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City of Cape Town's Biodiversity Network

C-PLAN & MARXAN ANALYSIS: 2009 METHODS & RESULTS

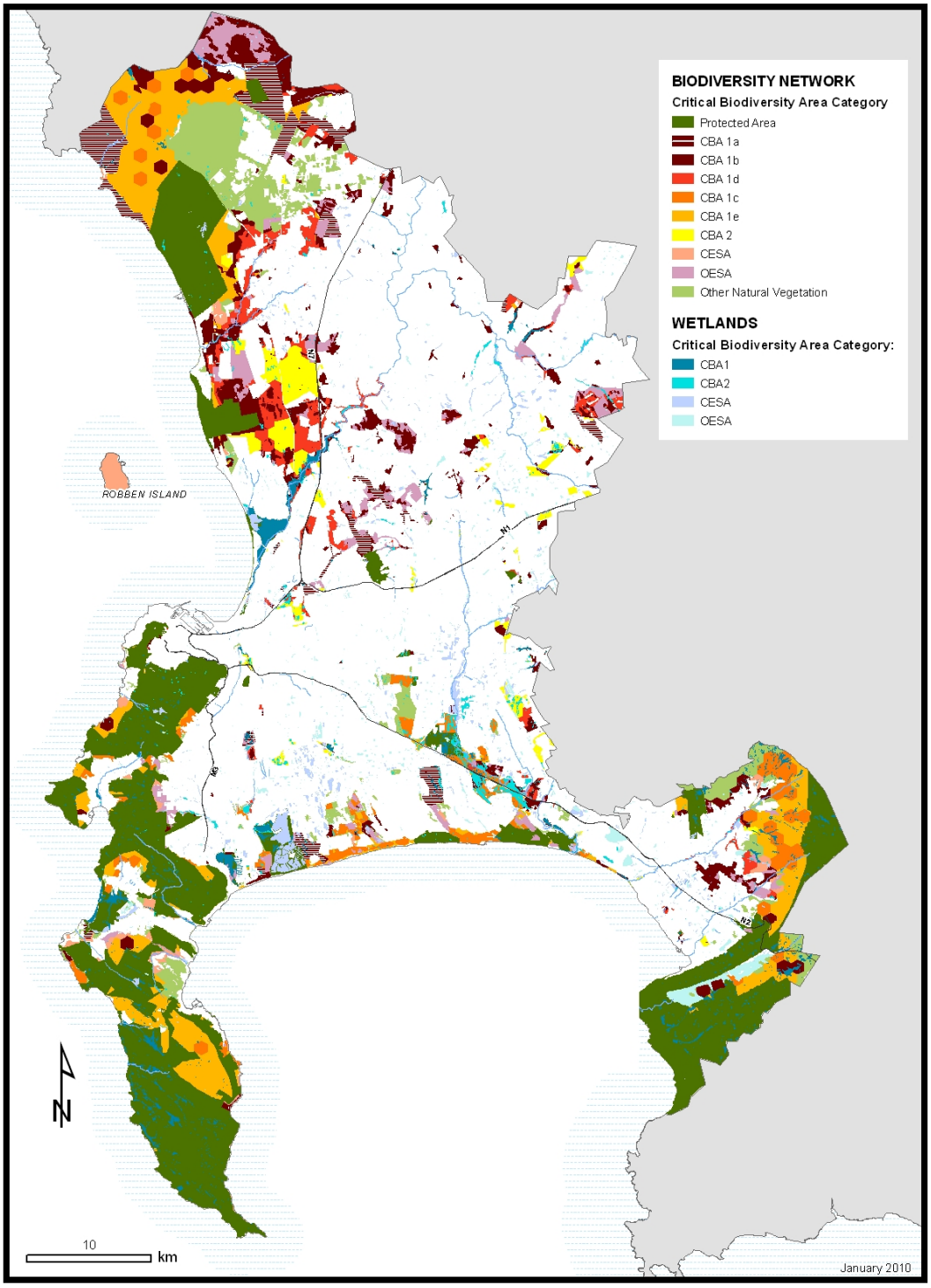

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TABLE OF CONTENTS

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 Wildlife
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 Data	Plant taxa that have been assessed according to their risk of extinction in the near future (See www.redlist.org)
SANBI	South African National Biodiversity Institute
SPF	Species Penalty Factor
VU	Vulnerable (IUCN Red List)

Acknowledgement

The 2008 unpublished report by Grant Benn of GeoCline Consulting CC entitled “City of Cape Town’s BioNet: Terrestrial Systematic Conservation Plan Re-Analysis: Methods and Results”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 2009 report (www.capetown.gov.za – follow links to ERMD, reports).

INTRODUCTION

The City of Cape Town (CCT) has used a systematic conservation planning approach to prioritise its remnant indigenous vegetation based on factors such as connectivity, habitat condition and location of rare and endangered flora. Systematic conservation 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 conservation planning software packages of C-Plan and MARXAN/CLUZ is described in a separate manual for internal use only.

History of Systematic Conservation Planning In the City

In 2002, the first systematic conservation planning study to identify the minimum set of conservation areas required in the CCT was initiated using the conservation 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" report (Maze & Rebelo 1999[1]). In the

[1] *Maze K E & Rebelo A G 1999. Core flora conservation areas on the Cape Flats. FCC Report 99/1. Botanical Society of South Africa.*

latter report 38 sites were identified as critically important contributors to Cape Town's biodiversity and have since been 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 B. Low. The study culminated in the Biodiversity Network Prioritization Report (2004[2]).

