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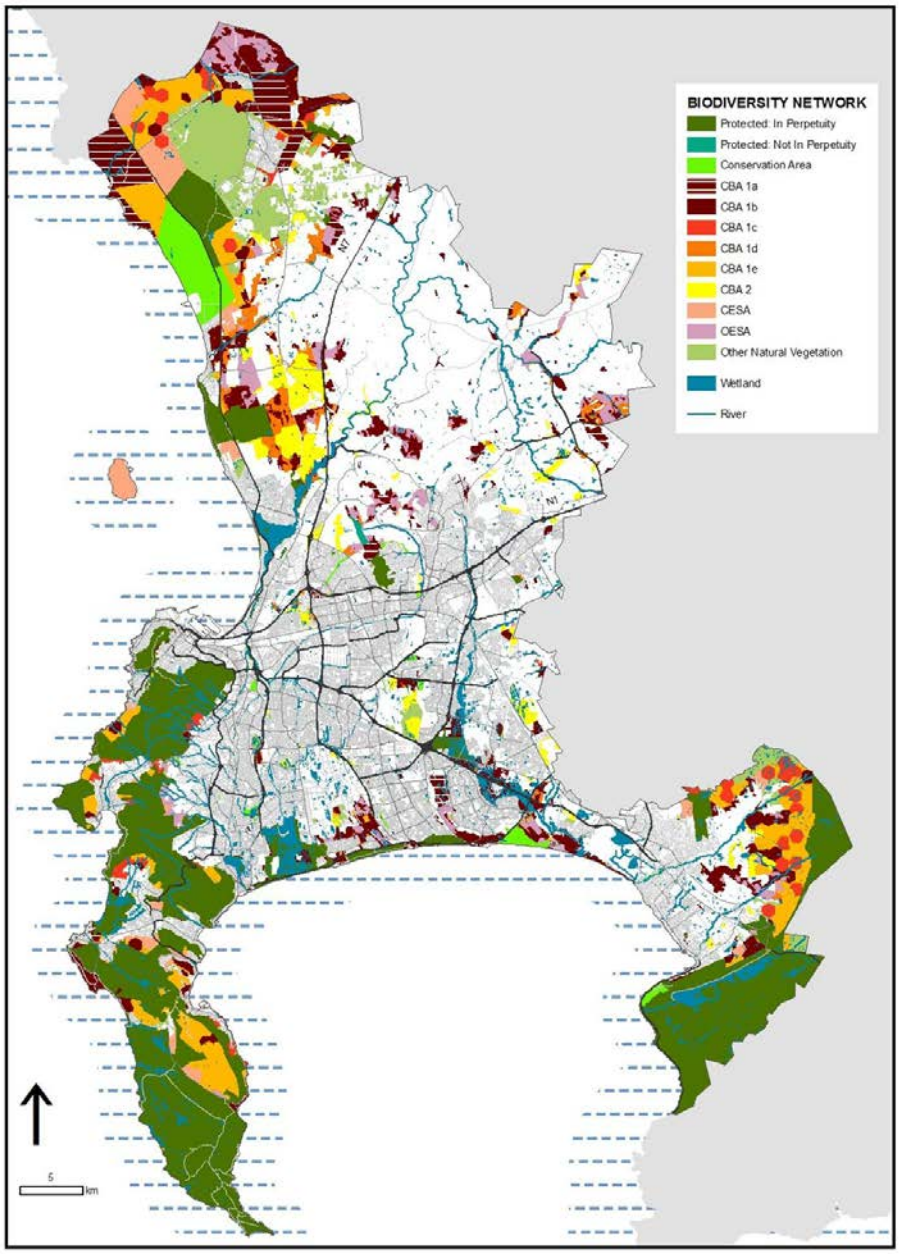
City of Cape Town's Biodiversity Network

C-PLAN & MARXAN ANALYSIS: 2011 METHODS & RESULTS



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Acronyms

BioNet	Biodiversity Network
BLM	Boundary Length Modifier
CBA	Critical Biodiversity Area
CCT	City of Cape Town
CLUZ	Conservation Land Use Zoning
CR	Critically Endangered (IUCN Red List)
CREW	Custodians of Rare & Endangered Wildflowers
EN	Endangered (IUCN Red List)
ERMD	Environmental Resource Management Department
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System/s
LT	Least Threatened (IUCN Red List)
NSBA	National Spatial Biodiversity Assessment
Red List	Plant taxa assessed according to their risk of extinction in near future (See www.redlist.org)
SANBI	South African National Biodiversity Institute
SPF	Species Penalty Factor
VU	Vulnerable (IUCN Red List)
WWF–SA TMF	World Wildlife Fund – South Africa: Table Mountain Fund

Acknowledgements

This analysis was not possible without the use of the conservation planning software; so many thanks go to the creators of C-Plan[1] and Marxan[2]. The 2008 unpublished report by Grant Benn of GeoCline Consulting CC entitled "City of Cape Town's BioNet: Terrestrial Systematic Conservation Plan Re-Analysis: Methods and Results" formed the basis for this 2011 report (www.capetown.gov.za/environment – follow links to *>Publications, >Reports and Scientific Papers*). Thanks are due to consultants Grant Benn and Genevieve Pence for on-going discussion and advice, Dr Tony Rebelo (SANBI) for compiling the endemic flora layer for the city, Stephen Holness for use of the new national Ecosystem-based Adaptation layer, interns Cindy Lee Williams and Sivile Mgese for assisting with data preparation, and Sivile with map production, and City Biodiversity Management Branch colleagues for reviewing the BioNet analysis outputs.

[1] *Pressey, R.L., Watts, M.E., Barrett, T.W. and Ridges, M.J. (2008). The C-Plan conservation planning system: origins, applications, and possible futures. In: Spatial Conservation Prioritization. Eds. A. Moilanen, H.P. Possingham and K.A. Wilson. Oxford University Press, Oxford (in press).*

[2] *Ball, I.R., H.P. Possingham, and M. Watts. 2009. Marxan and relatives: Software for spatial conservation prioritisation. Chapter 14: Pages 185-195 in Spatial conservation prioritisation: Quantitative methods and computational tools. Eds Moilanen, A., K.A. Wilson, and H.P. Possingham. Oxford University Press, Oxford, UK.*

INTRODUCTION

The City of Cape Town (CCT) has used a systematic biodiversity planning approach to prioritise its remnant indigenous vegetation based on factors such as connectivity, habitat condition and location of threatened flora. Systematic biodiversity planning generally involves the following steps:

- Subdividing a region into a series of planning units
- Gathering data describing the distribution of biodiversity features within this region
- Calculating the amount of each biodiversity feature found in each planning unit
- Setting targets for each biodiversity feature in order to ensure their adequate conservation
- Using software to select a set of planning units which meets these targets in an efficient manner.

The primary product of this approach is the CCT's Biodiversity Network (BioNet), which exists in the form of a GIS shapefile, with associated tabular information. The shapefile can be mapped and analysed and statistics can be derived, giving users a picture of not only the situation on the ground but most importantly, where to focus their conservation efforts in light of limitations in staff, budget and available open space. This report gives an overview of the methodology used but the technical process using GIS technology and the biodiversity planning software packages of C-Plan and MARXAN/CLUZ is described in a separate manual (contact enviro.gis@capetown.gov.za).

History of Systematic Biodiversity Planning in the City

In 2002, the first systematic biodiversity planning study to identify the minimum set of conservation areas required in the CCT was initiated using the biodiversity planning software "C-Plan". This study pre-dated the National Environmental Management: Biodiversity Act (2004), the new National Vegetation Map (SANBI 2005) and the National Spatial Biodiversity Assessment (2004). The study built on earlier work done in partnership with the Botanical Society which resulted in a report entitled: "Core Flora Conservation Areas on the Cape Flats" (Maze & Rebelo 1999[3]). In the latter report, 38 sites were identified as critically important contributors to Cape Town's biodiversity and have since become known as the "Core Flora Sites". Data informants for the 2002 study included a remnant layer based on 1998 aerial photography, available plant species information and a local vegetation map drawn up by botanical consultant A. B. Low. The study culminated in the Biodiversity Network Prioritization Report (2004[4]).

In 2006, a revised desktop systematic biodiversity planning study was initiated to update the BioNet using the latest: 1) remnant layer based on 2005 aerial photography, 2) species information and 3) a vegetation map aligned to the new national vegetation map (Mucina et al. 2005[5]). Results from this re-analysis may be found in the 2007 report[6]. This version of the BioNet was approved by council (PEPCO, November 2006) subject to continuing collaborations with Spatial Planning and Urban Design.

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[3] *Maze K E & Rebelo A G 1999. Core Flora Conservation Areas on the Cape Flats. FCC Report 99/1. Botanical Society of South Africa.*

4 Note: all City biodiversity reports are available on the ERMD website: http://www.capetown.gov.za/en/environmentalresourcemanagement/Pages/default.aspx; "publications > reports"
City of Cape Town. 2004. Biodiversity Network Prioritisation Project, Final Draft Report prepared by MLA-Sustainability Matters, in association with GISCOE, Biodiversity & Conservation Biology Department UWC, Settlement Planning Services & Freshwater Consulting Group.

5 Mucina L, Rutherford M L & Powrie L W (editors) 2005. Vegetation Map of South Africa, Lesotho and Swaziland. SANBI, Pretoria.

6 City of Cape Town. 2007. The Identification and Prioritisation of a Biodiversity Network for the City of Cape Town, Final Report prepared by MLA-Sustainability Matters, in association with GISCOE (Pty) Ltd.

In 2008, after extensive ground-truthing of vegetation remnants during 2007-8, the remnant layer was again updated and C-Plan was re-run using habitat condition as an additional informant. The programme "Marxan" was next applied, using a "Boundary Length Modifier" tool, to select additional remnants needed to improve connectivity among selected remnants. This, together with expert corridor sites, replaced the friction analysis used in the first analysis to identify corridors on the BioNet. Corridors help to conserve ecological processes, which include the dispersal and migration of plants and animals, and are necessary to conserve healthy populations in the long-term. All wetlands and rivers in this and earlier versions are considered part of the BioNet.

In the 2008 analysis, the national ecosystem thresholds were adopted for the first time in setting the targets for conservation, and continue to be used. Methods and results of the 2008 analysis of the BioNet are reported in Benn (2008[7]). In 2009, the analysis was redone closely following the methodology of the 2008 analysis but with improved input data. The methods and results of the 2009 analysis of the BioNet are reported in *Holmes & Stipinovich 2009[8].*

DATA PREPARATION

Software

The data were prepared using ESRI's GIS software versions ArcGIS 9.3 and ArcView 3.3. C-Plan 3.4, Spatial Analyst, Marxan and CLUZ extensions to ArcView 3.3 were used as well as Microsoft's Excel and Access.

Analysis Data Inputs

See Table 1: Analysis Data Inputs on page 9.

Formation of the Planning Units

The planning domain was the area enclosed by the administrative boundary of the CCT. The basis for the formation of the planning units within the planning domain was the CCT indigenous vegetation remnants coverage. The remnants had been ground-truthed in 2008 for the third C-Plan analysis and creation of the BioNet of 2008. Each remnant's habitat condition was evaluated as being high, medium or low. Over the subsequent years, the status of some of these remnants was updated by the Environmental Resource Management Department (ERMD) so the information was as current as possible, habitat condition being a key factor in the analysis. In the 2009 analysis, the Protected Areas were considered to be in high habitat condition as time did not permit their being ground-truthed. Since the 2009 analysis, the Protected Areas have been ground-truthed.

Each high, medium or low portion of a remnant formed a separate planning unit. Any remnants over 100 hectares in size that were not classified as Protected Areas were further subdivided into hexagon grid cells of 100 hectares in area. Existing protected area boundaries were integrated into the remnant layer before this process was carried out. "Protected Areas" included those in process of being proclaimed that are managed by City of

7 *Benn G. 2008. City of Cape Town BioNet: Terrestrial Systematic Conservation Plan Re-Analysis: Methods & Results. (Available for download from ERMD website)*

8 *Holmes P. M. & Stipinovich A. 2009. City of Cape Town's Biodiversity Network: C-PLAN & MARXAN ANALYSIS: 2009 METHODS & RESULTS. (Available for download from ERMD website)*

Cape Town and other organizations. Core Flora Sites were also considered as *a priori* "protected areas" for the purposes of the analysis although not all are protected (Figure 1).

Only features that were located on the existing remnants coverage were considered in the analysis.

Threats to the Biodiversity Network

A combined threats layer for the analysis was generated (Figure 2), which included the following threats:

- Urban expansion (based on latest Urban Edge)
- Potential agriculture
- Potential mining areas
- New Development Areas

The factors were then assessed as being either of high, medium or low threat. The relative area of each threat level per planning unit was calculated. This information was used to select sites under least threat as a rule in the C-plan analysis.

