the process, all transformed areas were excluded from the set of biodiversity priority areas. Targets were set at 10 % of the original extent of each of the 992 bioclimatic zones. In addition, a 30 % target was set for ridge areas based on their original extent. Only areas outside the urban edge were available for selection and only intact areas contributed to meeting targets.

**Bioclimatic zone priorities identified**

The analysis identified areas which met 92.5 % of the targets for the 992 individual bioclimatic zones within an area of 78 586ha. Spatial efficiency was significantly improved compared with previous analyses, which had been based on buffering ridges by 500m (Previous prioritizations delivered a similar 92 % representation of bioclimatic types, but in a much larger area of 499 370ha). The priority areas were selected to favour connected and adjacent areas which improves the potential for long term persistence of these areas. Although the previously used ridges proxy is ecologically reasonable, it was not as spatially efficient. Because the MARXAN analysis was (a) already spatially efficient, (b) only targeting 10 % of each bioclimatic zone, and (c) the prioritized bioclimatic zones covered a relatively small area (4.3 % of the province), a target of 90 % was used to ensure that almost the entire extent (ha) of the prioritized areas to represent all bioclimatic zones were included. Ideally, to ensure a spatially optimal outcome, the analysis of all biodiversity features should have been done simultaneously. However, because the Gauteng C-Plan v3.3 was undertaken in C-Plan, it was necessary to undertake this separate MARXAN analysis as C-Plan does not take adjacency into account.

**Biodiversity Target:** A target of 90 % of the prioritized areas was set (70 727ha).

### 2.5.2. Carbon Sequestration

Woodlands within Gauteng were targeted as important biodiversity features in Gauteng C-Plan v3.3 as they were seen to be most important for carbon sequestration. Four woodland types were mapped, namely:

1. Dinokeng Scarp Woodland.
4. Wilge Scarp Woodland.

These woodlands are not only a carbon store but an extremely rare vegetation types in Gauteng, which are not identified in the broader vegetation map. The woodlands potentially contain rare species or at least species that are rare in Gauteng, possibly even species that are at the limits of their distribution and therefore unique genetically, which is advantageous for climate change adaptation (Pfab, 2010, pers. comm.).

Initially, the scarp woodlands were identified by modelling steep south facing slopes and ravines. The actual remaining intact woodland patches were then manually mapped off detailed Quickbird Imagery (2004/05). A target of 100 % was set for these areas, as they represent an unknown but probably very small percentage of the original extent of the woodlands.

**Biodiversity Target:** A target of 100 % of each mapped woodland habitat was set.
3. BIODIVERSITY FEATURES USED TO DEFINE ECOLOGICAL SUPPORT AREAS

In addition to the features included in the prioritization of Critical Biodiversity Areas (Section 2 above), which have specific biodiversity targets, additional areas were included as Ecological Support Areas. The Ecological Support Areas are designed to support ecological processes that Critical Biodiversity Areas and Protected Areas depend upon (Refer Section 5.2.2). These areas represented spatial surrogates for ecological process, encompassing:

1. Dolomite Areas
2. Rivers
3. Wetlands
4. Pans
5. Corridors for climate change and species migration
6. Ridges

3.1. DOLOMITE AREAS

Dolomite systems play a major role in controlling the hydrology of the region. Dolomite areas were identified from the geology dataset. Areas not available for selection in the conservation plan (e.g. urban areas) were excluded (See section 2.1).

3.2. RIVERS

The 1:50 000 river data from Department of Water Affairs was combined with detailed data for the Ekurhuleni Metropolitan Area. Additional river areas were digitized off detailed Quickbird Imagery (2004/05) for the Vaal, Suikerbosrant, Blesbok and parts of the Klip rivers.

Ecological Buffers were adopted, and were included as part of the Ecological Support Areas, namely:

<table>
<thead>
<tr>
<th>Aquatic Features</th>
<th>Buffer Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-perennial rivers</td>
<td>20 m</td>
</tr>
<tr>
<td>Perennial rivers within the urban edge</td>
<td>32m</td>
</tr>
<tr>
<td>Perennial rivers outside the urban edge</td>
<td>100m</td>
</tr>
</tbody>
</table>
3.3. PANS

Remaining pans that were not included into the identified set of Critical Biodiversity Areas were included as Ecological Support Areas. These features included:

1. Remaining good condition pans (i.e. those with less than 40% urban land cover within the 1 km pan catchment) which had not already been prioritized. These pans were buffered by 1km to ensure ecological integrity.

2. Other pans. These areas were buffered by 30m inside the urban edge and 50m outside the urban edge.

The pans and buffers were included with Ecological Support Areas.

3.4. OTHER WETLANDS

Any other wetlands which were not identified as Critical Biodiversity Areas were included as Ecological Support Areas. These wetlands included:

1. Other wetlands in the GDARD wetland dataset

2. Wetlands, including riparian areas, mapped off Quickbird Imagery (2004/05)

3. Wetlands for the Ekurhuleni and Johannesburg Metropolitan Areas

Ecological Buffers were adopted, and were included as part of the Ecological Support Areas, namely:

<table>
<thead>
<tr>
<th>Aquatic Features</th>
<th>Buffer Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good quality wetlands (&lt; 40% urban transformed) inside priority quaternary catchments</td>
<td>340m (Semlitsch &amp; Bodie, 2003).</td>
</tr>
<tr>
<td>Wetlands inside the urban edge</td>
<td>30m</td>
</tr>
<tr>
<td>Wetlands outside of the urban edge</td>
<td>50m</td>
</tr>
</tbody>
</table>

3.5. CORRIDORS: IMPORTANT ECOLOGICAL PROCESSES

In order to facilitate wildlife dispersal and species migration between biodiversity priority areas, which is particularly important in response to climate change, a corridor network was created to be included in the Ecological Support Areas. This is important to ensure the maintenance of ecological processes.