In 2005 a revised desktop systematic conservation planning study was initiated to update the Biodiversity Network using the latest: 1) remnant layer from 2005 aerial photography, 2) species information and 2) vegetation map

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[2] 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.

aligned to the new national vegetation map (Mucina et al. 2005[3]). Results from this re-analysis may be found in the 2007 report[4]. This version of the Biodiversity Network was approved by council (PEPCO, November 2006) subject to continuing collaborations with Spatial Planning and Urban Development.

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 Biodiversity Network. Corridors help to conserve ecological processes, which include the dispersal and migration of plants and animals, necessary to conserve healthy populations in the long-term. All wetlands and rivers in this and earlier versions are considered part of the Biodiversity Network. In this analysis, the national ecosystem targets were used for the first time in setting the targets for conservation. Methods and results of this third run of the Biodiversity Network are reported in Benn (2008[5]).

DATA PREPARATION

Software

The data was prepared using ESRI's GIS software versions ArcGIS 9.3 and ArcView 3.3 and Microsoft's Excel and Access.

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

[4] *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.*

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

Analysis Data Inputs

See Table 1: Analysis Data Inputs

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 months, 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.

Each high, medium or low fragment of a remnant formed a 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 that were not yet proclaimed but that were managed by City of Cape Town.

Only features that were located on the existing BioNet, the current mapped extent of indigenous vegetation, within this planning domain were considered.

Table 1: Analysis Data Inputs

DATA	CONTENT	SOURCE	VERSION	FORMAT
Biodiversity Network (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	August 2008	Polygon shapefile mapped at varying scales but constantly being refined to a scale of 1:2000; ground-truthed in 2008
Indigenous vegetation	Historic Indigenous vegetation cover of City of Cape Town	City of Cape Town (based on national SANBI version of 2005)	July 2009	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 Data species	Indigenous floral species locations	CREW, SANBI	July 2009	Point shapefile (accurate to within 10m)
Protea Atlas Project Red Data species	Indigenous floral species locations	Protea Atlas Project	July 2009	Centroid coordinates (point taken to be accurate within a radius of 250m)
SaSflora Red Data species	Indigenous floral species locations	Barrie Low - Coastec	July 2009	Centroid coordinates (point taken to be accurate within a radius of 250m)
CCT Red Data 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	July 2009	Polygon shapefile digitized at 1:10 000 from orthophotos and sample groundtruthed
Threats to Biodiversity Network	Agricultural, urban, mining and development threats	City of Cape Town	July 2009	Polygon shapefile created from best available CCT shapefile inputs

Threats to the Biodiversity Network

The threat level of each planning unit was used in the analysis of the BioNet as a cost surface, which influenced the potential selection of sites. Dr Tony Rebelo of SANBI had generated a combined threat layer for the 2008 analysis, which included the following threats:

- Human settlement
- Potential agriculture
- Potential mining areas

These were updated to reflect the situation in August 2009 and the cost surface revised to include:

- New Development Areas

The factors were then assessed as being of either high, medium or low threat. The relative area of each threat level per planning unit was calculated.

Biodiversity Features Incorporated

The indigenous flora of a planning unit was used to indicate biodiversity as the coverage of the available GIS data was far greater than that available for indigenous fauna. Existence of the flora is also a reliable indicator of existence of the fauna which depend on it. "Flora" includes the various national vegetation types and subtypes as well as the individual Red List threatened species: 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 being of high, medium or low condition
- Revised CCT indigenous vegetation: This uses SANBI's National Vegetation types but classes them at a finer scale per local subtype
- CREW's indigenous flora species data
- CCT's indigenous flora species data
- Protea Atlas Project's indigenous flora species data
- SaSflora's indigenous flora species data
- CCT wetlands (for post-analysis incorporation only: wetland prioritization was analyzed separately and then priority wetlands occurring on natural remnants were included in the BioNet).

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 "Beach" or "Reclaimed" areas in the Vegetation coverage were also excluded. The bare sand would have affected the vegetation target statistics if included.
- 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 found 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. The large natural and semi-natural water bodies (e.g. Rondevlei) fall into the Cape Lowland Freshwater Wetland vegetation type.

Allowing for Biodiversity Processes: Connectivity

Potential corridors to ensure connectivity through the fragmented landscapes of the City of Cape Town were mapped by Biodiversity Management Branch's experienced staff in 2008 and included in the analysis as a factor:
- Blaauwberg Conservation Area to Koeberg
- Diep River Fynbos Corridor (Rietvlei to Blaauwberg Conservation Area)
- Kuils River Corridor (Driftsands to Coast)
- False Bay Coastline

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. The SANBI categories are as follows:

SANBI ecosystem status categories and thresholds
- Critically endangered (CR): current area less than target area
- 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 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 number of times a data point indicating the location of a particular species intersected with a planning unit. Available information on the IUCN Red Data status of each species e.g. CR, EN, was included.

The same was done for the planning units and vegetation datasets and the planning units and threats datasets. However, these recorded the areas in hectares of each vegetation type and each level of threat as opposed to number of locations. If wetlands had been incorporated into the C-plan/ Marxan analysis, the same would have been done for them too.

Setting Conservation Targets

Indigenous Vegetation

Targets were based on National Vegetation Type target 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 type (Please refer to Table 2: General Vegetation Statistics).

Indigenous Flora Species Locations

For CREW, Protea Atlas Project, SaSflora and CCT's recorded floral 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 Red Data species (including those with no status listed)

In other words, every known location of a CR species is targeted and rarer species are assigned relatively higher targets than more common species.

Wetlands

Targets for the City wetland types were based on the percentage target applied to all wetland types by the NSBA. A standard target of 24% was used by the NSBA, with actual target values based on the percentage of mapped wetland area for each type. However, wetlands data were not brought into

this C-plan/Marxan run directly. Wetland prioritization was analyzed separately by expert consultants (Snaddon et al. 2009; www.capetown.gov.za – follow links to ERMD/ Publications/ Reports).