Biodiversity Features Incorporated

The indigenous vegetation (Figure 3) and flora (Figure 4) of a planning unit was used as a surrogate for biodiversity, as the coverage of the available GIS flora data was far greater than that available for indigenous fauna. Vegetation and flora generally are good indicators for the fauna. Included were the various national vegetation types and their local CCT subtypes as well as three plant species databases, additional CCT records and their individual Red List threatened species status. The variety, numbers or area, and rarity of each are considered by the conservation planning software. The biodiversity features brought into the analysis as factors were as follows:

- Current indigenous vegetation extent with remnants classified as high, medium or low habitat condition
- Revised CCT indigenous vegetation: This aligns the CCT vegetation types with the South African National Biodiversity Institute (SANBI) National Vegetation types; the CCT types are classed as subtypes at a finer scale
- CREW[9] indigenous flora species data
- CCT indigenous flora species data
- Protea Atlas Project (SANBI) indigenous flora species data
- SaSflora[10] indigenous flora species data

CCT wetlands were prioritized in a separate analysis (Snaddon & Day 2009)[11] and incorporated into the terrestrial Critical Biodiversity Area (CBA) map. In addition, the internal expert review of the analysis ensured that Important Birding Areas, known localities of threatened and endemic fauna and Baboon home ranges were included in the BioNet.

9 CREW = Custodians of Rare and Endangered Wildflowers
10 SaSflora = Site and Species flora database (Coastec)
11 Snaddon K. & Day E. (2009) Prioritization of City Wetlands. www.capetown.gov.za/environment - follow links to Publications > Reports and scientific papers.

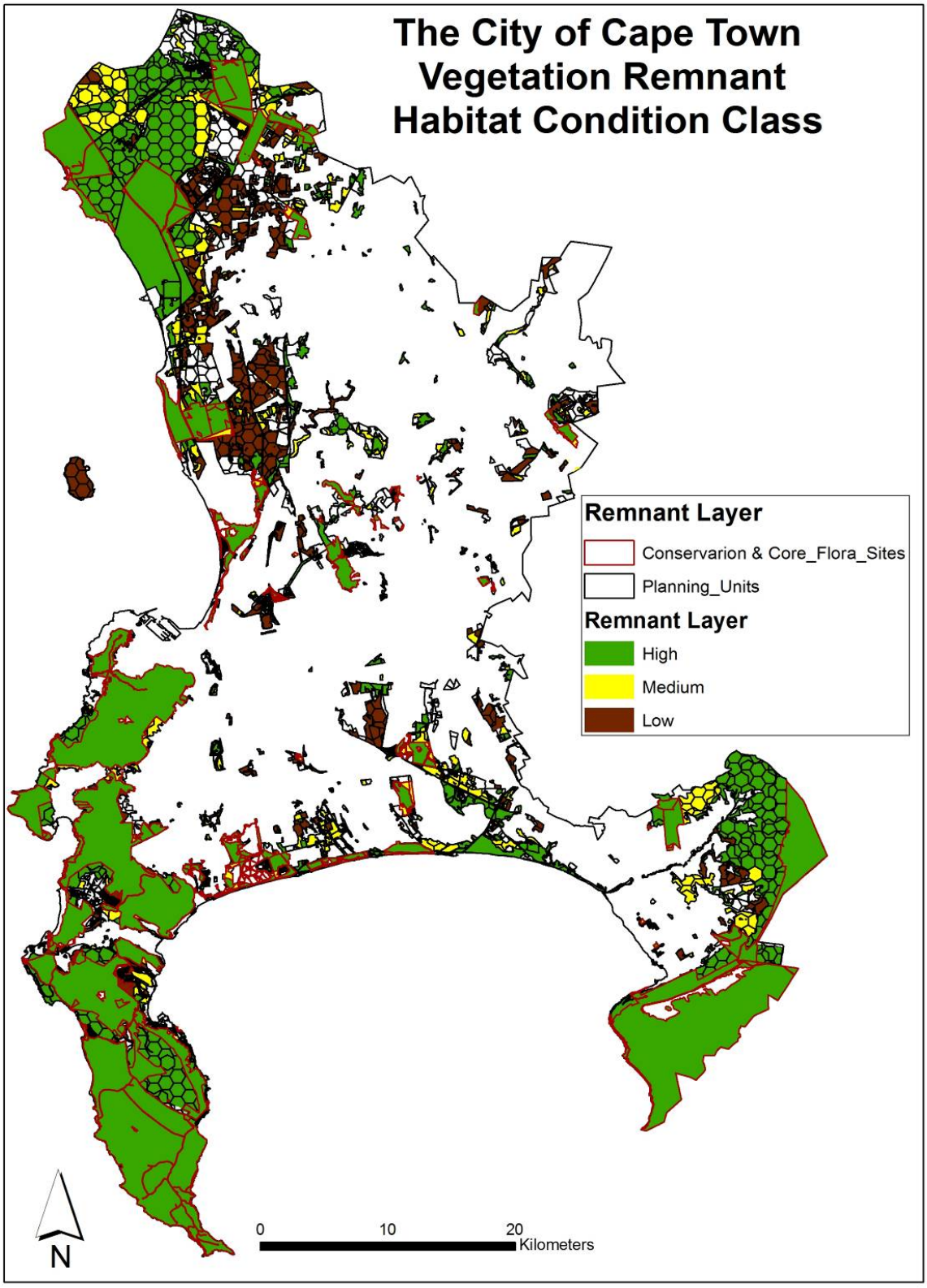

Figure 1: Natural remnants in the City of Cape Town showing i) habitat condition class (high, medium or low), ii) conservation areas and core flora sites, and iii) planning unit boundaries

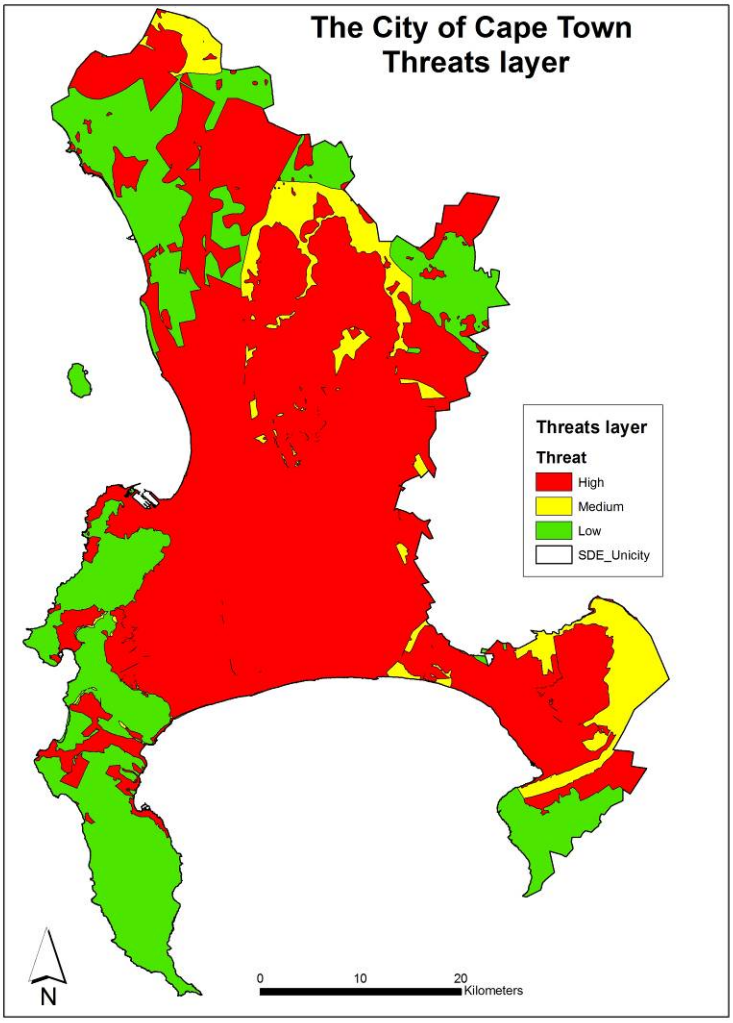

Figure 2: The threats to biodiversity layer used in the C-plan analysis

Excluded Biodiversity Features

- The dunes at Atlantis were extracted from the vegetation coverage as they extend over an area of 270 hectares. Areas identified as "Reclaimed" areas in the Vegetation coverage were also excluded.
- Beach vegetation types in the False Bay area were grouped with the False Bay subtype of Cape Flats Dune Strandveld and Beach vegetation types in the West Coast area were grouped with the West Coast subtype of Cape Flats Dune Strandveld.
- Subtypes of Southern Afrotemperate Forest vegetation were combined and brought in as one "Southern Afrotemperate Forest" unit as this type covers a very small area and is formally conserved in the Table Mountain National Park.
- Any exotic flora species listed in the CREW, CCT, SaSflora or Protea Atlas Project data were excluded.
- Large artificial water bodies and waste water treatment works (e.g. dams such as Steenbras and Kleinplasie) were extracted from the vegetation coverage so as not to bias vegetation statistics. Other areas of natural and semi-natural water bodies fell into the Cape Lowland Freshwater Wetland vegetation type.

Table 1: Analysis Data Inputs

Data	Content	Source	Version	Format
BioNet remnants (used to create Planning Units and to bring in habitat condition information)	Remnants of indigenous vegetation remnants classified as being of high, medium or low condition	City of Cape Town	November 2011	Polygon shapefile mapped at varying scales and ground-truthed in 2008 but constantly being refined to a scale of 1:2000 and updated.
Indigenous vegetation	Historic Indigenous vegetation cover of City of Cape Town	City of Cape Town (based on national SANBI version of 2005)	November 2011	Polygon shapefile originally mapped at National scale 1:50 000 but refined at a scale of 1:2000 in areas by City of Cape Town
CREW Red List Threatened species	Indigenous floral species locations	CREW, SANBI	September 2011	Point shapefile (accurate to within 10m)
Protea Atlas Project species	Indigenous floral species locations	Protea Atlas Project, SANBI	September 2011	Centroid coordinates (point taken to be accurate within a radius of 250m)
SaSflora Red List Threatened species	Indigenous floral species locations	Barrie Low - Coastec	September 2011	Centroid coordinates (point taken to be accurate within a radius of 250m)
CCT species (added to the CREW data during the analysis)	Indigenous floral species locations	CCT staff & BioNet groundtruthing team. Also Nick Helme (consultant)	July 2009	Point shapefile (accurate to within 10m)
Wetlands (used for comparison purposes only)	Natural and artificial wetlands	City of Cape Town	October 2011	Polygon shapefile digitized at 1:10 000 from orthophotos and sample groundtruthed
Threats to BioNet	Agricultural, urban, mining and development threats	City of Cape Town	November 2011	Polygon shapefile created from latest, best available CCT shapefile inputs
Local plant endemics	Number of local endemic plant species per 100ha hexagon grid	SANBI	October 2011	Shapefile created from available data on local endemic plant species distribution

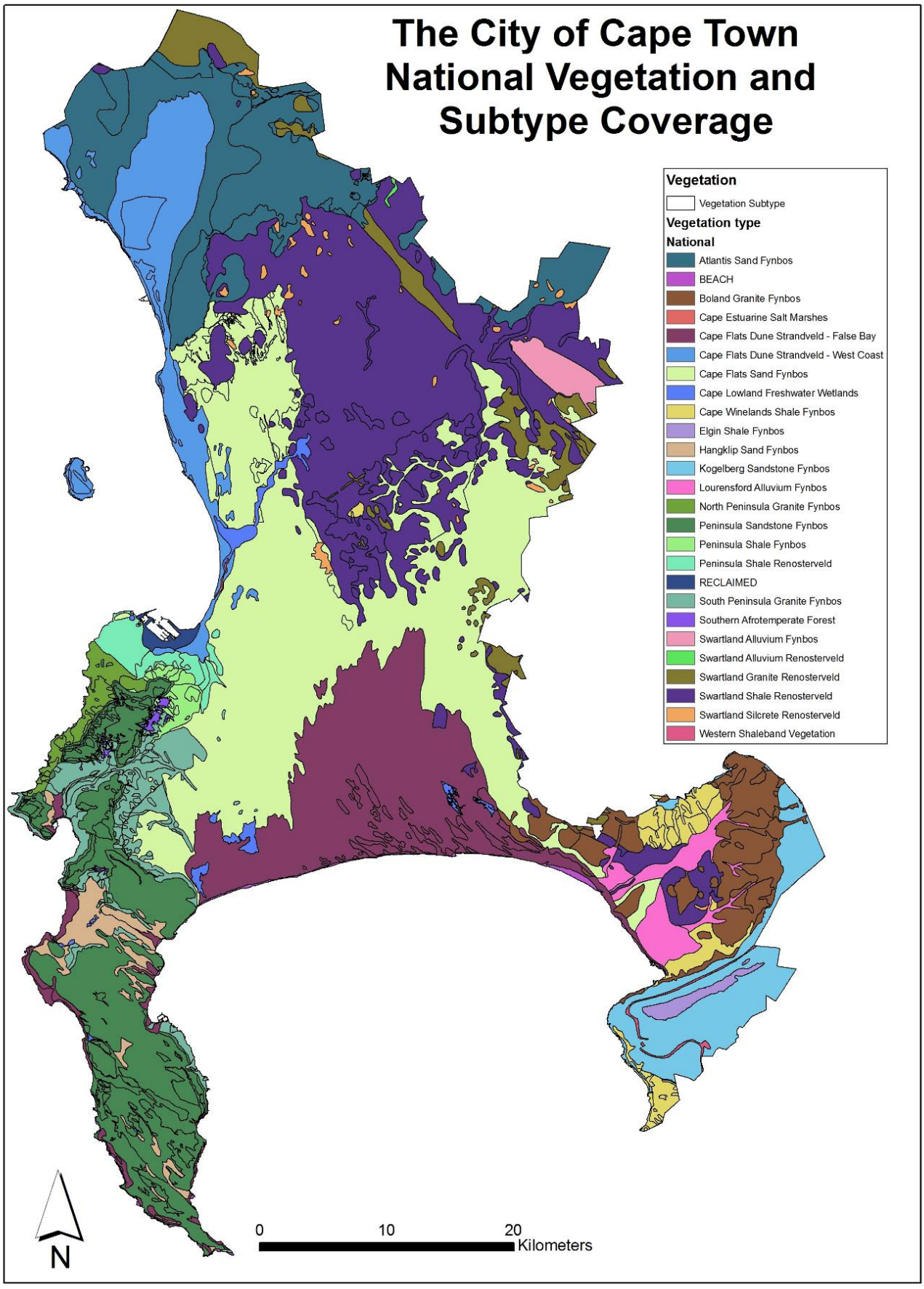

Figure 3: National vegetation types in the City of Cape Town. City vegetation subtypes are hollow polygons overlying the national