Ecological process corridors along ridges and hills, and rivers and wetlands, were identified using a frictional surface approach. Frictional values were assigned to specified land cover classes or areas, with low frictional
values assigned to (i) biodiversity priority areas identified in the previous C-Plan version (especially where these overlapped with ridges in the first analysis; and wetlands and rivers in the second); and (ii) other remaining natural land cover. High frictional values were assigned to (i) areas in close proximity (300 m) to permanently modified areas; and (2) permanently modified areas of the landscape (with higher costs for urban areas than agricultural areas). Least cost pathways between biodiversity priority areas and along expected gradients of climatic change, specifically relating to temperature and rainfall, were determined using cost and distance surfaces derived from the frictional surfaces. A separate document detailing the method is available (GDARD, 2013). A standard buffer width of 600 m was applied to all identified corridors, and this area was included as an Ecological Support Area.

3.6. RIDGES

Ridges are important as climate change refugia. Ridges were identified as areas with slopes steeper than 5°. This was supplemented by the ridges and koppies data for Merafong (received from North West Province in 2009). All irreversibly modified areas were excluded from the analysis. Identified ridges were included as Ecological Support Areas.

3.7. BIODIVERSITY PRIORITY AREAS ALIGNED WITH EXISTING METROPOLITAN OPEN SPACE SYSTEMS IN JOHANNESBURG, EKURHULENI AND TSHWANE

A layer of biodiversity areas prioritized by other environmental planning processes undertaken by the Gauteng Metropolitan Areas was developed. The process to identify these priority areas included examining the spatial data underlying existing Open Space Frameworks and Open Space Systems for the various Metropolitan Areas of Gauteng in order to identify areas that are either:

1. Areas forming part of the current open space systems, and are reflected as such in the applicable zoning system or equivalent land use planning mechanism, such as an Environmental Management Framework, or
2. Areas that have been identified as being high value areas for future inclusion into the open space system.

The intention was that these areas could be utilized either as biodiversity features or in a cost surface analysis to increase spatial efficiencies and to reduce conflict with the underlying spatial planning instruments for the metros. Importantly, this does not necessarily mean that there are high value features at an identified site or that all these areas should be included in the Gauteng Conservation Plan. Nevertheless, where the identified sites formed part of the conservation planning outcome, it is likely that these areas will be mainstreamed into planning processes more rapidly, and that the features found on these sites would be provided stronger protection compared with similar features on sites outside of the network. Inclusion of natural portions of these areas into the Gauteng C-Plan v3.3 could be undertaken at significantly lower cost than areas that are outside the open space network. It was therefore recommended that the areas that contribute to targets (even if they are not the most efficient sites) should be included in the identified set of Ecological Support Areas, as these areas were:

- Part of a formally recognized open space system.
- Identified as priority areas for the expansion of the open space system.
- Zoned or reflected in a way that restricts development options at a site.
- Known high ecological value sites that are reflected in metropolitan spatial planning processes.
The layers were developed based on the following documents and their associated data layers:

1. *Ekurhuleni Metropolitan Open Space System (EMOSS) and Environmental Management Framework (EMF).* The underlying data used for the analysis of the EMOSS system, were examined to identify sites within the identified open space system that are (a) currently protected, (b) identified to become part of this system, and (c) additional high value sites identified in the EMOSS analysis that are not part of the final system, but nevertheless are identified by the EMOSS or EMF as being of high value (usually intact primary grasslands or wetlands), but which are not necessarily included in the major nodes, minor nodes or corridors of the EMOSS.

2. *Tshwane Open Space Framework.* The outcomes of the Open Space Framework planning process were examined. The key data that were extracted included (a) “Green Nodes”, which are current and future sites of high value, and (b) “Green Ways”, which are broader important linkages (especially ridges and corridors), and (c) “Blue Ways”, which are important wetland features.

3. *City of Johannesburg Open Space Framework.* The outcomes of the Open Space Framework planning process were examined. The key data that were extracted included identified portions of the “Green Network” (Nodes, corridors), which are effectively sites with identified high ecological value.

These identified biodiversity priority areas (excluding sites of under 2ha) were selected as Ecological Support Areas.

*Recommendations for future iterations of Gauteng C-Plan:* Ideally, the prioritized areas from the metropolitan areas should have been included as features with targets in the spatial prioritization process for Critical Biodiversity Areas, instead of being added on at the end of the process as Ecological Support Areas. The consequence of this is that the potential for alignment with metropolitan priorities was partially missed and spatial inefficiency increased, i.e. these areas were treated as additional Ecological Support Areas rather than as features in the optimization process. However, this inefficiency was offset by these areas being included Selection Order layer used in the Critical Biodiversity Area analysis.
4. PROTECTED AREAS

As noted in Section 1.2, Protected Areas form part of the biodiversity priority areas identified in the Gauteng C-Plan v3.3 (Table 12).

Protected Areas included in the Gauteng C-Plan v3.3 encompass:

1. Provincial Nature Reserves (declared under the National Environment Management: Protected Areas Act 57 of 2003).
2. Municipal Nature Reserves (including Bird Sanctuaries) which are declared under various local and provincial declarations and by-laws.
3. Other state owned protected areas (Meteorite Crater Reserve & natural portions of Botanical Gardens).
4. Private Nature Reserves and Natural Heritage Sites with management plans that have biodiversity conservation as the primary objective.