Priority wetlands occurring on natural remnants were included post-hoc into the BioNet. Wetland ground-truthing indicated that priority wetlands located in transformed land were degraded and in practice would be difficult to restore and conserve. Such wetlands were only prioritized in the wetlands study owing to a lack of alternative natural sites supporting these wetland types.

ANALYSIS

Software

The ArcView 3.3 extension C-Plan 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. C-Plan is a conservation-planning tool that provides the tools for the application of a logical and sequential planning process. To assist in ensuring connectivity within the conservation network, MARXAN[6] was used 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[7] 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 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 are tied,

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[6] Possingham et al. 2000, Ball and Possingham, 2000, http://www.ecology.uq.edu.au/index.html

[7] Smith 2004, http://www.mosaic-conservation.org/cluz

planning units within these corridors were preferentially selected. The Minset algorithm rules are as follows:

1. Highest Irreplaceability score
2. Habitat condition = High
3. High or medium threat lowest
3. Location of planning unit in one of the expert mapped corridors
4. Highest percentage contribution to meeting targets
5. Feature rarity
6. Summed rarity
7. Richness
8. Site Area Highest
9. 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.

Checking of SaSflora Data Influences

Each change in status of a planning unit due to the addition of the SaSflora species and subspecies data into the C-plan analysis of 2009 was manually checked by Dr Patricia Holmes against a C-plan 2009 run that excluded this data. This was to ascertain the extent to which the SaSflora data influenced the results as this data had not been included in recent BioNet runs. All sites that were only included due to their containment of SaSflora species were found to have species required to meet minimum targets. The C-plan output with SaSflora data included was therefore considered to be the best result and was used as the input into Marxan.

MARXAN Analysis

The SaSflora biodiversity features were not included in the MARXAN analysis as they caused the software to freeze. This was not considered to be of concern as the required SaSflora sites had already been selected by C-Plan.

Boundary Length Modifier

The protected areas and the high and medium condition sites selected during the C-Plan analysis were set aside as having already been identified as essential to conserve. MARXAN was then run to select further sites that would allow for connectivity between these conserved areas. The sites would therefore be selected by Marxan even if they were not required to directly meet conservation targets. Considering the fragmented nature of the natural habitats of the CCT, it is important for connectivity to be considered in identifying critical areas for conservation.

A BLM of 0.5 was used, based on the findings of Grant Benn[8] 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 you make the BLM, 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 would generally improve the efficiency of the portfolio that MARXAN identifies but also increase the processing time. [1]

CLASSIFICATION OF CRITICAL BIODIVERSITY AREAS

[8] 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).

The selected planning units were given attributes by both the C-Plan and the MARXAN software. These attributes were combined and used to identify a range of different Critical Biodiversity Area (CBA) categories is presented in Table 3.

CBA 2 areas that had additional importance in that they served to consolidate CBA 1b remnants were manually upgraded to CBA 1d status. In most cases, remnants that were selected as CBA 2 in 2009 but were CBA 1d in 2008 could have this status transferred across but this was checked and corrected where necessary and where the remnant no longer demonstrated this additional value to the network it remained CBA 2.

IN FUTURE ANALYSES

- Prior to the next run, the SaSflora database should be checked and decisions made as to how to deal with the different species and subspecies and varieties and as to whether to treat them all as different taxa.
- The available fauna data needs to be assessed to see whether it could be incorporated in the future
- A check needs to be made of the appropriate categories for sites selected for species. Species targets have been set, and sites selected for a species should either qualify as MinSet or Irreplaceable categorization. Consideration should be given as to whether sites required to protect Red List threatened and least threatened species, respectively, require different categories, or whether Critical Biodiversity Area is appropriate to both.

Table 2: Results: General Vegetation Statistics

Units are in hectares unless otherwise specified.

National Vegetation Type	Historic extent *	Current extent	% Remaining from historic extent	National Ecosystem Target %	Target	Selected in BioNet	% Selected in Bionet from current extent	Target met in selected BioNet	Extent in proclaimed Protected Areas	% Target met in proclaimed Protected Areas	Ecosystem Status (calculated*)	SANBI conservation statistic for "protected"
Atlantis Sand Fynbos	25235	15712	62	30	7570	12696	81	Yes	0	0	LT	Not
Boland Granite Fynbos	9575	6064	63	30	2873	4807	79	Yes	355	12	LT	Poorly
Cape Estuarine Salt Marshes	40	26	65	24	10	26	99	Yes	26	268	LT	Well
Cape Flats Dune Strandveld: False Bay	27260	8468	31	24	6542	7273	86	Yes	1856	28	EN	Poorly
Cape Flats Dune Strandveld: West Coast	12700	10604	83	24	3048	6893	65	Yes	965	32	LT	Poorly
Cape Flats Sand Fynbos	54410	8467	16	30	16323	8465	100	No	464	3	CR	Hardly
Cape Lowland Freshwater Wetlands	1464	1095	75	24	351	1069	98	Yes	787	224	LT	Well
Cape Winelands Shale Fynbos	2667	1706	64	30	800	1389	81	Yes	218	27	LT	Poorly