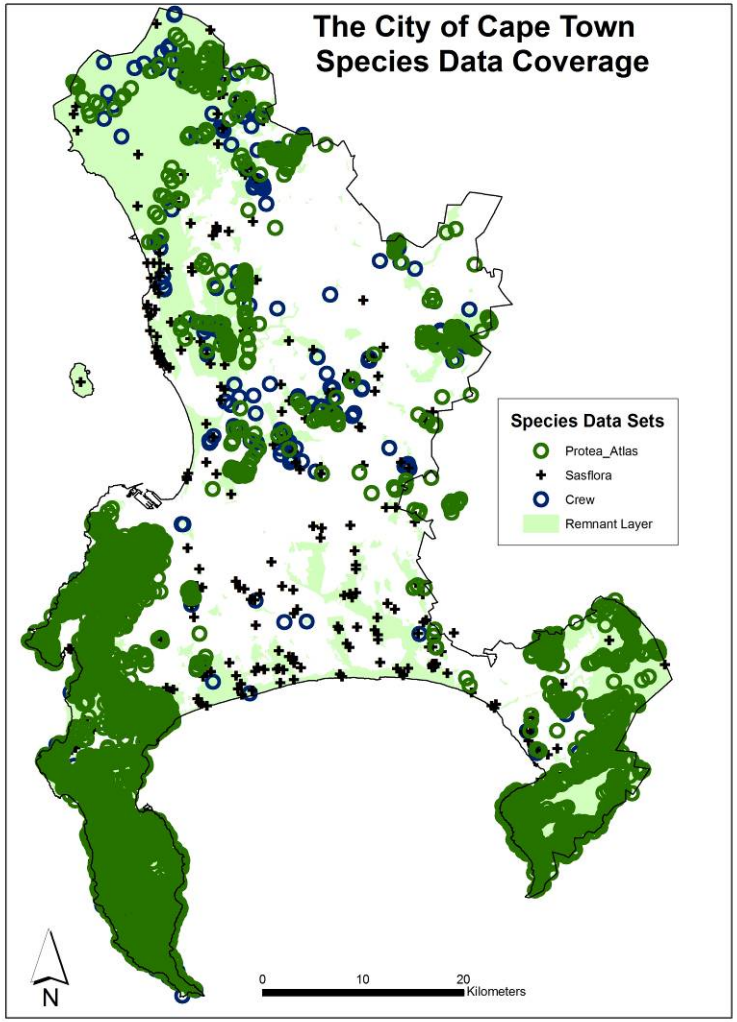

Figure 4: Coverage of species data localities

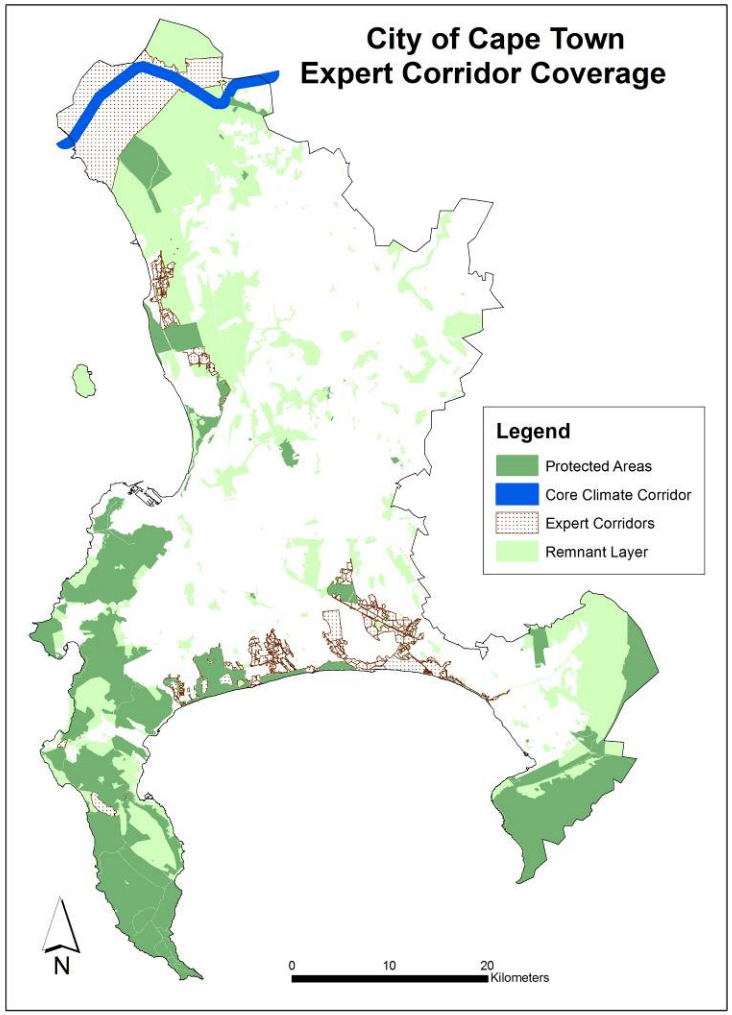

Figure 5: Core climate adaptation and expert corridors

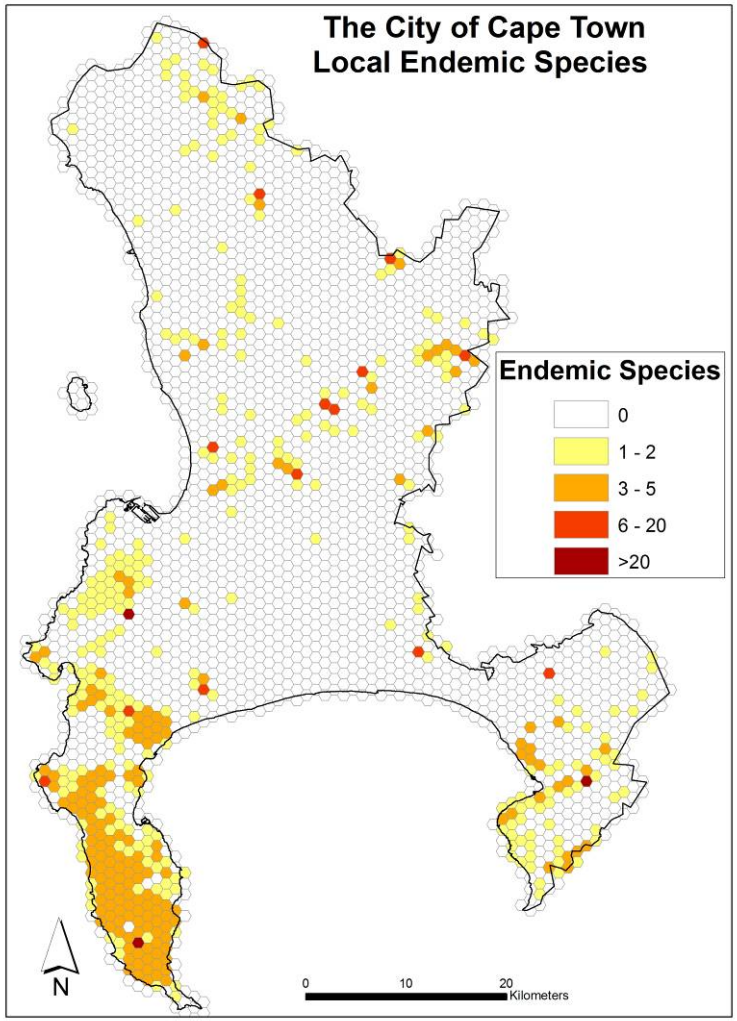

Figure 6: Number of local endemic species per 100ha hexagon grid

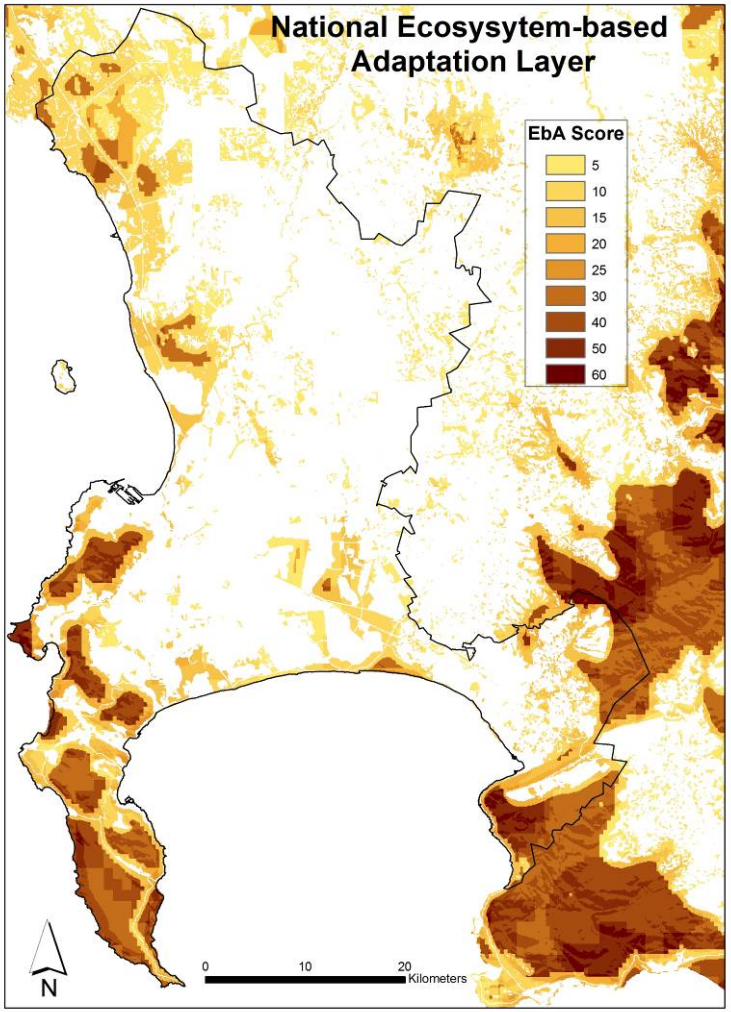

Figure 7: National Ecosystem-based Adaptation (EbA) Layer

Allowing for Biodiversity Processes: Connectivity

Potential corridors to ensure connectivity through the fragmented landscapes of the CCT were mapped by Biodiversity Management Branch's experienced staff in 2011 and included in the analysis as a factor (Figure 5):

- Blaauwberg Nature Reserve to Koeberg Private Nature Reserve
- Diep River Fynbos Corridor (Rietvlei to Blaauwberg Nature Reserve)
- Kuils River Corridor (Driftsands Nature Reserve to the coast at Macassar Dunes)
- False Bay Coastline
- Dassenberg Coastal Catchment Corridor (Silverboomstrand to Riverlands Nature Reserve)
- Important linkages on the Cape Peninsula.