Table 12: Protected Area Definitions used in the Gauteng C-Plan v3.3

<table>
<thead>
<tr>
<th>Level 1 Protected Areas:</th>
<th>Level 2 Protected Areas:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proclaimed in terms of relevant legislation specifically for the protection of biodiversity, have a management plan that has biodiversity conservation as the primary management objective, and which are ecologically intact.</td>
<td>(a) Proclaimed in terms of relevant legislation specifically for the protection of biodiversity (or for the purposes of nature conservation), and which are ecologically intact; OR (b) Are not proclaimed in terms of relevant legislation specifically for the protection of biodiversity (or for the purposes of nature conservation), but are managed for biodiversity and have a management plan that has biodiversity conservation as the primary management objective, and which are ecologically intact.</td>
</tr>
</tbody>
</table>

Areas not included as part of the Protected Area network were sites which are not proclaimed, do not have a management plan, and which do not included intact areas.

A summary of the Protected Areas included in the Gauteng C-Plan v3.3 is presented in Table 13.

Table 13: Protected Areas included in the Gauteng C-Plan v3.3

<table>
<thead>
<tr>
<th>Protected Area</th>
<th>Type</th>
<th>Level</th>
<th>Hectares</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abe Bailey</td>
<td>Provincial Nature Reserve</td>
<td>2</td>
<td>5090.43</td>
</tr>
<tr>
<td>Alice Glöckner</td>
<td>Provincial Nature Reserve</td>
<td>2</td>
<td>155.19</td>
</tr>
<tr>
<td>De Onderstepoort</td>
<td>Private Nature Reserve</td>
<td>2</td>
<td>2948.39</td>
</tr>
</tbody>
</table>
## Issues regarding the Protected Areas used in the Gauteng C-Plan v3.3

The Protected Area definition used in Gauteng C-Plan v3.3 deviates from national policy documents and guidelines (Protected Areas Act, National Biodiversity Assessment, 2011 and National Protected Areas Expansion Strategy, 2008). These documents include all formally proclaimed Protected Areas (including World Heritage Sites and Protected Environments) and exclude undeclared/informal conservation areas which do not have secure legal status.

Gauteng C-Plan v3.3 includes most types of formal Protected Areas, but deviates from the norm by excluding Protected Environments and World Heritage Sites, while including undeclared private nature reserves and natural heritage sites that have biodiversity focussed management plans in place (these would be categorised as informal Conservation Areas under the National Protected Area Expansion Strategy and would not be seen to be meeting Protected Area targets).
* Recommendations for future iterations of Gauteng C-Plan: Although there is good justification in taking an approach that focuses on land management rather than legal protection, it is strongly recommended that future iterations of the conservation plan be closely aligned to national norms, as the current approach causes significant problems in the publishing of the content of the Gauteng C-Plan v3.3 as a bioregional plan for the metros and districts. This issue was dealt with by indicating Protected Environments and World Heritage sites on the Bioregional Plan maps to improve alignment with national bioregional plan norms, but unresolved issues remain in terms of alignment with national ecosystem Protection Levels. In addition to complicating the inclusion of Gauteng C-Plan 3.3 into the Bioregional plans, the approach taken also complicates the inclusion of identified priorities into Protected Area Expansion Strategies.
5. CONSERVATION PLANNING APPROACH

This section describes the Systematic Conservation planning approach adopted in the Gauteng C-Plan v3.3. The components covered are:

1. Planning Units
2. Availability of units for selection
3. Selection Order layer
4. Software used
5. Integration approach to identify Critical Biodiversity Areas
6. Approach to identify Ecological Support Areas

1. Planning Units

100ha hexagonal units were used as the basic planning unit. Excluded areas (refer below) were removed from the units. Protected Areas were included as single units. Remaining intact areas, where these were smaller than 30% of an original planning unit, and were adjacent to a larger intact areas in a neighbouring hexagon, were merged with these adjacent areas. Hence, the planning units were initially hexagons but had irreversibly modified sections removed and small intact adjacent sections added to create some irregular planning units. Slivers of $< 10 \text{ m}^2$ were eliminated, but true “islands”, which were not adjacent to any larger unit, were retained as separate planning units. These areas were often isolated pans.

2. Availability of units for selection

As described in Section 2.1, a dataset of excluded areas was developed, which comprised:

1. Urban areas.
3. Industrial areas.
4. Large exotic plantations.
5. Areas fragmented to smaller than 0.2ha.

These areas were considered to be irreversibly modified with little or no remaining biodiversity value, and were excluded from the analysis.

All other planning units were either flagged as Protected Areas or Available, depending on their status. Refer to Section 4 for the Protected Area definitions and Section 2.1.1 for the Land Cover data set which presents the land cover classes selected as Available for selection in the planning process.

* Recommendations for future iterations of Gauteng C-Plan: Unlike many conservation plans, cultivated lands were retained as available to accommodate threatened bird species utilizing these ploughed fields. This approach caused significant problems which had to be dealt with in the bioregional plan by creating unique categories for arable fields that were identified as important. It is recommended that this approach is not used in future iterations, but rather that alternative methods are adopted to deal with the requirements of specific threatened species.
3. Selection Order layer

A selection order layer was created for use in the Gauteng C-Plan v3.3 analysis. The purpose of this layer is to steer selection away from areas with a high cost/threat, and to steer towards areas aligned with other priority biodiversity features and where greater opportunities exist for conservation activities. The values used are detailed in Table 15 below.