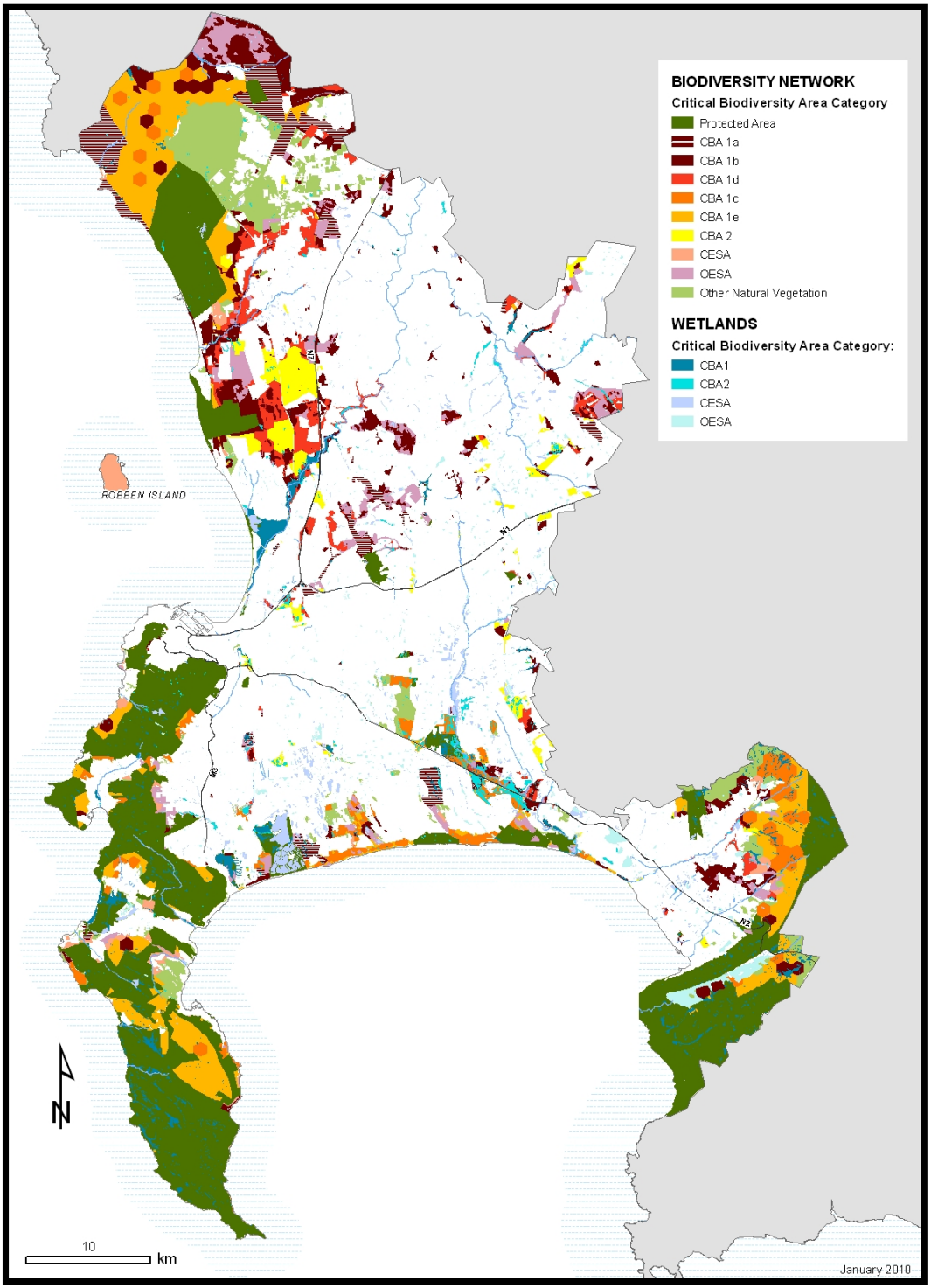
Elgin Shale Fynbos	841	321	38	30	252	283	88	Yes	5	2	EN	Hardly
Hangklip Sand Fynbos	3302	1910	58	30	990	1490	78	Yes	1364	138	VU	Well
Kogelberg Sandstone Fynbos	9500	9261	97	30	2850	8814	95	Yes	1944	68	LT	Moderately
Lourensford Alluvium Fynbos	4819	410	9	30	1446	410	100	No	190	13	CR	Poorly
Peninsula Granite Fynbos: North	1997	1439	72	30	599	1344	93	Yes	986	165	LT	Well
Peninsula Granite Fynbos: South	7149	2482	35	30	2145	2291	92	Yes	1770	83	EN	Moderately
Peninsula Sandstone Fynbos	21896	21349	98	30	6569	20762	97	Yes	17307	263	LT	Well
Peninsula Shale Fynbos	1263	690	55	30	379	689	100	Yes	687	181	VU	Well
Peninsula Shale Renosterveld	2375	317	13	26	617	317	100	No	262	42	CR	Poorly
Southern Afrotemperate Forest	348	347	100	34	118	347	100	Yes	277	234	LT	Well
Swartland Alluvium Fynbos	1742	76	4	30	523	76	100	No	0	0	CR	Not

Swartland Granite Renosterveld	8059	1952	24	26	2095	1952	100	No	36	2	CR	Hardly
Swartland Shale Renosterveld	46712	4019	9	26	12145	4019	100	No	408	3	CR	Hardly
Swartland Silcrete Renosterveld	1067	188	18	26	277	188	100	No	0	0	CR	Not
Western Shaleband Vegetation	329	329	100	30	99	329	100	Yes	31	32	LT	Poorly

* for City portion of vegetation type only

RESULTS

Figure 1: October 2009 Biodiversity Network of the City of Cape Town



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. In addition, Peninsula Shale Fynbos may be considered a 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 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 for maintaining ecosystem processes and to provide habitat for certain threatened plant and animal species and migration corridors for conserving animal species. 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 for connectivity as CBA1e. The ecological support areas required for ecosystem processes are indicated on the map as CESA.

In 2009, seven 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 Granite, Shale and Silcrete Renosterveld vegetation types. Three of these are endemic to the City and thus cannot be conserved elsewhere: Cape Flats Sand Fynbos with 16% habitat remaining, Lourensford Alluvium Fynbos with 9% and Peninsula Shale Renosterveld with 13% remaining. The latter already is mainly 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 the City.