Allowing for Biodiversity Processes: Adaptation to Climate Change

For the 2011 analysis, the methodology was updated to explicitly incorporate climate adaptation strategies based on international best practice (Pence 2009; Pence 2011)[12],[13]. Previous analyses had addressed the protection of representative habitats, critical habitats & large intact habitats; risk-spreading through replication; incorporation of ecological connectivity; and reduction of threats. The potential for the BioNet to adapt to climate change was further strengthened by inclusion of the potential key climate refugia, identified as areas of high local endemic plant species richness (Figure 6) and prioritisation of regional connectivity. The latter adaptation features were incorporated into the C-plan Minset rules. In the Marxan analysis, an important climate change adaptation corridor that was identified in a WWF-SA TMF study (Pence 2009), aligning with the Dassenberg Coastal Catchment Corridor, was included as a conservation feature. In addition, Holness' (2011)[14] Ecosystem-based Adaptation layer (EbA), part of the draft National Biodiversity Assessment (NBA), was used as the cost surface in Marxan to preferentially select areas of high adaptation value (Figure 7). The EbA layer incorporates the following areas:

- Areas with a high diversity of habitats
- Environmental gradients (including topographic, temperature, and precipitation)
- Climate refugia (including south-facing slopes and gorges)
- Corridors
- Large unfragmented natural ecosystems
- Intact centres of endemism; and
- Buffer ecosystems (i.e. riparian and coastal).

Assessment of Vegetation Type, Ecosystem & Conservation Status

Ecosystem status and conservation status were calculated using the status categories developed by SANBI. The assessment of the status can be done at either the National vegetation type or the CCT vegetation subtype level. This analysis operated at the subtype level, but the results are also presented at the national vegetation level in order to summarize the contribution towards achieving national targets.

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12 Pence, G.Q.K., 2009. Climate Adaptation Scenarios for the Cape Floristic Region: Technical Report. Unpublished Report, Table Mountain Fund, World Wildlife Fund-South Africa, Cape Town.

13Pence G. (2011). Incorporating Climate Change Adaptation Strategies into the Updating of the City of Cape Town's Biodiversity Network Analysis. Unpublished Report City of Cape Town.

14 Holness, S., 2011. Identification of areas important for Ecosystem-based Adaptation. Unpublished Report, SANBI. South Africa, Cape Town.

SANBI ecosystem status categories and thresholds[15]

- Critically Endangered (CR): current area less than target area (e.g. 30% of historical distribution for fynbos vegetation types)
- Endangered (EN): current area less than target + 15% of historical distribution
- Vulnerable (VU): current area < 60% of historic distribution
- Least Threatened (LT): current area > 60% of historic distribution

SANBI conservation status categories

- Not protected: 0% of target conserved
- Hardly protected: 0 - ≤5% of target conserved
- Poorly protected: 5> - ≤50% of target conserved
- Moderately protected:>50 - <100% of target conserved
- Well protected: 100% of target conserved

Please see Table 2: Vegetation Statistics on page 19 for the results of these calculations.

Calculation of Biodiversity Feature per Planning Unit

The planning unit and biodiversity feature datasets were then brought together in GIS to summarise the features per planning unit. The inputs required for the C-plan and Marxan software were tables. Population figures for each recorded location of a species were rare. The species input tables were instead records of the frequency of a species' locality data point intersecting with a planning unit. Available information on the IUCN Red List status of each species e.g.CR, EN, was included.

The above process was done for the planning units and vegetation and threats datasets, respectively. However, these recorded the areas in hectares of each vegetation type/ each level of threat as opposed to number of locations.

Setting Conservation Targets

Indigenous Vegetation

Targets were based on National Vegetation Type threshold percentages as determined for the 2004 National Spatial Biodiversity Assessment (NSBA) but were applied at the level of the city vegetation subtypes. Actual target values were calculated from the historic area for each subtype (Please refer to Table 2: General Vegetation Statistics).

15 Note that in the latest ecosystem assessment: Driver A (2011) Threatened ecosystems for listing under NEM:BA 2004, South African Biodiversity Institute, Pretoria; vegetation types may be assessed as threatened owing to both habitat loss and the species criteria (i.e. containing high numbers of threatened species). In 2011 only two national vegetation types in the City were considered Least Threatened: Southern Afrotemperate Forest and Western Coastal Shaleband Vegetation. For the purposes of this analysis however, we adopt the habitat transformation criteria to report on ecosystem status within the city.

Indigenous Flora Species Locations

For CREW, Protea Atlas Project, SaSflora and CCT's recorded flora species, targets were based on the number of known species locations. For species described in the datasets, a simple sliding scale target was used for each species on the basis of the number of locations:

- 100% of all locations for Critically Endangered (CR) species
- 10 locations for Endangered (EN) species
- 5 locations for any other species, including Red List and common species.

In other words, every known location of a CR species is targeted and endangered species are assigned relatively higher targets than less threatened species. These were assigned on the basis that common species also will be conserved at localities of more threatened species and there are likely to be more unrecorded localities of the commoner species.

Wetlands

Wetlands were not brought into this C-plan/Marxan run directly. Wetland prioritization was analyzed separately by specialist consultants (Snaddon et al. 2009)[9]. Priority wetlands occurring on natural remnants were included post-hoc into the BioNet as CBA wetlands. Wetland ground-truthing indicated that priority wetlands located in transformed areas were degraded and in practice would be difficult to restore and conserve. The latter were assigned to either CESA or OESA status based on level of transformation. Wetland ground-truthing has continued since the 2009 BioNet re-analysis and the wetland layer updated accordingly.

ANALYSIS

For the detailed biodiversity planning analysis technical manual please refer to Stipinovich (2011)[16].

Software

The ArcView 3.3 extension C-Plan 3.4 was used to calculate the irreplaceability of a planning unit and to select an optimal and efficient set of remnants to meet the conservation targets. To assist in ensuring connectivity within the conservation network, MARXAN[17] was also used in order to select additional planning units aimed at ensuring connectivity across the BioNet. MARXAN has the ability to consider spatial pattern in selecting reserve networks through the use of its Boundary Length Modifier (BLM). The BLM allows the selection process to consider landscape connectivity in the selection process. CLUZ[18] is an extension to ArcView3.3 and was used to provide a user-friendly interface to MARXAN.

C-Plan Analysis

Selection from High & Medium Habitat Condition Sites

To ensure that high and medium condition planning units were selected preferentially over low condition planning units, the latter were initially excluded from the analysis. Irreplaceability was then calculated, and those planning units with 100% irreplaceability

16 Stipinovich, 2011. City of Cape Town's Biodiversity Network C-Plan and Marxan Analysis Manual. City of Cape Town: Cape Town. This is based on *Benn 2009, City of Cape Town BioNet Analysis Manual. GeoCline Consulting: Cape Town.*
17 Possingham et al. 2000, Ball and Possingham, 2000, http://www.ecology.uq.edu.au/ index.html
18 Smith 2004, http://www.mosaic-conservation.org/cluz

scores selected. Irreplaceable planning units are those for which no alternatives exist if targets are to be met.

The Minset Algorithm

Outstanding target values were then met by running C-Plan's Minset algorithm that uses a series of rules. Successive rules in the Minset algorithm are only used when a tie occurs. The expert mapped corridors were used in the Minset to ensure that where possible, and if the preceding rules result in ties, planning units within these corridors were preferentially selected. The Minset algorithm rules were as follows:

1. Highest Irreplaceability score
2. Habitat condition = High
3. Location of planning unit in one of the expert mapped corridors
4. Highest "local endemics" value
5. Lowest High plus Medium threat value
6. Highest percentage contribution to meeting targets
7. Feature rarity
8. Summed rarity
9. Richness
10. Site Area Highest
11. Select first site in list

Selection from Low Habitat Condition Sites

The low condition planning units were then brought into the analysis and irreplaceability recalculated to try to meet any targets that had not yet been met when only high and medium condition planning units were considered. Any low condition planning units given a status of 100% irreplaceability were included in the set of selected planning units. At this point, all achievable targets were attained.

Inclusion of SaSflora Data

The previous analysis in 2009 included the entire large SaSflora species database, as well as the CREW and Protea Atlas plant species databases. However, during the 2011 analysis, software problems were experienced owing to the large size of the SaSflora database. For this reason a reduced database was used that included only the Red List Threatened species, as these are the species most likely to influence planning unit selection. The C-plan output with the reduced SaSflora data included was considered to produce the best result and was used as the input into Marxan.

MARXAN Analysis

The protected areas and the high and medium condition sites selected during the C-Plan analysis in order to reach biodiversity targets were set aside as having already been identified as essential to conserve (i.e. "mandatory"). MARXAN was then run to select further sites that would allow for connectivity between them in order to meet ecological process targets. Sites could therefore be selected by Marxan even if they were not required to directly meet biodiversity pattern targets. The plant species features were not included in the MARXAN analysis as they cause the software to freeze. This was not considered to be of concern as the feasible flora targets had already been met and the relevant sites selected in the C-Plan step of the analysis. Vegetation features and the climate change adaptation corridor feature were included.

The NBA's Ecosystem-Based Adaptation layer was used as a cost surface (see description on p. 9) in order to connect the selected planning units using sites of high climate adaptation potential where possible.

A Boundary Length Modifier (BLM) of 0.5 was used, based on the findings of Benn[19] in the 2008 BioNet run: the value 0.5 proved to be the least land-hungry, important in the case of the CCT where open land is at a premium. The higher the BLM is defined, the more land hungry a run will be with the selection being more biased towards reducing boundary length and less towards meeting feature targets.

External edges were included in the determination of boundary length, although certain edges could be excluded in future where they make up a natural boundary, such as a coastline.

Species Penalty Factor

The Species Penalty Factor (SPF) is the cost associated with not meeting the target for a specific biodiversity feature. Setting a high cost value for a particular feature will increase the likelihood of that feature's target being met, as MARXAN acts to minimise the cost of the final portfolio that it identifies. 100 000, a very high value, was set for all features in the MARXAN analysis to ensure that all targets were met.

The number of iterations was set at 1,000,000 and the number of runs at 10. Increasing the number of iterations and runs generally improves the efficiency of the portfolio that MARXAN identifies but also increases the processing time.

CLASSIFICATION OF CRITICAL BIODIVERSITY AREAS

The selected planning units were ranked and given specific attributes by both the C-Plan and the MARXAN software. These rankings and attributes were combined and used to identify a range of different Critical Biodiversity Area (CBA) categories (Tables 3, 5).

CBA 2 areas that had additional importance in that they served to consolidate CBA 1b remnants were manually upgraded to CBA 1d status.

Transformed areas of open land and areas of unselected natural vegetation were upgraded to OESA (Other Ecological Support Areas) and CESA (Critical Ecological Support Areas) respectively wherever they fell within Baboon home ranges, a large mammal movement corridor or a management consolidation area.

IN FUTURE ANALYSES

- Prior to the next run, duplications *among* the flora datasets need to be cleaned up before data processing commences. For this 2011 analysis, only duplications within each dataset were cleaned up.
- Any additional fauna data needs to be assessed to gauge whether it should be incorporated in the future.

19 Benn, Grant. 2008. City of Cape Town's BioNet: Terrestrial Systematic Conservation Plan Re-Analysis: Methods and Results. GeoCline Consulting CC (www.capetown.gov.za – follow links to ERMD/ Reports).

RESULTS

National Vegetation Types

The results for 18 national terrestrial and two national wetland vegetation types are presented in Table 2. Three of the national types have been divided into two subtypes of regional importance, namely: Cape Flats Dune Strandveld into False Bay and West Coast subtypes, and Peninsula Granite Fynbos into North and South subtypes, the latter usually being located on wetter aspects and slopes. Peninsula Shale Fynbos is a locally significant subtype of Cape Winelands Shale Fynbos.

Six national vegetation types are endemic (i.e. largely confined to the city). These are: Cape Flats Dune Strandveld, Cape Flats Sand Fynbos, Lourensford Alluvium Fynbos, Peninsula Granite Fynbos, Peninsula Sandstone Fynbos and Peninsula Shale Renosterveld.

The national targets (or thresholds) were calculated from species-area curves as the minimum area required to conserve 70% of the plant species in a vegetation type. Note that this is the minimum requirement and that additional areas are needed to maintain ecological processes and to provide habitat for certain threatened plant and animal species and migration corridors for conserving animal species. The latest 2011 draft National Biodiversity Assessment indicates which vegetation types have elevated threat status based on the species criterion: i.e. high concentrations of Red List threatened species. For the city this applies to Atlantis Sand Fynbos (CR), Peninsula Sandstone Fynbos (EN) and Kogelberg Sandstone Fynbos (CR). The areas required to meet vegetation and species targets are indicated on the map (Figure 1) as CBA1a-d and CBA2; and those areas required to conserve ecological processes as CBA1e. Additional ecological support areas required primarily for Baboon home ranges and other large mammal movement corridors are indicated on the map as CESA for natural remnants and OESA for transformed land (usually extensive agriculture areas).

In 2011, eight of the national vegetation types in the city have insufficient habitat remaining to conserve the minimum target. These are Cape Flats Sand Fynbos, Lourensford Alluvium Fynbos, Peninsula Shale Renosterveld, Swartland Alluvium Fynbos, and Swartland Alluvium, Granite, Shale and Silcrete Renosterveld vegetation types. Three of these national vegetation types are endemic to the city and thus cannot be conserved elsewhere: Cape Flats Sand Fynbos with 14.5% habitat remaining, Lourensford Alluvium Fynbos with 8.5% and Peninsula Shale Renosterveld with 12.3% remaining. The latter one is mostly all conserved in the Table Mountain National Park, but the other two are an urgent priority for conserving remaining habitat. The four non-endemic types have traditionally been exploited for commercial agriculture (cereal & fruit crops) and little natural habitat remains either inside or outside of the city.