Table 14: Cost and Opportunity Values and Features Used in the Selection Order Layer

<table>
<thead>
<tr>
<th>COST VALUE</th>
<th>FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Level 3 protected areas (i.e. Areas in the GDARD Protected Area datasets which are not proclaimed, have no management plan, but which are intact) Conserves Biodiversity priority areas aligned with existing Metropolitan Open Space Systems in Johannesburg, Ekurhuleni and Tshwane.</td>
</tr>
<tr>
<td>2</td>
<td>Corridors</td>
</tr>
</tbody>
</table>
| 3          | Ecological processes – includes the following features all merged together:  
  • Dolomite  
  • Ridges  
  • Perennial rivers plus buffers (urban = 32m; rural = 100m)  
  • Wetlands plus buffers (urban = 30m; rural = 50m)  
  • Poor condition / transformed pans (more than 40% urban land cover within the 1km pan catchment) plus buffers (urban = 30m; rural = 50m)  
  • Good condition pans (less than 40% urban land cover within the 1km pan catchment) plus buffers (1km) |
| 4          | Low cost areas (agriculture areas) |
| 5          | Moderate cost areas (mineral deposits) |
| 6          | High cost areas (urban areas) |

*Recommendations for future iterations of Gauteng C-Plan:* Although the development of a cost surface is valid and necessary, it appears that the use of this layer was largely to simulate the spatial efficiencies that are intrinsic to a MARXAN approach. It is suggested that future iterations of the Gauteng C-Plan both use spatial optimization tools such as MARXAN and also utilize all relevant features (e.g. corridors) with appropriate targets to ensure optimal spatial configurations.

4. Software Used

The Gauteng C-Plan v3.3 analysis used C-Plan (Pressey et al., 2005, 2009).

Issues regarding the Software Used
5. **Integration approach to identify Critical Biodiversity Areas**

The following planning process was used:

1. A C-Plan database, which identifies how much of each feature is included in each planning unit, was compiled using standard conservation planning processes.

2. The C-Plan software programme was then run.

3. Irreplaceable sites, which are required for all solutions, were identified and earmarked as Critical Biodiversity Areas.

4. Because many biodiversity feature targets were not met by the step above, the steps below were repeated iteratively:
   
   i. The top 5% summed irreplaceability sites which contribute to meeting most targets were identified.
   
   ii. Select from this set all sites with Selection Order values of 1 (Refer to Selection Order section above).
   
   iii. Re-calculate summed irreplaceability values.
   
   iv. Repeat the above steps i to iii. If no further sites with a cost value of 1 were found, select all sites with a Selection Order value of 2 into the conservation plan. Once these sites are exhausted, sites with a Selection Order value of 3 were exhausted, and then sites with a Selection Order value of 4.
   
   v. After numerous iterations (42), no further sites with a Selection Order value of 1-3 were being identified. A minset was then created in C-Plan to identify an efficient set of sites. Where there were ties in the selection process, the largest site was selected. This process continued until all targets were met.

   vi. Areas of < 5ha were then removed from the plan.

The identified areas were flagged as Critical Biodiversity Areas.

6. **Integration approach to identify Ecological Support Areas**

In addition to the features identified as Critical Biodiversity Areas, additional areas were included as Ecological Support Areas, namely:

1. Dolomite Areas
2. Rivers
3. Pans

* **Recommendations for future iterations of Gauteng C-Plan:** While there is no real flaw in the C-Plan process and the software programme has benefits in terms of generating true “irreplaceability” values, the programme is now seldom used as a stand-alone in South African conservation planning. The alternative spatial annealing process using MARXAN (Ball et al., 2009) is widely preferred because it delivers spatially efficient, connected outcomes. It is strongly recommended that a switch is made for future iterations of the Gauteng conservation plan.
4. Wetlands

5. Corridors for climate change and species migration

6. Ridges

7. Biodiversity priority areas aligned with existing Metropolitan Open Space Systems in Johannesburg, Ekurhuleni and Tshwane

If an area had already been identified as a Critical Biodiversity Area, it was not selected an Ecological Support Area.

Ecological Support Areas are described fully in Section 3.

7. **Final Critical Biodiversity Area Map**

The final product of systematic conservation planning is a map delineating the biodiversity priority areas, namely Protected Areas, Critical Biodiversity Areas, and Ecological Support Areas. This map is commonly known as a Critical Biodiversity Areas Map.

The conservation planning process identified a total of 7.1% or 129 081ha of irreplaceable area (where there is no choice) and an additional 16.4% or 298 915ha of ‘best design’ areas, which constitute the Critical Biodiversity Areas (Table 14). These are the areas that are additional to the current Protected Area network of 43 956ha, or 2.4% of Gauteng, which are required to meet biodiversity targets.

An additional 333 124ha or 18.3 % of the province was identified as Ecological Support Areas.

Refer Section 6 for a summary of these values (Table 14) and a graphic illustration of the final Critical Biodiversity Areas Map (Figure 3).
6. FINAL RESULT: THE GAUTENG CRITICAL BIODIVERSITY AREAS MAP

6.1. CATEGORIES ON THE CRITICAL BIODIVERSITY AREAS MAP

As noted in Section 1.1, the Gauteng Critical Biodiversity Areas Map is the final spatial outcome of the systematic conservation planning process, and is a composite map of the existing Protected Areas, areas selected as Critical Biodiversity Areas and Ecological Support Areas.

Refer to Section 5 which explains the conservation planning approach in the integration of these biodiversity priority areas.