Although sufficient remnant habitat remains to meet targets for the other 13 ecosystems, there is a very long way to go in attaining adequate protection for these types in protected areas. 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, Hangklip Sand Fynbos, North Peninsula Granite Fynbos, Peninsula Shale Fynbos, Peninsula Sandstone Fynbos and Southern Afrotemperate Forest (Table 2). These are mainly conserved in the Table Mountain National Park.

It is important to note that Elgin Shale Fynbos – a vegetation type occurring mainly outside the City – largely has 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.

Wetlands

The City's wetlands were studied at a much finer scale than the vegetation units and to a large extent are seasonal wetlands nested within the national vegetation units (Table 5). City wetland extent thus exceeds that recognized at the national scale as Cape Lowland Freshwater Wetland and Cape Estuarine Salt Marsh. 48 wetland types out of 54 identified types have natural or semi-natural wetlands remaining, but in some cases these are degraded by surrounding land use and are classed as "Ecological Support Areas" rather than "Critical Biodiversity Areas". This is true for Alluvium Fynbos, Renosterveld and some Granite Fynbos wetland types.

Eighty percent (38) of wetland types have the minimum target (by area) selected in the Biodiversity Network and the remainder (10) do not. Of the latter, six have no selected wetlands, as the remaining sites are all in a transformed landscape (Table 5: Alluvium Fynbos isolated depression, Alluvium Renosterveld valley bottom, Granite Fynbos depression, Granite Renosterveld isolated depression, 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. However, they still serve important ecosystem functions.

Twelve wetland types have the minimum target conserved within protected areas. These comprise mainly the strandveld and sandstone fynbos wetland types. However, Sand Fynbos depression is also well conserved owing to waterbodies such as Princessvlei, Rondevlei and Zeekoevlei being included in this type (Table 5).

City Vegetation Types

A more detailed break-down of the conservation planning analysis results by the 59 City vegetation types is presented in Table 6. 17 types have insufficient remnant remaining to meet minimum targets. Of these, four are very small types that historically covered <100ha. The general patterns remain the same as for national vegetation types, with lowland vegetation types and those on richer soils having the lowest proportion of natural habitat remaining.

Table 3: 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	+	Res	+	Conserved
		Medium		Res		Conserved
		Low		Res		Conserved
CBA 1a (where Core Flora Site only)		High		Res		Conserved
		Medium		Res		Conserved
		Low		Res		Conserved
CBA 1b		High		R 2		Conserved
		Medium		R 2		Conserved
CBA 1d (selection from CBA 2 sites based on expert opinion)		Low		R1_low/ R2_low		Available/ Earmarked
CBA 1c		High		R 1		Conserved
		Medium		R 1		Conserved
CBA 1e		High		0Co		Earmarked
		Medium		0Co		Earmarked
		Low		Exc		Earmarked
CBA 2		Low		R1_low		Available
		Low		R2_low		Available
		Low		R2_low		Earmarked
CESA 1a (selection from Other Natural Vegetation or Transformed areas based on expert opinion)		High		0Co/ Exc/<NULL>		Available/ Excluded/ <NULL>
		Medium		0Co/ Exc/<NULL>		Available/ Excluded/ <NULL>
		Low		0Co/ Exc/<NULL>		Available/ Excluded/ <NULL>
		Transformed		0Co/ Exc/<NULL>		Available/ Excluded/ <NULL>
Other Natural Vegetation unless CESA 1a		High				Available
		Low				Available
		High		0Co		Available
		Medium		0Co		Available
		Low		Exc		Available
Transformed unless CESA 1a		Transformed				Excluded
		Transformed		Exc		Excluded

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 having been 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 4: CBA: Significance & Descriptions of Permissible Activities

SDF Cat	CBA Cat	CBA name	Subtype	Description	Significance of Habitat	Objective	Action	Compatible Activities
Protected	Protected	Conservation sites	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.	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.
Protected	Protected	Sites with Conservation Management	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.	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.
Protected	Protected	Conservation Areas	Private	Private Nature Reserves, some of which have been secured under the CapeNature Stewardship programme	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.	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.

CCT Biodiversity Network 2009 Analysis

Critical Biodiversity Area 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.
Critical Biodiversity Area 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.
Critical Biodiversity Area 1	CBA 1c	Minset High & Medium Condition sites	Minset Targets	High & Medium condition vegetation that is endangered or vulnerable & 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.
Critical Biodiversity Area 1	CBA 1d	Irreplaceable Consolidation sites	Minset Targets	Critically Endangered vegetation of 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 & exhorbitant 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.

Critical Biodiversity Area 1	CBA1e	Connectivity sites	Marxan & expert corridor	High, Medium & Low condition vegetation that is endangered or vulnerable & selected on the Biodiversity Network for connectivity (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.
Critical Biodiversity Area 2	CBA 2	Restorable Irreplaceable sites	Minset Targets	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 (playparks, 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.
Critical Biodiversity Area 1	CESA 1a	Transformed/ Unselected Natural Vegetation Sites of Conservation Significance	Additional consolidation & ecological support areas	Unselected Natural Vegetation or sites transformed by agriculture or other activities. Essential for management consolidation, connectivity & viability of biodiversity elements in CBA1a, CBA1b & protected sites.	Local, National & International significance: These areas are required to make existing remnants ecologically viable & for movement of larger fauna. Loss would result in the remnants or faunal species being lost through degradation of ecological processes & exhorbitant 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 agricultural or rural. Ensure agricultural activity is compatable with ecosystem processes. Where possible, acquire, rezone & rehabilitate. High priority, but low urgency (15 year horizon).	Generally areas outside the urban edge: existing agriculture 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.