Although sufficient remnant habitat remains to meet targets for the other 13 national vegetation types, there is much work to be done in attaining adequate protection for them in nature reserves. The best conserved types (i.e. proportion in proclaimed protected areas in the city relative to targets) are Cape Estuarine Salt Marsh, Cape Lowland Freshwater Wetlands, Cape Winelands Shale Fynbos (including Peninsula Shale Fynbos subtype), Hangklip Sand Fynbos, Kogelberg Sandstone Fynbos, Peninsula Granite Fynbos (North subtype), Peninsula Sandstone Fynbos, Southern Afrotemperate Forest and Western Coastal Shaleband Vegetation (Table 2). These are mainly conserved in the Table Mountain National Park and various reserves in the Helderberg district.

It is important to note the anomaly for the city statistics for Elgin Shale Fynbos – a vegetation type occurring mainly outside of the city – which has largely been exploited for agriculture and is nationally Critically Endangered. However, within the City, a lower proportion has been transformed and there is an opportunity to secure as much of this ecosystem as possible to improve its national conservation status. However, currently these remnants are under pine plantations in the land adjacent to the Steenbras Dam and are in need of restoration.

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Table 2: Results: General Vegetation Statistics

These statistics are for the vegetation extent within City of Cape Town only and exclude portions of the vegetation type occurring outside city boundaries. Note that six national vegetation types – marked with "*" are endemic to the city.

Vegetation type	Historic exent (ha)	Current extent (ha)	% Remaining from Historic Extent	National Ecosystem Target %	Target Area (ha)	Selected in BioNet (P.A.s/Conservation Areas/CBA 1s & 2s) (ha)	% Target Selected in BioNet	Target met in selected BioNet	Extent In Proclaimed P.A.s - In Perpetuity/For Limited Period (ha)	% Target met in proclaimed P.A.s	CCT Ecosystem Status	SANBI Conservation Status
Atlantis Sand Fynbos	25177.30	15475.05	61.46	30	7553.19	10585.25	140.14	YES	236.10	3.13	LT	Hardly Protected
Boland Granite Fynbos	9379.03	5649.03	60.23	30	2813.71	4796.16	170.46	YES	296.19	10.53	LT	Poorly Protected
Cape Estuarine Salt Marshes	40.55	30.73	75.79	24	9.73	30.57	314.18	YES	30.57	314.18	LT	Well Protected
Cape Flats Dune Strandveld * - False Bay subtype	27823.37	7762.95	27.90	24	6677.61	7156.56	107.17	YES	2736.77	40.98	EN	Poorly Protected
Cape Flats Dune Strandveld * - West Coast subtype	12734.27	10447.66	82.04	24	3056.23	6248.58	204.45	YES	2669.23	87.34	LT	Moderately Protected
Cape Flats Sand Fynbos *	54334.76	7888.65	14.52	30	16300.43	7888.65	48.40	NO	937.61	5.75	CR	Poorly Protected
Cape Lowland Freshwater Wetlands	1655.59	850.97	51.40	24	397.34	818.87	206.09	YES	492.19	123.87	VU	Well Protected
Cape Winelands Shale Fynbos	4005.90	2278.89	56.89	30	1201.77	2074.43	172.61	YES	1379.06	114.75	VU	Well Protected
Elgin Shale Fynbos	841.18	327.39	38.92	30	252.35	325.92	129.15	YES	325.46	128.97	EN	Well Protected
Hangklip Sand Fynbos	3295.04	1839.64	55.83	30	988.51	1598.34	161.69	YES	1372.65	138.86	VU	Well Protected
Kogelberg Sandstone Fynbos	9435.21	9196.62	97.47	30	2830.56	8934.77	315.65	YES	8220.39	290.42	LT	Well Protected
Lourensford Alluvium Fynbos *	3585.27	303.19	8.46	30	1075.58	303.19	28.19	NO	8.85	0.82	CR	Hardly Protected
Peninsula Granite Fynbos * – North subtype	2070.10	1438.91	69.51	30	621.03	1351.04	217.55	YES	982.16	158.15	LT	Well Protected
Peninsula Granite Fynbos * – South subtype	7157.69	2421.94	33.84	30	2147.31	2243.62	104.49	YES	1727.46	80.45	EN	Moderately Protected
Peninsula Sandstone Fynbos *	21935.69	20975.66	95.62	30	6580.71	20399.12	309.98	YES	17516.66	266.18	LT	Well Protected
Peninsula Shale Fynbos (Cape Winelands subtype)	1262.79	658.20	52.12	30	378.84	654.99	172.90	YES	651.75	172.04	VU	Well Protected
Peninsula Shale Renosterveld *	2384.27	292.85	12.28	26	619.91	292.85	47.24	NO	238.92	38.54	CR	Poorly Protected
Southern Afrotemperate Forest	347.52	345.87	99.53	34	118.16	344.10	291.23	YES	271.62	229.89	LT	Well Protected
Swartland Alluvium Fynbos	1734.06	71.48	4.12	30	520.22	71.48	13.74	NO	0.00	0.00	CR	Not Protected
Swartland Alluvium Renosterveld	60.78	0.00	0.00	26	15.80	0.00	0.00	NO	0.00	0.00	CR	Not Protected
Swartland Granite Renosterveld	7291.68	1876.40	25.73	26	1895.84	1851.29	97.65	NO	137.53	7.25	CR	Poorly Protected
Swartland Shale Renosterveld	47315.84	3924.24	8.29	26	12302.12	3924.24	31.90	NO	530.27	4.31	CR	Hardly Protected
Swartland Silcrete Renosterveld	1091.09	177.67	16.28	26	283.68	177.67	62.63	NO	0.03	0.01	CR	Hardly Protected
Western Coastal Shaleband Vegetation	317.39	316.70	99.78	30	95.22	316.69	332.60	YES	298.09	313.06	LT	Well Protected
TOTAL (ha)	245276.4	94550.69			68735.85	82388.38			41059.56			

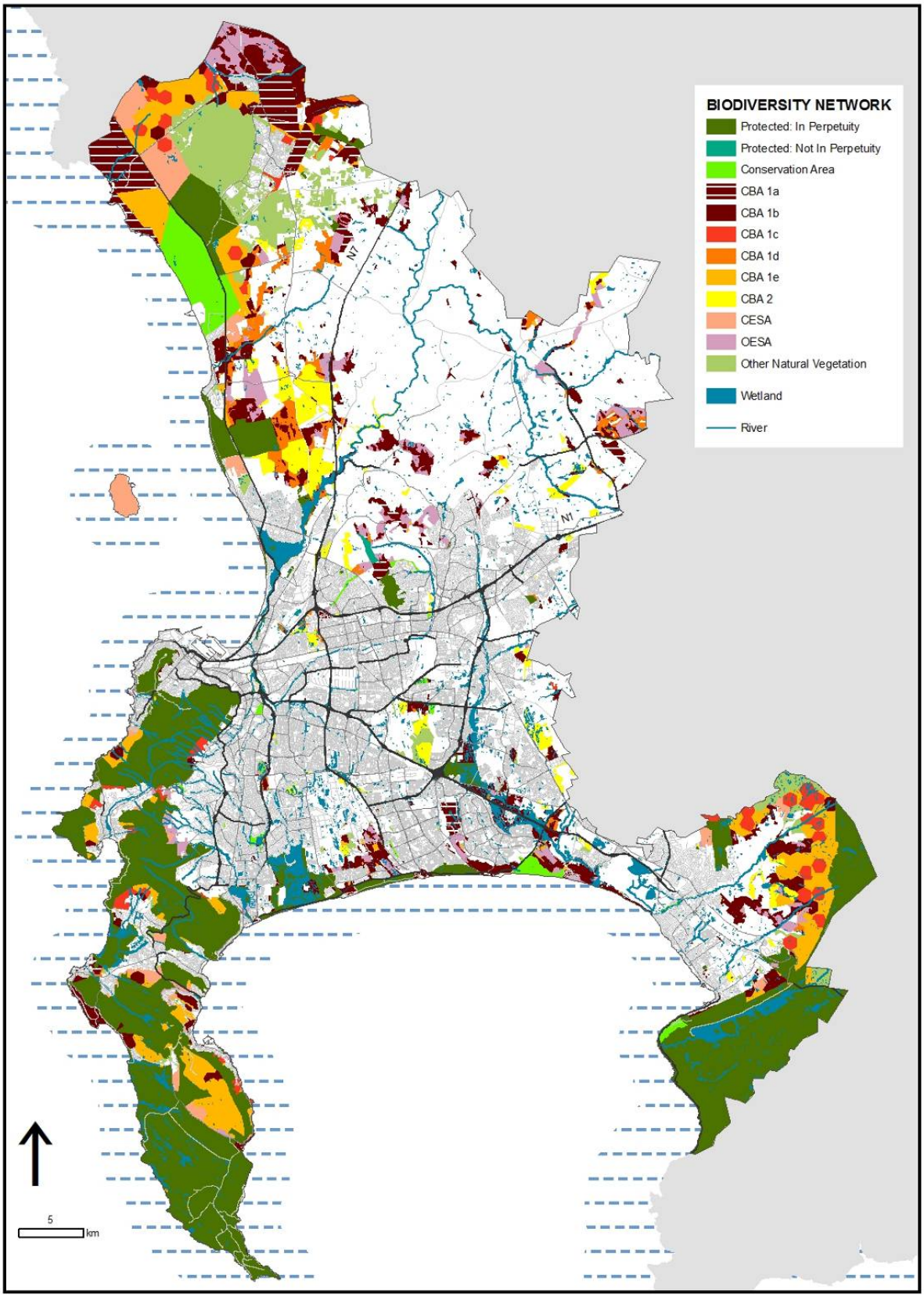

Figure 8: December 2011 Biodiversity Network of the City of Cape Town

Species Targets

The comprehensive flora data sets available for the city enabled all the known locations of threatened species to be selected in the BioNet, or where these exceeded targets (e.g. ten populations for Endangered species) for the targets to be met. Vegetation types rich in endemic and threatened species have more extensive areas selected in the BioNet in order to accommodate species populations, except for those types that are highly transformed such as Cape Flats Sand Fynbos and Lourensford Alluvium Fynbos. An example of a vegetation type for which additional areas are selected for threatened species targets is Atlantis Sand Fynbos. Two other vegetation types that are conserved as Mountain Catchment Areas (Kogelberg Sandstone Fynbos in the Steenbras Nature Reserve) and National Park (Peninsula Sandstone Fynbos in the Table Mountain National Park), conserve many endemic and threatened species.

Table 3: Results: BioNet CBA Category Statistics

BioNet category	Natural (ha)	Transformed (ha)	Total (ha)	% of BioNet
Protected: In Perpetuity	40927.5	2284.9	43212.4	48.8
Protected: Not In Perpetuity	121.6	8.1	129.7	0.1
Conservation Area	3524.1	236.9	3760.9	4.2
CBA 1a	4776.0	16.8	4792.8	5.4
CBA 1b	12569.9	-	12569.9	14.2
CBA 1c	2899.6	-	2899.6	3.3
CBA 1d	3002.6	1.0	3003.6	3.4
CBA 1e	9369.4	-	9369.4	10.6
CBA 2	5229.2	-	5229.2	5.9
CESA	3604.1	13.9	3618.0	4.1
Total	**86024.0**	**2561.5**	**88585.5**	**100.0**

Critical Biodiversity Area (CBA) Categories

Table 3 presents the general statistics by CBA map category for the BioNet analysis. For an explanation of categories refer to Table 5. CBAs comprising natural remnants cover 82,420 ha or 33.5% of the city; with CESAs included, this amounts to 86,024ha or 35% of the city. Some proclaimed nature reserves and unproclaimed conservation areas include portions of transformed land, which increases the BioNet total area to 36% of the city although these latter areas do not contribute towards meeting biodiversity targets.
Just over half (53.1%) of the BioNet is conserved, although some of these areas currently have no statutory protection (i.e. Conservation Areas in Table 3). A process currently is underway to proclaim City-run nature reserves under the National Environmental Management: Protected Areas Act (NEM:PAA 57 of 2003). The 100% irreplaceable, high-medium condition remnants comprise the next highest category of the BioNet (CBA1b: 14.2%) followed by areas selected for ecological process targets (CBA1e: 10.6%). A significant portion (9.3%) of the BioNet is in low condition (i.e. CBA1d and CBA2) and requires ecological restoration in order to promote the long-term conservation of biodiversity.

In terms of ecological processes, the Marxan analysis selected the larger unfragmented areas, achieving connectivity where most efficient and meaningful in terms of expert corridors and areas important for ecosystem-based adaptation (EbA). On a scale of 0-60 only 11% of the city has an EbA score of $\geq$30, whereas 32% of the BioNet has a score of $\geq$30, equating to an area of 27,000 ha (Figure 7) and including the majority of the high-scoring EbA land in the

city. It is anticipated that this area will have higher climate change resilience than the surrounding landscape (Pence 2011).