The Gauteng Critical Biodiversity Areas Map (Figure 3) is made up of the following categories:

1. Protected Areas
2. Critical Biodiversity Areas
3. Ecological Support Areas

A summary of the categories included in the Gauteng Critical Biodiversity Areas Map is presented in Table 14 and Figure 3 below.

**TABLE 15: FINAL GAUTENG C-PLAN V3.3 RESULTS – CATEGORIES AND SUMMARIZED VALUES (HECTARES AND PERCENTAGE) FOR THE CATEGORIES ON THE CRITICAL BIODIVERSITY AREAS MAP**

<table>
<thead>
<tr>
<th>Category</th>
<th>Ha</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected areas</td>
<td>43 956</td>
<td>2.4</td>
</tr>
<tr>
<td>Critical Biodiversity Areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irreplaceable areas</td>
<td>129 081</td>
<td>7.1</td>
</tr>
<tr>
<td>Important areas</td>
<td>298 915</td>
<td>16.4</td>
</tr>
<tr>
<td>Ecological Support Areas</td>
<td>333 124</td>
<td>18.3</td>
</tr>
<tr>
<td>Not an Identified Priority</td>
<td>1 012 763</td>
<td>55.7</td>
</tr>
</tbody>
</table>

For the categories on the Critical Biodiversity Areas Map.
Figure 3: Final Gauteng Critical Biodiversity Areas Map generated by Gauteng C-Plan v3.3.
6.2. SUMMARY CRITERIA OF THE CATEGORIES ON THE CRITICAL BIODIVERSITY AREAS MAP

In summary, the areas identified as priorities in Gauteng C-Plan v3.3 fall into the following categories:

6.2.1. Protected Areas

Protected Areas included in the Gauteng C-Plan v3.3 encompass:

- Provincial Nature Reserves (declared under the National Environment Management: Protected Areas Act 57 of 2003).
- Municipal Nature Reserves (including Bird Sanctuaries) which are declared under various local and provincial declarations and by-laws.
- Other state owned protected areas (Meteorite Crater Reserve & natural portions of Botanical Gardens).
- Private Nature Reserves and Natural Heritage Sites with management plans that have biodiversity conservation as the primary objective.

See Section 4 for important details on how the definitions used differ from those typically applied in other South African systematic conservation plans.

6.2.2. Critical Biodiversity Areas (CBAs)

(1) Any natural or near-natural terrestrial or aquatic area required to meet targets for biodiversity pattern and/or ecological processes, such as:

- These include irreplaceable sites where no alternative options exist for meeting targets, and ‘best design’ areas where there are options, but where the identified network meets the targets in a spatially efficient and ecologically robust way that avoids conflict with other land uses where possible. These sites include areas required to meet targets for ecosystems, areas required to meet targets for threatened species; areas required for ecological processes targets (e.g. climate change adaptation linkages; and hydrological process areas, such as high priority wetlands and catchments, pan clusters and pans within priority catchments).

(2) Intensive agricultural landscapes required to meet biodiversity targets for threatened species. Although the conservation planning process preferentially attempted to meet biodiversity targets in natural or near-natural landscapes, in some cases intensive agricultural landscapes may perform a key role in maintaining populations of threatened species (e.g. ploughed fields may be key foraging areas for threatened bird species such as Blue Crane or Secretary Birds).

6.2.3. Ecological Support Areas (ESAs)

(1) Natural, near-natural or degraded areas required to be maintained in an ecologically functional state to support Critical Biodiversity Areas and/or Protected Areas. These include:

- Remaining floodplain, corridor, catchment, wetland and other ecological process areas that have not been identified as Critical Biodiversity Areas but which need to be maintained in a functional state to prevent degradation of CBAs and Protected Areas.

(2) Areas with no natural habitat remaining, but which retain potential importance for supporting ecological processes.
7. DOES GAUTENG C-PLAN V3.3 MEET THE REQUIREMENTS OF A SYSTEMATIC CONSERVATION PLAN AND A BIOREGIONAL PLAN?

The "Guideline regarding the Determination of Bioregions and the Preparation and Publication of Bioregional Plans" (DEAT, 2009) identifies the key characteristics of a systematic conservation plan as being representation, persistence, quantitative targets, and efficiency and conflict avoidance. Gauteng C-Plan v3.3 is evaluated below in terms of these key characteristics:

1. The principle of representation - the plan needs to identify those areas needed to conserve a representative sample of all biodiversity pattern.

Gauteng C-Plan v3.3 is based on a new habitat map for the Gauteng Province. Data on the distribution of wetland and river systems was also included. In addition to the broad habitats mapped, detailed data on the distribution and habitat requirements of a range of threatened species were also included. These species were subjected to a robust filtering process to ensure that all required species were included. Quantitative targets were set for all biodiversity features to ensure that the principle of representation was adhered to in the identification of Critical Biodiversity Areas. All targets for features described in this document were met in the identified set of Critical biodiversity Areas.

Section 8 identifies to what extent the identified areas meet targets for national habitat types, and to what extent the nationally identified Freshwater Ecosystem Priority Areas are incorporated.

2. The principle of persistence - the plan needs to identify those areas required to support ecological and evolutionary processes that allow biodiversity to persist in the long term.

Gauteng C-Plan v3.3 focuses on three key areas to ensure that biodiversity persists into the future, namely:

- **Species requirements**: The persistence requirements for each of the threatened species included in the plan were identified and incorporated into the plan. For instance, range sizes and habitat requirements, as well as buffers around known species locations, were built into the plan.

- **Climate change**: The plan identifies and includes (a) corridors, (b) areas that represent the full range of bioclimatic variables (altitude, aspect, geology), and (c) intact ridges, which represent important environmental gradients and linkages.