Critical Biodiversity Area 1	CESA 1b	Additional Wetlands, Rivers & Groundwater Recharge areas	Ecological support areas	Areas not selected on Biodiversity Network that are in natural vegetation or areas transformed by agriculture or other activities. Essential ecological support for CBA1, CBA2 & protected sites.	Local significance: These areas may be required for long-term ecological functioning of 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.	Map areas & check zoning is appropriate. Where possible rehabilitate to enhance ecosystem functioning, including invasive alien control.	Activities that do not impinge on wetland functioning & water quality are permissable; ground-water recharge areas should retain sufficient infiltration areas.
Other Natural Vegetation	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 Biodiversit 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.
Transformed	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 5: 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%) (ha)	Extent in proclaimed Protected Areas	Target met in selected BioNet	CBA1		CBA2		CESA		OESA		Total	
					Area (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)	Number
alluvium fynbos floodplain	4.2	1.0	0.0	2.4	3.0	4	0.0	0	1.2	2	0.0	0	4.2	6
alluvium fynbos isolated depression	1.8	0.4	0.0	0.0	0.0	0	0.9	2	0.9	2	0.0	0	1.8	4
alluvium fynbos isolated seep	15.0	3.6	2.0	2.0	2.0	1	0.0	0	13.0	16	0.0	0	15.0	17
alluvium fynbos seep	88.6	21.3	19.4	46.5	15.2	7	0.2	1	73.2	32	0.0	0	88.6	40
alluvium fynbos valley bottom	43.6	10.5	0.0	42.6	38.7	3	2.2	1	2.8	3	0.0	0	43.6	7
alluvium renosterveld valley bottom	0.7	0.2	0.0	0.0	0.0	0	0.0	0	0.7	1	0.0	0	0.7	1
cape estuarine channel	103.2	24.8	100.1	100.1	100.0	9	3.2	2	0.0	0	0.0	0	103.2	11
cape estuarine depression	133.6	32.1	131.0	131.0	131.0	14	2.7	4	0.0	0	0.0	0	133.6	18
cape river mouth	23.2	5.6	0.0	20.4	18.4	5	4.8	4	0.0	0	0.0	0	23.2	9
dune strandveld depression	74.0	17.8	35.2	53.9	35.2	6	25.7	5	13.2	7	0.0	0	74.0	18
dune strandveld floodplain	748.3	179.6	279.4	744.3	194.4	26	494.4	102	54.7	32	4.7	1	748.3	161
dune strandveld isolated depression	716.7	172.0	77.6	443.7	171.2	127	278.6	271	239.0	197	27.9	50	716.7	645
dune strandveld isolated seep	313.8	75.3	65.8	99.2	81.3	25	23.7	23	200.8	72	8.0	13	313.8	133
dune strandveld seep	84.8	20.3	74.9	83.2	81.9	23	0.7	1	0.6	1	1.6	1	84.8	26
dune strandveld valley bottom	60.8	14.6	45.3	58.7	45.1	12	12.9	3	2.0	9	0.8	2	60.8	26
granite fynbos depression	0.6	0.1	0.0	0.0	0.0	0	0.0	0	0.6	2	0.0	0	0.6	2
granite fynbos floodplain	216.0	51.8	0.0	21.0	54.8	4	25.3	11	14.5	13	121.4	1	216.0	29
granite fynbos isolated depression	1.1	0.3	0.3	0.3	0.3	2	6.5	4	0.6	2	0.3	5	7.6	13
granite fynbos isolated seep	63.5	15.2	6.9	31.0	34.0	43	0.0	0	18.4	23	4.7	7	57.1	73
granite fynbos seep	375.9	90.2	49.7	281.3	274.6	119	40.2	49	60.9	26	0.2	1	375.9	195
granite fynbos valley bottom	148.5	35.6	23.4	84.2	96.7	21	1.0	3	49.1	49	1.5	1	148.5	74
granite renosterveld depression	1.1	0.3	0.0	1.1	0.0	0	1.1	1	0.0	0	0.0	0	1.1	1
granite renosterveld floodplain	2.4	0.6	0.0	0.0	2.4	1	0.0	0	0.0	0	0.0	0	2.4	1
granite renosterveld isolated depression	0.5	0.1	0.0	0.2	0.2	1	0.0	0	0.3	1	0.0	0	0.5	2