The 1 km-wide core climate change adaptation corridor in the north of the city, which is nested within part of the Dassenberg Coastal Catchment Corridor, was included in its entirety, linking several existing conservation areas to each other and the coast. This is one of the few areas of the city where significant choices can be made without forfeiting biodiversity targets. This important corridor influenced the selections of adjacent planning units for meeting associated vegetation type targets as well as buffering the core corridor, the result of which is an effective corridor width of 2 km-wide along most of its length.

The BioNet also includes significant areas of potential climate refugia, corresponding with known concentrations of local endemic plant species (Figure 6), where it is postulated that ecological communities are more stable despite past climate change and will be less likely to undergo significant climate-induced changes in future. These areas are embedded in the BioNet and are relatively secure inside the Table Mountain National Park, but in other areas highlight irreplaceable sites requiring urgent conservation and restoration.

The City Local Biodiversity Strategy and Action Plan (LBSAP 2009-2014)[20] includes a Local Biodiversity Implementation Plan which outlines the conservation implementation priorities for CBA remnants in the BioNet.

City Vegetation Types

A more detailed break-down of the biodiversity planning analysis results by the 65 city vegetation types is presented in Table 6. Twelve of the types historically covered very small areas of <100ha and of these, five are extinct in the city. In addition to the extinct subtypes, 17 types have insufficient remnant remaining to meet minimum targets. The general patterns remain the same as for the national vegetation types, with lowland vegetation types and those on richer soils having the lowest proportion of natural habitat remaining.

Wetlands

The City's wetlands were studied at a much finer scale than the vegetation types and to a large extent are seasonal wetland plant communities nested within the vegetation units (Table 7). City wetland extent thus exceeds that recognized at the national scale as Cape Lowland Freshwater Wetland and Cape Estuarine Salt Marsh. Since 2009, wetland ground-truthing and mapping corrections have been ongoing by the Biodiversity Management Branch, and in addition, wetlands lost to developments have been removed from the wetland layer. Currently 4,196 (or an extent of 8,198 ha) of natural and semi-natural wetlands occur in the city. All of this is included in the BioNet, either as CBA or Ecological Support Area (ESA) wetlands. 60% of this wetland extent is conserved in nature reserves or non-proclaimed conservation areas. A total of 1,542 (or 37% of) wetlands have CBA1 status.

Six of the identified wetland types no longer occur in the city while 48 identified types have natural or semi-natural wetlands remaining, but in some cases the latter are degraded by surrounding land use and are classed as ESA rather than CBAs. This is true for some Alluvium Fynbos, Alluvium Renosterveld, Granite Fynbos, Granite Renosterveld and Silcrete Renosterveld wetland types.

20 LBSAP www.capetown.gov.za/environment - follow links to Publications > Reports and scientific papers.

The historical extent of wetlands in lowland areas is unknown owing to the high level of land transformation (from both agriculture and urbanization) which obscures former wetland pattern. The national target of 24% may be appropriate for mountain systems which remain relatively intact, but in the transformed lowlands will underestimate the requirement if based on current wetland extent. Therefore we have assessed whether wetland targets are met based only on the CBA wetlands, which remain relatively natural. ESA wetlands are excluded as meeting biodiversity targets, although they may be important for ecological processes. On this basis, 71% (34) of wetland types have the minimum target (by area) selected in the BioNet and the remainder (14) do not. Of the latter, six have no selected CBA wetlands, as the remaining sites are all in transformed landscapes (Table 7: Alluvium Fynbos isolated depression, Alluvium Renosterveld valley bottom, Granite Fynbos depression, Granite Renosterveld floodplain, Silcrete Renosterveld seep and valley bottom). In general, these wetlands have a lower habitat condition and will be difficult to restore given current land-use.

Twelve wetland types have the minimum target met within conservation areas. These comprise mainly the strandveld and sandstone fynbos wetland types. However, Sand Fynbos depression is also well conserved owing to water bodies such as Princessvlei, Rondevlei and Zeekoevlei being included in this type (Table 7). Historically, these vleis would have been seasonal wetlands, but have become permanent water bodies following urban development and altered drainage patterns. This has altered their ecological and biodiversity characteristics.

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Table 4: Calculation of Critical Biodiversity Area Categories

CRITICAL BIODIVERSITY AREA CATEGORY		Habitat condition		C-plan Result		Marxan Result
Protected unless Core Flora Site only (CBA 1a)	=	High Medium Low	+	Res	+	Conserved
CBA 1a (Core Flora Site)		High Medium Low		Res		Conserved
CBA 1b		High Medium		R 2		Conserved
CBA 1c		High Medium		R1		Conserved
CBA 1d (selection from CBA 2 sites based on expert opinion)		Low		R1_low/ R2_low		Available/ Earmarked
CBA 1e		High Medium Low		0Co/ Exc/ <NULL>		Earmarked
CBA 2		Low		R1_low/ R2_low		Available/ Earmarked
CESA (selection from Other Natural Vegetation based on expert opinion)		High Medium Low		0Co/ Exc/<NULL>		Available/ <NULL> Excluded/
OESA (selection from Transformed based on expert opinion)		Transformed		0Co/ Exc/<NULL>		Available/ <NULL> Excluded/
Other Natural Vegetation unless CESA		High Medium Low		0Co/ Exc/ <NULL>		Available
Transformed unless OESA		Transformed		Exc/ <NULL>		Excluded

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C-Plan Outputs	
Res	Sites that are set as reserved in analysis as they have a Protected status
R 2	Mandatory sites (Irreplaceability =1) selected by C-plan when low habitat condition sites excluded from analysis
R2_low	Mandatory sites (Irreplaceability =1) selected by Minset algorithm when low habitat condition sites brought into analysis
R 1	Negotiable sites selected by C-plan
R1_low	Negotiable sites selected by Minset algorithm when low habitat condition sites brought into analysis
0Co	Sites that are not selected by C-plan
Exc	Sites that are excluded in C-plan initially due to having either Low habitat condition or for being transformed so that better condition sites are considered first

Marxan Outputs	
Conserved	Sites that are set as reserved in analysis as they have a Protected status or were selected in C-plan as R2 or R1 sites
Earmarked	Sites that were earmarked by Marxan
Available	Sites that were available for Marxan to choose from but were not earmarked by Marxan
Excluded	Sites that were excluded from the analysis as they are transformed

Table 5: CBA: Significance & Descriptions of Permissible Activities

Spatial Development Framework Category	Critical Biodiversity Area (CBA) Category	CBA Name	Subtype	Description	Significance of Habitat	Objective	Action	Compatible Activities
Core 1	Protected: In Perpetuity	Protected: In Perpetuity	National, Provincial, Local	Protected Areas (National, Provincial, Local & Contractual Nature Reserves)	Local, National & International significance: Loss of habitat will probably result in extinction of some species & inability to attain conservation targets.	Maintain natural ecosystems, restore degraded land to natural & manage for no further degradation. Ensure site is an asset to the surrounding communities.	Statutory conservation Areas. Ensure management plans are in place, implemented and audited.	Conservation, low impact recreation & environmental education as outlined in the management plan for the site; hard infrastructure should not be situated in critical biodiversity areas, but outside & adjacent to these, or in existing highly degraded areas only.
Core 1	Protected: Not In Perpetuity	Protected: Not In Perpetuity	National, Provincial or Local government land managed but with no status	These areas are currently being managed as part of existing reserves or core flora sites, but have no legal status as yet.	Local, National & International significance: Loss of habitat will probably result in extinction of some species & inability to attain conservation targets.	Maintain natural ecosystems, restore degraded land to natural & manage for no further degradation.	Secure legal conservation status under the Protected Areas Act. Consolidate into existing provincial or local authority reserves where they lie adjacent. Ensure management plans are in place, implemented and audited.	Conservation, low impact recreation & environmental education as outlined in the management plan for the site; hard infrastructure should not be situated in critical biodiversity areas, but outside & adjacent to these, or in existing highly degraded areas only.
Core 1	Conservation Area	Conservation Area	Local or Private areas managed for conservation but without statutory protection	Non- proclaimed local and private conservation areas.	Local, National & International significance: Loss of habitat will probably result in extinction of some species & inability to attain conservation targets.	Maintain natural ecosystems, restore degraded land to natural and manage for no further degradation.	Pursue appropriate stewardship conservation status (contractual or biodiversity agreement). Ensure management plans are in place, implemented and audited.	Conservation, low impact recreation & environmental education as outlined in the management plan for the site; hard infrastructure should not be situated in critical biodiversity areas, but outside & adjacent to these, or in existing highly degraded areas only.

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Spatial Development Framework Category	Critical Biodiversity Area (CBA) Category	CBA Name	Subtype	Description	Significance of Habitat	Objective	Action	Compatible Activities
Core 1	CBA 1a	Irreplaceable Core Flora sites	Non-protected core flora sites	Core Flora Sites: Irreplaceable sites of historical significance & very high priority	Local, National & International significance: Loss of habitat will probably result in extinction of some species & inability to attain conservation targets.	Obtain appropriate legal conservation status. Maintain natural ecosystems, restore degraded land to natural & manage for no further degradation.	Core Flora sites to be gazetted ASAP - we need action. High priority, very high urgency (immediate). Land owner negotiations. Invasive aliens to be controlled.	Conservation, low impact recreation & environmental education as outlined in the management plan for the site; hard infrastructure should not be situated in critical biodiversity areas, but outside & adjacent to these, or in existing highly degraded areas only.
Core 1	CBA 1b	Irreplaceable High & Medium Condition sites	Irreplaceable sites	Critically Endangered vegetation of High & Medium quality. Needed for national targets. Any loss is a permanent & irrevocable loss.	Local, National & International significance: Loss of habitat will probably result in extinction of some species & inability to attain conservation targets.	Obtain appropriate legal conservation status. Maintain natural ecosystems, restore degraded land to natural & manage for no further degradation.	Needed for national targets. High priority, very high urgency (immediate). Invasive aliens to be controlled.	Conservation, low impact recreation & environmental education as outlined in the management plan for the site; hard infrastructure should not be situated in critical biodiversity areas, but outside & adjacent to these, or in existing highly degraded areas only.
Core 1	CBA 1c	Minset High & Medium Condition sites	Minset Targets	High & Medium condition vegetation that is selected on the Biodiversity Network for meeting national targets (C Plan). Loss can be replaced by obtaining specific Unselected Natural Vegetation sites.	Local, National & International significance: Any loss will require specific alternative areas to be targeted for conservation, but these areas have been set as not negotiable so that the alternative sites can be freed up for development. Consequently these are not negotiable unless alternative, equivalent sites not on the Biodiversity Network are secured first.	Obtain appropriate legal conservation status. Maintain natural ecosystems, restore degraded land to natural & manage for no further degradation.	Needed for national targets. High priority, high urgency (5-10 year horizon). Invasive aliens to be controlled.	Conservation, low impact recreation & environmental education as outlined in the management plan for the site; hard infrastructure should not be situated in critical biodiversity areas, but outside & adjacent to these, or in existing highly degraded areas only.
Core 1	CBA 1d	Irreplaceable Consolidation sites	Minset Targets	Critically Endangered vegetation of low/ restorable condition. Essential for management consolidation & viability of CBA1a, CBA1b & protected sites.	Local, National & International significance: These areas are required to make existing remnants ecologically viable. Loss would result in higher condition remnants being lost through degradation of ecological processes & exorbitant interventionary ecosystem management costs.	Obtain appropriate legal conservation status. Maintain natural ecosystems, restore degraded land to natural & manage for no further degradation.	Needed for national targets. High priority, high urgency (10 year horizon). Invasive aliens to be controlled.	As above, but higher impact activities (picnic sites, conservation offices, restaurants, EE centres etc) may be situated on highly degraded areas on existing development footprints where this does not impact negatively on ecological processes.