- **Hydrological processes**: Key wetland and river systems are included in the plan. In addition, targets were set for identified priority freshwater catchments and dolomite systems.

3. Biodiversity targets - quantitative targets are set for biodiversity features, indicating how much of each feature is required to ensure representation and persistence.

Targets were set for all features included within the plan. Targets ranged from 8 % to 27 % of the original area for particular vegetation types (with most targets being in the range 18 % to 23%), and up to 100 % of known habitat for key threatened species.

The ‘species area curve’ based target setting process for habitats is comparable with that used for other systematic conservation plans in South Africa (especially the National Biodiversity Assessment 2011 – Driver et al 2012).
The target setting process for species generally followed the method described by Pfab et al. 2011. Although this results in very high targets, especially for Near Threatened and Vulnerable species, these targets are not arbitrarily set and do have a basis in published literature.

The basis for certain other targets, such as those used for pristine catchments, are less clear, but they are not out of line with values used in other systematic conservation plans. In some species, there are some logic jumps in terms of required area, which are not adequately explained. More importantly, for some species, if the logic was extended to the whole of South Africa, effectively the full extent of all suitable habitats for some very wide-ranging Near Threatened and Vulnerable species would need to be selected. Although these issues have a small impact in Gauteng, as the areas would have been required to meet habitat targets anyway; this does represent a conceptual problem which needs to be addressed in future iterations of the Gauteng conservation plan. The question of whether it is rational and efficient to meet all targets proportionally in all provinces is problematic; and needs to be addressed in future iterations, as it results in unnecessarily high levels of conflict in urban areas. Nevertheless, these issues should not be seen as serious flaws in the current product, but rather as suggestions for improving future iterations of the plan.

4. Efficiency and conflict avoidance - the configuration of priority areas must be spatially efficient and, where possible, avoid conflict with other land uses.

Gauteng C-Plan v3.3 utilized an iterative summed irreplaceability process for selecting sites that were most important for meeting biodiversity targets for a range of features (this ensures spatial efficiency by selecting sites which meet targets for a range of features first, and then selects the sites which are required for specific features only), while at the same time avoiding areas with high levels of conflict with other land uses through the use of a Selection Order layer.

Conflict with other land uses was avoided by precluding sites with existing incompatible land uses and also by deliberately focussing on sites which are already identified either for conservation or as being incompatible for other uses within existing spatial planning documents, such as Environmental Management Frameworks and Open Space Systems.

The main criticism of the Gauteng C-Plan v3.3 is that it is not as efficient as possible. Spatial inefficiency is compromised to some extent by:

(a) the use of planning tools which do not optimize spatial configurations (e.g. the use of C-Plan rather than MARXAN, and then the subsequent use of a Selection Order layer to accommodate for issues that could have been built into the assessment process),

(b) the way the summed irreplaceability values and the Selection Order layer have been used imply the identified Critical Biodiversity Areas are not as efficient as possible (i.e. full use is not made of an efficient set of areas with high levels of complementarity), and

(c) the inclusion of Biodiversity priority areas aligned with existing Metropolitan Open Space Systems in Johannesburg, Ekurhuleni and Tshwane, and Ecological Support Areas as add-on areas, rather than as features included in the spatial optimization.

(d) the inclusion of the full extent of habitat for Near Threatened and Vulnerable species rather than clearly identifying the minimum required areas necessary for these species.

However, given the fragmented nature of Gauteng, where many features are either irreplaceable or near-irreplaceable, it is unlikely that the spatial configuration identified using alternative methods would be significantly
different. In conclusion, it is clear that although it may not be as efficient as possible, Gauteng C-Plan v3.3 meets all the requirements of a systematic conservation plan.

In addition to these general requirements, the guideline also specifies that a systematic conservation plan must be undertaken at an appropriate scale for informing land use planning and decision-making, include both terrestrial and aquatic features, identify a portfolio of critical biodiversity areas required to meet targets, use up to date spatial data, use appropriate methods and technology, and be accompanied by a technical report. C-Plan v3.3 meets all of these requirements, viz.:

1. **Scale:** Gauteng C-Plan v3.3 is designed to be used at approximately 1:50 000 scale, which is appropriate for informing land use planning and decision-making. As with all systematic plans, site visits by biodiversity specialists are necessary for confirming the accuracy of the data, and identifying the specific location and condition of the biodiversity features, when decisions are made at a site level.

2. **Terrestrial and aquatic features:** Both terrestrial and aquatic features are included. Although there is less detail on aquatic habitat types than is included for terrestrial habitats, variation within aquatic types is addressed by the inclusion of a range of river and wetland associated species.

3. **Identify a portfolio of Critical Biodiversity Areas required to meet targets:** The set of Critical Biodiversity Areas meets the biodiversity targets for all features (addressed in the following section), and also meets requirements for representation of national habitat type (See next section).

4. **Use up to date spatial data:** The Gauteng C-Plan v3.3 generally makes use of the most up-to-date, accurate, fine-scale GIS data available. The only major exception is the exclusion of FEPA data (Nel *et al*., 2011), but as the FEPA priority areas are sufficiently included in the identified set of priorities (see next section), this is not a major issue. A new vegetation map was created for the plan and the transformation data was significantly improved and updated. The land cover data, which is useable at a 1:30 000 scale, is based on the interpretation of high resolution satellite and aerial photography (GTI, 2009), with significant additional refinement and updating being undertaken as part of the Gauteng C-Plan v3.3 process.