CCT Biodiversity Network 2009 Analysis

Wetland type	Current Extent (ha)*	Target (24%) (ha)	Extent in proclaimed Protected Areas	Target met in selected BioNet	CBA1		CBA2		CESA		OESA		Total	
					Area (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)	Number	Area (ha)	Number
granite renosterveld isolated seep	6.2	1.5	0.0	1.7	4.8	2	0.4	1	1.0	4	0.0	0	6.2	7
granite renosterveld seep	51.8	12.4	0.0	15.1	0.7	1	8.8	4	42.3	18	0.0	0	51.8	23
granite renosterveld valley bottom	78.5	18.8	0.0	66.8	37.2	3	26.3	2	15.0	13	0.0	0	78.5	18
sand fynbos depression	561.5	134.8	515.0	542.3	159.7	13	48.2	11	347.3	12	6.3	8	561.5	44
sand fynbos floodplain	800.6	192.1	249.6	694.3	494.3	34	44.3	10	253.5	58	8.6	11	800.6	113
sand fynbos isolated depression	454.7	109.1	10.8	213.3	55.8	35	187.4	128	122.5	132	89.0	145	454.7	440
sand fynbos isolated seep	665.3	159.7	57.2	213.9	76.7	36	141.8	73	383.6	171	54.7	47	656.8	327
sand fynbos seep	210.9	50.6	1.2	107.4	15.2	9	86.9	34	89.1	51	19.7	17	210.9	111
sand fynbos valley bottom	319.9	76.8	107.2	221.1	153.2	8	14.7	12	77.9	30	74.0	33	319.9	83
sandstone fynbos isolated depression	20.7	5.0	7.5	15.6	20.4	35	0.1	2	0.2	1	0.0	0	20.7	38
sandstone fynbos isolated seep	230.3	55.3	165.3	214.9	210.5	377	16.6	36	3.3	3	0.0	0	230.3	416
sandstone fynbos seep	485.9	116.6	275.6	477.4	453.8	371	26.3	46	5.1	6	0.7	1	485.9	424
sandstone fynbos valley bottom	330.4	79.3	180.3	326.8	312.4	94	13.0	7	4.8	2	0.2	1	330.4	104
shale band seep	17.1	4.1	0.0	17.1	17.1	5	0.0	0	0.0	0	0.0	0	17.1	5
shale fynbos valley bottom	21.2	5.1	1.6	16.2	12.0	4	4.2	4	4.2	1	0.8	2	21.2	11
shale renosterveld depression	18.0	4.3	0.0	12.6	0.0	0	6.0	9	12.0	6	0.0	0	18.0	15
shale renosterveld floodplain	161.6	38.8	0.0	15.4	3.0	1	140.8	22	17.8	9	0.0	0	161.6	32
shale renosterveld isolated depression	21.6	5.2	0.0	6.0	4.2	3	1.8	1	15.6	22	0.0	0	21.6	26
shale renosterveld isolated seep	128.3	30.8	0.3	52.4	16.8	1	18.2	11	93.3	74	0.0	0	128.3	86
shale renosterveld seep	226.2	54.3	0.4	59.4	12.7	8	38.8	15	164.5	89	4.4	2	220.3	114
shale renosterveld valley bottom	319.6	76.7	0.0	157.5	102.5	5	72.1	13	145.0	52	0.0	0	319.6	70
silcrete renosterveld isolated seep	1.8	0.4	0.0	0.4	0.1	1	0.3	1	1.5	1	0.0	0	1.8	3
silcrete renosterveld seep	1.0	0.2	0.0	0.0	0.0	0	0.0	0	1.0	2	0.0	0	1.0	2
silcrete renosterveld valley bottom	2.7	0.7	0.0	0.0	2.3	1	0.0	0	0.5	1	0.0	0	2.7	2
Total	8599.5	2063.9	2482.9	5694.6	3545.8	1500	1820.8	929	2546.2	1246	424.6	348	8337.4	4023

* 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

Table 6: Statistics from Conservation Planning Analysis for City vegetation types

Units are hectares unless specified.

City Vegetation Type	Historic extent	Current extent	% Remaining from historic extent	National Ecosystem Target %	Target	Selected in BioNet	% Selected in BioNet from current extent	Target met in selected BioNet	Extent in proclaimed Protected Areas	% Target met in proclaimed Protected Areas	Ecosystem Status (calculated)
Atlantis Sand Fynbos: Strandveld/Fynbos transition (on calcareous/acidic/neutral sands)	8930	7612	85	30	2679	6918	91	Yes	0	0	LT
Atlantis Sand Fynbos: on marine-derived acid sands	10799	6668	62	30	3240	4562	68	Yes	0	0	LT
Atlantis Sand Fynbos: on older non-aeolian colluvium	2817	1096	39	30	845	878	80	Yes	0	0	EN
Atlantis Sand Fynbos: on recent non-aeolian colluvium	2688	338	13	30	806	338	100	No	0	0	CR
Boland Granite Fynbos: on Granite	3542	2626	74	30	1063	2102	80	Yes	165	16	LT
Boland Granite Fynbos: on older non-aeolian colluvium	180	58	32	30	54	57	97	Yes	0	0	EN
Boland Granite Fynbos: on recent non-aeolian colluvium	5853	3382	58	30	1756	2649	78	Yes	189	11	VU
Cape Estuarine Salt Marshes: Wetlands	40	26	65	24	10	26	99	Yes	26	268	LT
Cape Flats Dune Strandveld: False Bay: on Granite	14	7	50	24	3	6	88	Yes	6	184	VU
Cape Flats Dune Strandveld: False Bay: on Mudstone	9	8	80	24	2	6	79	Yes	0	0	LT
Cape Flats Dune Strandveld: False Bay: on Sandstone	320	289	90	24	77	274	95	Yes	204	266	LT
Cape Flats Dune Strandveld: False Bay: on sands	24948	7605	30	24	5987	6269	82	Yes	1522	25	EN
Cape Flats Dune Strandveld: False Bay: on sands over or on limestone	1970	815	41	24	473	718	88	Yes	124	26	VU
Cape Flats Dune Strandveld: West Coast: on Shale	296	184	62	24	71	72	39	Yes	13	18	LT
Cape Flats Dune Strandveld: West Coast: on recent non-aeolian colluvium	80	7	9	24	19	7	100	No	0	0	CR
Cape Flats Dune Strandveld: West Coast: on sands	10093	8474	84	24	2422	5135	61	Yes	0	0	LT
Cape Flats Dune Strandveld: West Coast: on sands over or on limestone	2230	1938	87	24	535	1678	87	Yes	54	10	LT
Cape Flats Sand Fynbos: Strandveld/Fynbos transition (on	267	8	3	30	80	8	100	No	0	1	CR