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Spatial Development Framework Category	Critical Biodiversity Area (CBA) Category	CBA Name	Subtype	Description	Significance of Habitat	Objective	Action	Compatible Activities
Core 1	CBA1e	Connectivity sites	Marxan & expert corridor	Vegetation that is selected on the Biodiversity Network for connectivity & ecological processes (Marxan)	Local, National & International significance: required to maintain large-scale ecosystem processes, climate change mitigation, animal migration & other long-term, large-scale effects.	As above but with a focus on the maintenance of ecological processes.	Consideration can only be given if suitable alternatives exist. High priority, medium urgency (10-20 year horizon). Invasive aliens to be controlled.	Low impact recreation (hiking, environmental education, bird watching etc); higher impact activities only where environment is suitable (e.g. mountain biking; horse riding on existing roads; boating on vleis etc); hard infrastructure should not be situated in critical biodiversity areas, but outside & adjacent to these, or in existing highly degraded areas on existing development footprints only.
Core 1	CBA 2	Restorable Irreplaceable sites	Irreplaceable low condition sites	Critically Endangered vegetation of restorable condition. Needed for national targets but not for management consolidation, connectivity or viability of priority Biodiversity Network sites.	Although irreplaceable these are degraded. Their loss will have Local, National & International significance but low impact on high quality remnants.	Obtain appropriate conservation status. Maintain natural ecosystems, restore degraded land to natural & manage for no further degradation.	Conserve & restore. Alternatives can be negotiated with the use of compensation for the securing of priority sites. Medium priority, low urgency. Will require a bylaw: High priority, immediate urgency. Invasive aliens to be controlled.	Some higher impact activities (play parks, braai areas, picnic sites, conservation offices, restaurants, EE centres etc) may be situated on the edges of these sites or where the activity does not impact negatively on ecological processes, provided the remainder is restored; resource harvesting may be considered in accordance with the management plan for the site, but under strictly controlled conditions only.
Core 2	CESA	Unselected Natural Vegetation Sites of Conservation Significance	Consolidation & ecological support areas	Unselected areas that are in natural vegetation. Essential ecological support for CBA 1, CBA 2 & protected sites.	Local, national & international significance. Required to make existing remnants ecologically more viable & for larger fauna movement. Loss would result in the remnants or faunal species being lost & exorbitant interventionary ecosystem management costs.	Obtain appropriate legal status, such as open space zoning. Maintain as open space & where appropriate restore degraded land to natural or near-natural for consolidation of other remnants.	Map areas & check zoning is appropriate. Where possible rehabilitate to enhance ecosystem functioning, including invasive alien control.	Activities that do not impinge on ecological functioning & water quality are permissible.

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Spatial Development Framework Category	Critical Biodiversity Area (CBA) Category	CBA Name	Subtype	Description	Significance of Habitat	Objective	Action	Compatible Activities
Buffer 2	OESA	Transformed Site of Conservation Significance	Other Ecological support areas	Open space transformed by agriculture or other activities. Essential for protected sites.	Local significance: These areas may be required for long-term ecological functioning of neighbouring natural ecosystems. Loss would result in degradation of ecological processes & potential loss of biodiversity elements.	Maintain as open space & where appropriate restore degraded land to natural or near-natural for improved ecological functioning.	Ensure agricultural activity is compatible with ecosystem processes. Where possible, acquire, rezone & rehabilitate. High priority but low urgency (15 year horizon).	Generally outside urban edge. Existing agricultural practices may continue or other compatible farming may occur but the long-term vision is to restore natural ecosystem structure to some of the area to improve ecological processes.
Buffer 1	Other Natural Vegetation	Unselected natural vegetation in high, medium or restorable condition	Not selected	Natural vegetation in Endangered, Vulnerable & Least Concern in high, medium or restorable condition.	Local significance. Will result in impaired ability to meet targets, given that Higher categories will not always be achievable.	Sustainable management within general rural land-use principles	Negotiable. Low priority, no urgency. Invasive alien control	Until Biodiversity Network is secured elsewhere, these areas may become important if required as biodiversity offset sites. Some higher impact activities could be considered on degraded portions, but vegetation in good condition should be subject to low impact activities only.
Intensive Agriculture/ Settlement	Transformed	Unselected Transformed Sites	Not selected	Transformed land of no currently known conservation significance	No significance.	Sustainable management applying accepted land-use principles	In terms of biodiversity conservation, no action is required.	Agriculture & urban development

Table 6: Results: City Vegetation Type Statistics

National vegetation type plus subtype	Historic exent (ha)	Current extent (ha)	% Remaining from Historic Extent	National Ecosystem Target %	Target Area (ha)	Selected in BioNet (ha) (P.A.s/Conservation Areas/CBA 1s & 2s)	% Target Selected in BioNet	In Proclaimed P.A.s - In Perpetuity/For Limited Period (ha)	% Target met in proclaimed P.A.s	CCT Ecosystem Status	SANBI
Atlantis Sand Fynbos-on marine-derived acid sands	10766.50	6583.18	61.15	30	3229.95	4314.75	133.59	139.23	4.31	LT	Hardly Protected
Atlantis Sand Fynbos-on older non-aeolian colluvium	2777.22	1058.20	38.10	30	833.17	857.14	102.88	47.70	5.73	EN	Poorly Protected
Atlantis Sand Fynbos-on recent non-aeolian colluvium	2680.50	339.55	12.67	30	804.15	339.55	42.22	0.00	0.00	CR	Not Protected
Atlantis Sand Fynbos-Strandveld/Fynbos transition *	8953.08	7494.13	83.70	30	2685.92	5073.81	188.90	49.17	1.83	LT	Hardly Protected
Boland Granite Fynbos-on Alluvium	58.92	26.43	44.86	30	17.68	26.43	149.54	0.45	2.55	EN	Hardly Protected
Boland Granite Fynbos-on Brackish	245.73	0.00	0.00	30	73.72	0.00	0.00	0.00	0.00	CR	Not Protected
Boland Granite Fynbos-on Granite	4193.68	2629.83	62.71	30	1258.10	2432.40	193.34	156.92	12.47	LT	Poorly Protected
Boland Granite Fynbos-on Gravelly clay/ loam soil	14.17	0.00	0.00	30	4.25	0.00	0.00	0.00	0.00	CR	Not Protected
Boland Granite Fynbos-on Loam and sandy loam	427.80	0.00	0.00	30	128.34	0.00	0.00	0.00	0.00	CR	Not Protected
Boland Granite Fynbos-on older non-aeolian colluvium	180.13	63.38	35.19	30	54.04	60.12	111.24	0.00	0.00	EN	Not Protected
Boland Granite Fynbos-on recent non-aeolian colluvium	4258.61	2929.38	68.79	30	1277.58	2277.21	178.24	138.81	10.87	LT	Poorly Protected
Cape Estuarine Salt Marshes-Wetlands	40.55	30.73	75.79	24	12.16	30.57	251.34	30.57	314.18	LT	Well Protected
Cape Flats Dune Strandveld - False Bay-on Granite	17.91	9.41	52.56	24	5.37	8.77	163.28	8.77	204.09	VU	Well Protected
Cape Flats Dune Strandveld - False Bay-on Mudstone	9.38	7.76	82.75	24	2.81	7.08	251.73	0.00	0.00	LT	Not Protected
Cape Flats Dune Strandveld - False Bay-on sands	25490.15	6779.94	26.60	24	7647.04	6248.56	81.71	2420.88	39.57	CR	Poorly Protected
Cape Flats Dune Strandveld - False Bay-on sands over or on limestone	1927.15	653.11	33.89	24	578.15	588.30	101.76	131.03	28.33	EN	Poorly Protected
Cape Flats Dune Strandveld - False Bay-on Sandstone	378.78	312.73	82.56	24	113.63	303.85	267.39	176.10	193.71	LT	Well Protected
Cape Flats Dune Strandveld - West Coast-on recent non-aeolian colluvium	80.44	7.29	9.06	24	24.13	7.29	30.19	0.00	0.00	CR	Not Protected
Cape Flats Dune Strandveld - West Coast-on sands	10082.19	8399.44	83.31	24	3024.66	4584.71	151.58	2302.15	95.14	LT	Moderately Protected
Cape Flats Dune Strandveld - West Coast-on sands over or on limestone	2239.35	1838.64	82.11	24	671.81	1573.91	234.28	346.71	64.51	LT	Moderately Protected
Cape Flats Dune Strandveld - West Coast-on Shale	332.28	202.29	60.88	24	99.69	82.67	82.93	20.36	25.54	LT	Poorly Protected
Cape Flats Sand Fynbos-on marine-derived acid sands	49528.35	6771.86	13.67	30	14858.51	6771.86	45.58	873.91	5.88	CR	Poorly Protected
Cape Flats Sand Fynbos-on older non-aeolian colluvium	4104.46	964.12	23.49	30	1231.34	964.12	78.30	35.45	2.88	CR	Hardly Protected
Cape Flats Sand Fynbos-on recent non-aeolian colluvium	434.59	147.33	33.90	30	130.38	147.33	113.01	24.09	18.48	EN	Poorly Protected
Cape Flats Sand Fynbos-Strandveld/Fynbos transition *	267.36	5.33	1.99	30	80.21	5.33	6.65	4.17	5.19	CR	Poorly Protected
Cape Lowland Freshwater Wetlands-Wetlands	1655.59	850.97	51.40	24	496.68	818.87	164.87	492.19	123.87	VU	Well Protected
Cape Winelands Shale Fynbos-on Gritty sand	416.36	326.59	78.44	30	124.91	276.05	221.01	144.23	115.47	LT	Well Protected

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National vegetation type plus subtype	Historic exent (ha)	Current extent (ha)	% Remaining from Historic Extent	National Ecosystem Target %	Target Area (ha)	Selected in BioNet (ha) (P.A.s/Conservation Areas/CBA 1s & 2s)	% Target Selected in BioNet	In Proclaimed P.A.s - In Perpetuity/For Limited Period (ha)	% Target met in proclaimed P.A.s	CCT Ecosystem Status	SANBI
Cape Winelands Shale Fynbos-on Loam and sandy loam	862.63	200.64	23.26	30	258.79	200.64	77.53	131.13	50.67	CR	Moderately Protected
Cape Winelands Shale Fynbos-on recent non-aeolian colluvium	7.52	0.00	0.00	30	2.26	0.00	0.00	0.00	0.00	CR	Not Protected
Cape Winelands Shale Fynbos-on Scree	740.16	700.76	94.68	30	222.05	700.76	315.59	700.76	315.59	LT	Well Protected
Cape Winelands Shale Fynbos-on Shale	1979.22	1050.90	53.10	30	593.77	896.99	151.07	402.95	67.86	VU	Moderately Protected
Elgin Shale Fynbos-on Shale	841.18	327.39	38.92	30	252.35	325.92	129.15	325.46	128.97	EN	Well Protected
Hangklip Sand Fynbos-on marine-derived acid sands	2260.70	1088.98	48.17	30	678.21	938.07	138.32	907.49	133.81	VU	Well Protected
Hangklip Sand Fynbos-on sands	1034.34	750.66	72.57	30	310.30	660.27	212.78	465.16	149.91	LT	Well Protected
Kogelberg Sandstone Fynbos-on Sandstone	9435.21	9196.62	97.47	30	2830.56	8934.77	315.65	8220.39	290.42	LT	Well Protected
Lourensford Alluvium Fynbos-on Alluvium	354.89	104.38	29.41	30	106.47	104.38	98.04	0.00	0.00	CR	Not Protected
Lourensford Alluvium Fynbos-on Loam and sandy loam	328.36	0.42	0.13	30	98.51	0.42	0.42	0.00	0.00	CR	Not Protected
Lourensford Alluvium Fynbos-on recent non-aeolian colluvium	2902.02	198.40	6.84	30	870.61	198.40	22.79	8.85	1.02	CR	Hardly Protected
North Peninsula Granite Fynbos-on Granite	1190.42	776.51	65.23	30	357.12	747.88	209.42	616.03	172.50	LT	Well Protected
North Peninsula Granite Fynbos-on recent non-aeolian colluvium	879.68	662.41	75.30	30	263.90	603.17	228.56	366.13	138.74	LT	Well Protected
Peninsula Sandstone Fynbos-on marine-derived acid sands	30.63	30.63	100.00	30	9.19	30.63	333.33	0.00	0.00	LT	Not Protected
Peninsula Sandstone Fynbos-on Mudstone	868.54	763.95	87.96	30	260.56	746.53	286.51	664.86	255.16	LT	Well Protected
Peninsula Sandstone Fynbos-on Pakhuis formation diamictics	20.26	20.26	100.00	30	6.08	20.26	333.33	20.26	333.33	LT	Well Protected
Peninsula Sandstone Fynbos-on sands	551.54	517.79	93.88	30	165.46	516.41	312.10	515.67	311.65	LT	Well Protected
Peninsula Sandstone Fynbos-on Sandstone	20464.71	19643.03	95.98	30	6139.41	19085.29	310.87	16315.87	265.76	LT	Well Protected
Peninsula Shale Fynbos-on recent non-aeolian colluvium	805.39	360.02	44.70	30	241.62	358.09	148.20	356.05	147.36	EN	Well Protected
Peninsula Shale Fynbos-on Shale	457.39	298.18	65.19	30	137.22	296.91	216.37	295.70	215.50	LT	Well Protected
Peninsula Shale Renosterveld-on recent non-aeolian colluvium	491.86	15.15	3.08	26	147.56	15.15	10.27	10.53	8.23	CR	Poorly Protected
Peninsula Shale Renosterveld-on Shale	1892.41	277.70	14.67	26	567.72	277.70	48.91	228.39	46.42	CR	Poorly Protected
South Peninsula Granite Fynbos-on Granite	3279.32	1035.41	31.57	30	983.80	987.49	100.38	817.96	83.14	EN	Moderately Protected
South Peninsula Granite Fynbos-on marine-derived acid sands	232.80	111.76	48.00	30	69.84	103.10	147.63	87.83	125.75	VU	Well Protected
South Peninsula Granite Fynbos-on recent non-aeolian colluvium	3645.57	1274.78	34.97	30	1093.67	1153.02	105.43	821.68	75.13	EN	Moderately Protected
Southern Afrotemperate Forest-All subtypes	347.52	345.87	99.53	34	104.25	344.10	330.06	271.62	229.89	LT	Well Protected
Swartland Alluvium Fynbos-on Malmesbury Sandstone	1734.06	71.48	4.12	30	520.22	71.48	13.74	0.00	0.00	CR	Not Protected
Swartland Alluvium Renosterveld-on recent non-aeolian colluvium	60.78	0.00	0.00	26	18.23	0.00	0.00	0.00	0.00	CR	Not Protected
Swartland Granite Renosterveld-on Granite	5019.97	1432.72	28.54	26	1505.99	1407.61	93.47	137.53	10.54	CR	Poorly Protected