5. **Use appropriate, scientifically sound, up-to-date methodology and techniques, including software and analyses:** The Gauteng C-Plan v3.3 uses a methodology which is broadly aligned with those used in other systematic conservation plans. Although there are some aspects relating to targets and spatial efficiency which should ideally have been better dealt with in the conservation planning process, the overall spatial outcomes are robust to interrogation.
8. DOES GAUTENG C-PLAN V3.3 SUFFICIENTLY MEET NATIONAL BIODIVERSITY TARGETS?

The Gauteng C-Plan v3.3 did not make use of the South African vegetation map (Mucina & Rutherford, 2006) (Refer Section 2.2). In order to determine whether the Gauteng C-Plan v3.3 sufficiently meets the proportional national biodiversity targets for the SA vegetation types, the intact areas of the identified Protected Areas and Critical Biodiversity Area (Figure 3) were intersected with the national vegetation map. Table 16 shows that if all Gauteng C-Plan v3.3 PA and CBA areas were maintained in a natural state, that the province would contribute sufficient area to meet its proportional contribution to national biodiversity targets for 15 out of 21 types.

**Table 16: Extent to which the Gauteng C-Plan v3.3 PA and CBA areas contribute sufficiently to meeting national biodiversity targets for South African vegetation types.** All habitats where the proportional contribution to SA targets is sufficiently met are highlighted in green. The table summarizes the extent of intact habitat in PA and CBA categories as management objectives for these areas require them to be kept intact. ESA areas are not included as their management objectives only require them to be maintained in a functional rather than intact state and hence they may not remain in a condition suitable for meeting biodiversity targets.

<table>
<thead>
<tr>
<th>NAME</th>
<th>SA Target (%)</th>
<th>SA Target (ha)</th>
<th>Gauteng Proportional Target (ha)</th>
<th>Extent within Gauteng CBA &amp; PA Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andesite Mountain Bushveld</td>
<td>24%</td>
<td>47816</td>
<td>17507</td>
<td>36923</td>
</tr>
<tr>
<td>Carletonville Dolomite Grassland</td>
<td>24%</td>
<td>218827</td>
<td>63624</td>
<td>77434</td>
</tr>
<tr>
<td>Central Free State Grassland</td>
<td>24%</td>
<td>383574</td>
<td>1988</td>
<td>1169</td>
</tr>
<tr>
<td>Central Sandy Bushveld</td>
<td>19%</td>
<td>327607</td>
<td>34729</td>
<td>49233</td>
</tr>
<tr>
<td>Eastern Highveld Grassland</td>
<td>24%</td>
<td>304057</td>
<td>8456</td>
<td>5780</td>
</tr>
<tr>
<td>Eastern Temperate Freshwater Wetlands</td>
<td>24%</td>
<td>13362</td>
<td>3483</td>
<td>10581</td>
</tr>
<tr>
<td>Egoli Granite Grassland</td>
<td>24%</td>
<td>26237</td>
<td>26237</td>
<td>20686</td>
</tr>
<tr>
<td>Frankfort Highveld Grassland</td>
<td>24%</td>
<td>237033</td>
<td>762</td>
<td>18</td>
</tr>
<tr>
<td>Gauteng Shale Mountain Bushveld</td>
<td>24%</td>
<td>24600</td>
<td>20544</td>
<td>20166</td>
</tr>
<tr>
<td>Gold Reef Mountain Bushveld</td>
<td>24%</td>
<td>48743</td>
<td>12361</td>
<td>21098</td>
</tr>
<tr>
<td>Loskop Mountain Bushveld</td>
<td>24%</td>
<td>49591</td>
<td>8457</td>
<td>17626</td>
</tr>
<tr>
<td>Marikana Thornveld</td>
<td>19%</td>
<td>48045</td>
<td>19332</td>
<td>20620</td>
</tr>
<tr>
<td>Moot Plains Bushveld</td>
<td>19%</td>
<td>55116</td>
<td>7664</td>
<td>9529</td>
</tr>
<tr>
<td>Norite Koppies Bushveld</td>
<td>24%</td>
<td>6242</td>
<td>992</td>
<td>1579</td>
</tr>
<tr>
<td>Rand Highveld Grassland</td>
<td>24%</td>
<td>246271</td>
<td>59272</td>
<td>60396</td>
</tr>
<tr>
<td>Soweto Highveld Grassland</td>
<td>24%</td>
<td>348320</td>
<td>102011</td>
<td>72527</td>
</tr>
<tr>
<td>Springbokvlakte Thornveld</td>
<td>19%</td>
<td>167144</td>
<td>5464</td>
<td>6608</td>
</tr>
<tr>
<td>Subtropical Freshwater Wetlands</td>
<td>24%</td>
<td>15755</td>
<td>72</td>
<td>222</td>
</tr>
<tr>
<td>Subtropical Salt Pans</td>
<td>24%</td>
<td>785</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Tsakane Clay Grassland</td>
<td>24%</td>
<td>30811</td>
<td>25778</td>
<td>27580</td>
</tr>
<tr>
<td>Waterberg-Magaliesberg Summit Sourveld</td>
<td>24%</td>
<td>12621</td>
<td>103</td>
<td>425</td>
</tr>
</tbody>
</table>
The Gauteng C-Plan v3.3 did not include the outputs of the Freshwater Ecosystem Priority Areas (FEPA) project (Nel et al., 2011). Similar to the need to evaluate to what extent national vegetation type targets are sufficiently included into the areas identified by Gauteng C-Plan 3.3, we need to evaluate to what extent identified FEPA priorities are addressed. The level to which FEPA priorities (taken as level 1 and 2 FEPA catchments) were included into areas identified by Gauteng C-Plan 3.3 is summarized in Table 17. The identified Critical Biodiversity Areas include 32% of the FEPA priority catchments, while an additional 24% is included as Ecological Support Area. In all, over 56% of the FEPA priority catchments are included in Protected Areas, Critical Biodiversity Areas and Ecological Support Areas. Considering the developed nature of Gauteng Province, this level of FEPA inclusion is near-optimal. Further, prioritized FEPA wetlands are almost entirely included in the PA, CBA and ESA network.