City Vegetation Type	Historic extent	Current extent	% Remaining from historic extent	National Ecosystem Target %	Target	Selected in BioNet	% Selected in BioNet from current extent	Target met in selected BioNet	Extent in proclaimed Protected Areas	% Target met in proclaimed Protected Areas	Ecosystem Status (calculated)
calcareous/acidic/neutral sands)											
Cape Flats Sand Fynbos: on marine-derived acid sands	49601	7284	15	30	14880	7280	100	No	460	3	CR
Cape Flats Sand Fynbos: on older non-aeolian colluvium	4108	1038	25	30	1232	1038	100	No	3	0	CR
Cape Flats Sand Fynbos: on recent non-aeolian colluvium	435	139	32	30	130	139	100	Yes	0	0	EN
Cape Lowland Freshwater Wetlands: Wetlands	1464	1095	75	24	351	1069	98	Yes	787	224	LT
Cape Winelands Shale Fynbos: on Scree	698	697	100	30	209	697	100	Yes	0	0	LT
Cape Winelands Shale Fynbos: on Shale	1962	1011	52	30	589	692	68	Yes	218	37	VU
Cape Winelands Shale Fynbos: on recent non-aeolian colluvium	8	0	0	30	2	0	100	No	0	0	CR
Elgin Shale Fynbos: on Shale	841	310	37	30	252	283	91	Yes	5	2	EN
Hangklip Sand Fynbos: on marine-derived acid sands	2261	1138	50	30	678	942	83	Yes	929	137	VU
Hangklip Sand Fynbos: on sands	1041	773	74	30	312	548	71	Yes	434	139	LT
Kogelberg Sandstone Fynbos: on Sandstone	9500	9261	97	30	2850	8814	95	Yes	1944	68	LT
Lourensford Alluvium Fynbos: on recent non-aeolian colluvium	4819	410	9	30	1446	410	100	No	190	13	CR
North Peninsula Granite Fynbos: on Granite	1140	783	69	30	342	748	95	Yes	617	180	LT
North Peninsula Granite Fynbos: on recent non-aeolian colluvium	857	656	77	30	257	596	91	Yes	370	144	LT
Peninsula Sandstone Fynbos: on Mudstone	868	778	90	30	260	766	98	Yes	684	262	LT
Peninsula Sandstone Fynbos: on Sandstone	20455	20011	98	30	6137	19439	97	Yes	16098	262	LT
Peninsula Sandstone Fynbos: on marine-derived acid sands	31	31	100	30	9	31	100	Yes	0	0	LT
Peninsula Sandstone Fynbos: on sands	542	526	97	30	163	526	100	Yes	525	323	LT
Peninsula Shale Fynbos: on Shale	457	316	69	30	137	315	100	Yes	314	228	LT
Peninsula Shale Fynbos: on recent non-aeolian colluvium	805	374	46	30	242	374	100	Yes	373	155	VU
Peninsula Shale Renosterveld: on Shale	1883	305	16	26	490	305	100	No	253	52	CR
Peninsula Shale Renosterveld: on recent	492	12	2	26	128	12	100	No	8	6	CR

City Vegetation Type	Historic extent	Current extent	% Remaining from historic extent	National Ecosystem Target %	Target	Selected in BioNet	% Selected in BioNet from current extent	Target met in selected BioNet	Extent in proclaimed Protected Areas	% Target met in proclaimed Protected Areas	Ecosystem Status (calculated)
non-aeolian colluvium											
South Peninsula Granite Fynbos: on Granite	3258	1046	32	30	977	998	95	Yes	842	86	EN
South Peninsula Granite Fynbos: on marine-derived acid sands	233	114	49	30	70	106	93	Yes	90	129	VU
South Peninsula Granite Fynbos: on recent non-aeolian colluvium	3658	1303	36	30	1097	1187	91	Yes	838	76	EN
Southern Afrotemperate Forest: on Granite	31	31	100	34	10	31	100	Yes	27	254	LT
Southern Afrotemperate Forest: on Mudstone	31	31	100	34	10	31	100	Yes	24	229	LT
Southern Afrotemperate Forest: on Sandstone	44	44	100	34	15	44	100	Yes	38	259	LT
Southern Afrotemperate Forest: on Shale	13	13	100	34	4	13	100	Yes	13	294	LT
Southern Afrotemperate Forest: on marine-derived acid sands	2	2	100	34	1	2	100	Yes	2	294	LT
Southern Afrotemperate Forest: on recent non-aeolian colluvium	228	227	100	34	78	227	100	Yes	174	224	LT
Swartland Alluvium Fynbos: on Malmesbury Sandstone	1742	76	4	30	523	76	100	No	0	0	CR
Swartland Alluvium Renosterveld: on recent non-aeolian colluvium	62	0	0	26	2	0	0	No	0	0	CR
Swartland Granite Renosterveld: on Granite	5757	1491	26	26	1497	1491	100	No	36	2	CR
Swartland Granite Renosterveld: on older non-aeolian colluvium	2148	417	19	26	558	417	100	No	0	0	CR
Swartland Granite Renosterveld: on recent non-aeolian colluvium	154	44	29	26	40	44	100	Yes	0	0	EN
Swartland Shale Renosterveld: on Shale	41492	3746	9	26	10788	3746	100	No	381	4	CR
Swartland Shale Renosterveld: on older non-aeolian colluvium	21	0	0	26	5	0	0	No	0	0	CR
Swartland Shale Renosterveld: on recent non-aeolian colluvium	5200	273	5	26	1352	273	100	No	27	2	CR
Swartland Silcrete Renosterveld: on recent non-aeolian colluvium	1067	188	18	26	277	188	100	No	0	0	CR
Western Shaleband Vegetation: on Cedarberg Shale Band	329	329	100	30	99	329	100	Yes	31	32	LT

Note 1: Reclaimed areas & beach were excluded as little to no vegetation exists there; Note 2: Selected in BioNet: excludes Other Natural Vegetation & CESA 1a areas