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National vegetation type plus subtype	Historic exent (ha)	Current extent (ha)	% Remaining from Historic Extent	National Ecosystem Target %	Target Area (ha)	Selected in BioNet (ha) (P.A.s/Conservation Areas/CBA 1s & 2s)	% Target Selected in BioNet	In Proclaimed P.A.s - In Perpetuity/For Limited Period (ha)	% Target met in proclaimed P.A.s	CCT Ecosystem Status	SANBI
Swartland Granite Renosterveld-on older non-aeolian colluvium	2111.14	402.44	19.06	26	633.34	402.44	63.54	0.00	0.00	CR	Not Protected
Swartland Granite Renosterveld-on recent non-aeolian colluvium	160.58	41.24	25.68	26	48.17	41.24	85.61	0.00	0.00	CR	Not Protected
Swartland Shale Renosterveld-on Loam and sandy loam	712.41	17.47	2.45	26	213.72	17.47	8.18	7.85	4.24	CR	Hardly Protected
Swartland Shale Renosterveld-on older non-aeolian colluvium	20.59	0.00	0.00	26	6.18	0.00	0.00	0.00	0.00	CR	Not Protected
Swartland Shale Renosterveld-on recent non-aeolian colluvium	5203.69	248.19	4.77	26	1561.11	248.19	15.90	29.11	2.15	CR	Hardly Protected
Swartland Shale Renosterveld-on Shale	41379.15	3658.58	8.84	26	12413.75	3658.58	29.47	493.30	4.59	CR	Hardly Protected
Swartland Silcrete Renosterveld-on Ferricrete	25.72	0.00	0.00	26	7.72	0.00	0.00	0.00	0.00	CR	Not Protected
Swartland Silcrete Renosterveld-on recent non-aeolian colluvium	1065.36	177.67	16.68	26	319.61	177.67	55.59	0.03	0.01	CR	Hardly Protected
Western Coastal Shaleband Vegetation-on Cedarberg Shale Band	317.39	316.70	99.78	30	95.22	316.69	332.60	298.09	313.06	LT	Well Protected
TOTAL (ha)	245276.34	94550.71			73582.92	82388.4		41059.57			

* (on calcareous/acidic/neutral sands)

Note: The vegetation type “Reclaimed” was excluded as little to no vegetation exists there; the “Beach” vegetation type was grouped with “Strandveld”.

Table 7: Natural & Semi-Natural Wetland Prioritisation Study Statistics

General statistics from the wetland prioritization study, including only the natural and semi-natural wetlands, where prioritization ranking was performed within each wetland type. Six of the 54 wetland types had no natural or semi-natural wetlands remaining. CBA = Critical Biodiversity Area; CESA = Critical Ecological Support Area; OESA = Other Ecological Support Area (updated from Snaddon & Day 2009).

Wetland Type	Current Extent (ha)	Target (24%) of historic extent (ha)	Extent (ha) in proclaimed (In Perpetuity/ Limited Period) P.A.s	Target (ha) met in selected BioNet (P.A.s/Conservation Areas/CBA 1s & 2s)	Area of CBA 1 Wetlands (ha)	Number of CBA 1 Wetlands	Area of CBA 2 Wetlands (ha)	Number of CBA 2 Wetlands	Area of CESA Wetlands (ha)	Number of CESA Wetlands	Area of OESA Wetlands (ha)	Number of OESA Wetlands	Total Area of CBA 1, CBA 2, CESA & OESA Wetlands (ha)	Total Number of CBA 1, CBA 2, CESA & OESA Wetlands
Alluvium Fynbos floodplain	4.61	1.11	0.00	2.06	2.41	3	0.07	1	1.17	7	0.58	1	4.24	12
Alluvium Fynbos isolated depression	1.77	0.42	0.00	0.00	0.00	0	0.00	0	0.91	2	0.86	2	1.77	4
Alluvium Fynbos isolated seep	14.64	3.51	2.03	2.28	2.03	1	0.00	0	12.61	16	0.00	0	14.64	17
Alluvium Fynbos seep	84.83	20.36	16.49	19.48	14.33	7	0.27	2	70.50	40	0.00	0	85.10	49
Alluvium Fynbos valley bottom	43.63	10.47	0.00	40.45	38.68	3	2.20	1	2.75	3	0.00	0	43.63	7
Alluvium Renosterveld valley bottom	0.70	0.17	0.00	0.00	0.00	0	0.00	0	0.70	1	0.00	0	0.70	1
Cape Estuarine channel	103.23	24.78	93.86	94.18	99.69	9	0.36	1	3.06	3	0.00	0	103.11	13
Cape Estuarine depression	133.56	32.05	127.91	128.61	130.91	15	0.75	2	1.90	2	0.00	0	133.56	19
Cape river mouth	23.15	5.56	0.00	8.41	17.32	5	3.57	2	1.66	2	0.60	1	23.15	10
Dune Strandveld depression	77.50	18.60	34.40	52.99	35.16	6	10.91	4	13.16	7	15.34	2	74.57	19
Dune Strandveld floodplain	740.27	177.66	254.09	636.60	194.44	26	486.65	102	54.46	35	4.72	1	740.27	164
Dune Strandveld isolated depression	706.48	169.55	151.07	386.14	170.46	127	270.69	282	227.40	225	27.91	55	696.47	689
Dune Strandveld isolated seep	297.39	71.37	72.21	90.79	73.11	27	23.62	22	195.36	73	5.31	9	297.40	131
Dune Strandveld seep	83.98	20.16	70.53	82.03	81.17	31	0.65	3	0.59	2	1.57	1	83.98	37
Dune Strandveld valley bottom	60.63	14.55	45.19	58.52	44.98	15	12.79	3	2.04	9	0.81	2	60.62	29
Granite Fynbos depression	0.60	0.14	0.00	0.00	0.00	0	0.00	0	0.60	2	0.00	0	0.60	2
Granite Fynbos floodplain	215.13	51.63	0.00	13.98	38.09	4	0.00	0	51.27	25	125.77	4	215.13	33
Granite Fynbos isolated depression	1.13	0.27	0.29	0.29	0.29	2	0.00	0	0.59	2	0.25	5	1.13	9
Granite Fynbos isolated seep	66.55	15.97	6.86	26.49	33.19	43	6.47	4	22.66	23	4.24	6	66.56	76

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Wetland Type	Current Extent (ha)	Target (24%) of historic extent (ha)	Extent (ha) in proclaimed (In Perpetuity/ Limited Period) P.A.s	Target (ha) met in selected BioNet (P.A.s/Conservation Areas/CBA 1s & 2s)	Area of CBA 1 Wetlands (ha)	Number of CBA 1 Wetlands	Area of CBA 2 Wetlands (ha)	Number of CBA 2 Wetlands	Area of CESA Wetlands (ha)	Number of CESA Wetlands	Area of OESA Wetlands (ha)	Number of OESA Wetlands	Total Area of CBA 1, CBA 2, CESA & OESA Wetlands (ha)	Total Number of CBA 1, CBA 2, CESA & OESA Wetlands
Granite Fynbos seep	362.56	87.01	33.57	232.65	261.79	123	35.11	50	60.88	27	4.76	2	362.54	202
Granite Fynbos valley bottom	126.11	30.27	22.85	69.01	74.69	20	1.04	3	48.85	49	1.53	1	126.11	73
Granite Renosterveld depression	1.15	0.28	0.00	0.00	0.00	0	1.15	1	0.00	0	0.00	0	1.15	1
Granite Renosterveld floodplain	2.26	0.54	0.00	0.00	0.00	0	0.00	0	0.00	0	2.26	1	2.26	1
Granite Renosterveld isolated depression	0.45	0.11	0.00	0.15	0.15	1	0.00	0	0.30	1	0.00	0	0.45	2
Granite Renosterveld isolated seep	6.17	1.48	0.00	1.64	1.66	1	0.00	0	4.09	5	0.42	1	6.17	7
Granite Renosterveld seep	51.65	12.40	0.00	1.43	0.68	1	8.75	4	42.22	20	0.00	0	51.65	25
Granite Renosterveld valley bottom	78.35	18.80	0.00	27.86	37.04	4	26.27	2	15.04	13	0.00	0	78.35	19
Sand Fynbos depression	593.48	142.44	478.75	514.12	159.72	13	58.55	16	358.50	17	5.45	10	582.22	56
Sand Fynbos floodplain	775.63	186.15	339.98	542.22	492.01	35	39.08	9	235.01	62	8.55	11	774.65	117
Sand Fynbos isolated depression	430.95	103.43	19.25	180.53	63.53	39	176.14	124	102.74	121	85.64	141	428.05	425
Sand Fynbos isolated seep	615.74	147.78	73.65	179.71	76.70	36	123.28	64	359.77	179	56.00	51	615.75	330
Sand Fynbos seep	210.47	50.51	0.96	85.33	15.18	9	85.92	33	89.11	51	20.26	19	210.47	112
Sand Fynbos valley bottom	307.50	73.80	138.10	164.55	157.68	11	14.69	12	77.78	32	56.61	43	306.76	98
Sandstone Fynbos isolated depression	22.13	5.31	19.53	20.38	20.42	35	0.00	2	0.21	1	0.47	2	21.10	40
Sandstone Fynbos isolated seep	228.59	54.86	211.04	221.66	208.77	385	16.57	36	3.26	3	0.00	0	228.60	424
Sandstone Fynbos seep	491.50	117.96	454.59	478.65	453.26	373	32.33	54	11.19	13	0.82	2	497.60	442
Sandstone Fynbos valley bottom	332.72	79.85	298.21	314.18	312.13	103	18.51	13	7.44	8	0.16	1	338.24	125
Shale Band seep	17.13	4.11	17.13	17.13	17.13	5	0.00	0	0.00	0	0.00	0	17.13	5
Shale Fynbos valley bottom	21.22	5.09	12.80	15.46	11.96	4	4.21	4	4.23	1	0.82	2	21.22	11
Shale Renosterveld depression	17.93	4.30	0.00	2.07	0.00	0	3.11	4	11.94	6	2.87	5	17.92	15
Shale Renosterveld floodplain	161.38	38.73	0.00	10.98	2.99	1	5.57	3	106.05	21	46.78	11	161.39	36
Shale Renosterveld isolated depression	21.62	5.19	0.00	5.35	4.19	3	1.79	1	15.65	22	0.00	0	21.63	26
Shale Renosterveld isolated seep	126.45	30.35	0.34	26.24	16.80	1	17.35	9	91.44	75	0.86	2	126.45	87

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Wetland Type	Current Extent (ha)	Target (24%) of historic extent (ha)	Extent (ha) in proclaimed (In Perpetuity/ Limited Period) P.A.s	Target (ha) met in selected BioNet (P.A.s/Conservation Areas/CBA 1s & 2s)	Area of CBA 1 Wetlands (ha)	Number of CBA 1 Wetlands	Area of CBA 2 Wetlands (ha)	Number of CBA 2 Wetlands	Area of CESA Wetlands (ha)	Number of CESA Wetlands	Area of OESA Wetlands (ha)	Number of OESA Wetlands	Total Area of CBA 1, CBA 2, CESA & OESA Wetlands (ha)	Total Number of CBA 1, CBA 2, CESA & OESA Wetlands
Shale Renosterveld seep	220.84	53.00	1.37	19.23	12.66	8	26.93	9	166.06	90	14.48	10	220.13	117
Shale Renosterveld valley bottom	316.78	76.03	0.00	133.62	102.45	6	53.32	7	142.77	54	18.24	5	316.78	72
Silcrete Renosterveld isolated seep	1.84	0.44	0.00	0.15	0.10	1	0.28	1	1.46	1	2.25	1	4.09	4
Silcrete Renosterveld seep	0.98	0.24	0.00	0.00	0.00	0	0.00	0	0.98	2	0.00	0	0.98	2
Silcrete Renosterveld valley bottom	2.73	0.66	0.00	0.00	0.00	0	0.00	0	0.48	1	0.00	0	0.48	1
TOTAL	8198.02		3004.40	4915.14	3479.98	1542	1568.95	890	2620.85	1354	517.18	410	8186.96	4196

* Note: historical extent for wetlands is unknown; therefore targets are based on current extent. For highly transformed environments, such as the Cape Flats, the target should be set higher than 24% of current extent as Cape Lowland Freshwater Wetlands are now considered Critically Endangered.