**Table 17: Extent (in hectares) of Freshwater Ecosystem Priority Areas (FEPA) reflected in the CBA map categories**

<table>
<thead>
<tr>
<th>CBA Map Category</th>
<th>Extent of FEPA 1&amp;2 (ha)</th>
<th>Proportion of Total FEPA 1&amp;2 Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protected Areas</td>
<td>282</td>
<td>0.25%</td>
</tr>
<tr>
<td>Critical Biodiversity Areas</td>
<td>38 872</td>
<td>32 %</td>
</tr>
<tr>
<td>Ecological Support Areas</td>
<td>28 945</td>
<td>24 %</td>
</tr>
<tr>
<td>Outside of PA, and identified CBA and ESA areas</td>
<td>54 117</td>
<td>44 %</td>
</tr>
<tr>
<td>Grand Total</td>
<td>122 216</td>
<td></td>
</tr>
</tbody>
</table>

In conclusion, the proportional national biodiversity targets for the SA vegetation types are sufficiently met in the Gauteng C-Plan v3.3. Despite the non-inclusion of the Freshwater Ecosystem Priority Areas (FEPA) data, the Gauteng C-Plan v3.3 sufficiently includes all these priority areas.

**Recommendations for future iterations of Gauteng C-Plan:**

1.) Although it appears advantageous that the Gauteng CBA network meets such high portions of national biodiversity targets, whether this is appropriate for South Africa’s major development hub, needs to be fully evaluated. As a fundamental building block for a sufficiently representative network, no province or region should meet less that its proportional contribution to targets: However the extent to which a plan exceeds this baseline requires careful consideration.

2.) Although Freshwater Ecosystem Priority Areas (FEPA) are sufficiently covered by the network identified by Gauteng C-Plan 3.3, it would be advantageous for this dataset to be directly included in future iterations of C-Plan.
9. RECOMMENDATIONS FOR FUTURE ITERATIONS OF THE GAUTENG CONSERVATION PLAN

The Gauteng C-Plan v3.3 is built on a strong basic dataset, especially the species data, and a good quality land cover map, both of which meet current bioregional plan requirements. However, it is clear that certain refinements would improve the strength and quality of the final product.

The following recommendations are provided for future iterations of the Gauteng Conservation Plan:

1. Update the land cover map.

The Gauteng C-Plan v3.3 is based on 2008 – 2009 land cover data. All land cover datasets become outdated over time, but this is particularly the case in Gauteng where land cover in the province is rapidly changing. The land cover data needs to be keep up with on-going changes. Bioregional plans are designed to allow rapid update on the basis of changes in the underlying conservation plan. Hence, it is recommended that, although the Gauteng C-Plan v3.3 is suitable for current purposes and the initial publication of bioregional plans, the update process commence immediately.

2. Irreversibly modified areas should be excluded earlier on in the planning process.

Where there are specific agricultural or similar areas necessary for Critically Endangered, Endangered and Vulnerable species, or for supporting key ecological processes, it is recommended that they are specifically identified. Further, it may be better to deal with species that are dependent on irreversibly modified landscapes via species management plans or similar instruments, rather than a systematic conservation plan. Ideally, conservation plans should be focussed on the natural and semi-natural landscapes that are critical for supporting important biodiversity features.

3. Aim to more tightly prioritize included biodiversity features and identified areas

Although, GDARD is fully entitled to include whichever species and other biodiversity features it wishes in its conservation plan (especially where it requires that this data is used in evaluation of development proposals), the current plan could be seen as being too land hungry and conservation focussed for South Africa’s major development hub. Careful consideration needs to be given to whether future iterations of the plan should be more pragmatic in terms of its overall objectives, and potentially should aim to identify the most efficient possible network of priority areas to maintain biodiversity within the province rather than being as precautionary as the current plan. Possible increases in spatial efficiency could be achieved by:

- Apply a conservation planning methodology that is as spatially efficient as possible, and which fully utilizes all principles of complementarity. Careful decisions need to be made early on during the planning process to ensure that the spatial outcome is as efficient as possible.
- A planning tool, such as MARXAN, is used to provide a more ecologically sustainable set of adjacent and connected priority areas.
- Stronger alignment with local planning instruments, such as Spatial Development Frameworks and Environmental Management Frameworks.
- A tighter filter on the species used. For example: Near Threatened species or national widespread ones could be excluded.
- Using lower targets. Provide more clarity/explanation on the targets set. In particular, this is necessary where higher targets are applied. Further, the consequences of applying the principle that all species are proportionally targeted in all administrative areas, irrespective of the level of urbanization in these areas needs to be evaluated.
Development of more focussed species models. Significant improvement in the species models for some habitats is possible.

4. Include key national datasets, such as the Freshwater Ecosystem Priority Areas data.

5. Provide sufficient time to ensure detailed and transparent documentation of the planning process and explanation of the data inputs. For example, key input layers, such as the habitat map should be clearly described in the documentation in order to justify the deviation from the national vegetation map, and ideally should be formally published.
References


CARBON SEQUESTRATION definition: http://www.greenfacts.org/glossary/abc/carbon-sequestration.htm


