

13 CAPE FLATS SAND FYNBOS, SOUTH AFRICA

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CLASSIFICATION

National: Cape Flats Sand Fybos (FFd 5) is one of eleven vegetation units within the Sand Fynbos vegetation group (Rebello et al. 2006). Eight other fynbos vegetation groups are recognised on the basis of substrate. Fynbos is one of three major vegetation complexes, with renosterveld and strandveld, that make up the shrublands of the Fynbos Biome (Rebello et al. 2006).

IUCN Habitats Classification Scheme (Version 3.0): 3. Shrubland / 3.4 Temperate

Key references: Rebello et al. 2006.

ECOSYSTEM DESCRIPTION

Characteristic native biota

Cape Flats Sand Fynbos is a species-rich, dense, moderately tall shrubland with scattered emergent shrubs (Rebello et al. 2006). This ecosystem is species rich in low shrubs compared with other fynbos units on sand flats. The dominant plant families are Ericaceae, Proteaceae, Asteraceae and Restionaceae (Fig. 1). Tall shrubs include *Metalasia densa*, *Morella cordifolia*, *M. serrata*, *Passerina cormbosa*, *Protea burchellii*, *P. repens*, *Psoralea pinnata*, *Pterocelstrus tricuspoidatus*, *Rhus lucida* and *Wiborgia obcordata*. Low shrubs include *Diastella proteoides*, *Diosma hisuta*, *Erica lasciva*, *E. muscosa*, *Phylla cephalantha*, *Senecio halimifolius*, *Serruria glomerata*, *Stoebe plumosa* and a large number of less common species. Herbs include *Berkheya rigida*, *Conyza pinnatifida*, *Edmondia sesamoides*, *Helichrysum tinctum*, *Indigofera procumbens*, *Knowntonia vesicatoria* the succulent *Carpobrotus acinaciformis* and the climber *Dipogon lignosus*. Geophytes include *Watsonia meriana* with *Aristea dichotoma*, *Geoissorhiza tenella*, *Othonna heterohylla*, *Pelargonium longifolium*, *Wachendorfia paniculata* and *Zantedeschia aethiopica*. Graminoids include *Cynodon dactylon*, *Ehrharta villosa* var. *villosa*, *Elgia tectorum*, *Restio quinquefarius*, *Sporobolus virginicus*, *Thamnochortus erectus*, *Willdenowia incurvata* and numerous less common species (Rebello et al. 2006).



Figure S13. 1. Remnant of Cape Flats Sand Fynbos with *Gazania pectinata* at Rondebosch Common (left, photo: A. Massyn) and with *Leucodendron*, *Erica* and *Resto* species (right, photo: S. Molteno).

Plant taxa essentially restricted to Cape Flats Sand Fynbos include low shrubs *Erica margaritacea*, *Aspalathus variegata*, *Athanasia capitata*, *Cliffortia ericifolia*, *Erica pyramidalis*, *E. turgida*, *E. verticillata* (Fig. 2), *Leucadendron levisanus*, *Liparia graminifolia*, *Serruria aemula*, *S. foeniculacea*,

and *S. furcellata*; the succulent *Lampranthus stenus*; the geophytic *Ixia versicolor*; and graminoids *Tetraria variabilis* and *Trianoptiles solitaria* (Rebelo et al. 2006).



Figure S13. 2. *Erica verticellata*, endemic to Cape Flats Sand Fynbos and now listed as extinct in the wild. Photo: A. Shawka.

Dures & Cumming (2010) recorded 79 bird taxa within Cape Flats Sand Fynbos, the most common of which were Cape White Eye (*Zosterops virens*), Karoo Prinia (*Prinia maculosa*), Cape Turtle Dove (*Streptopelia capicola*) and Pied Crow (*Corvus albus*).

Abiotic environment

Cape Flats Sand Fynbos is an edaphically determined species assemblage restricted to Tertiary acid, deep grey regic sands at low elevations (20 - 200 m) on flat to undulating terrain (Rebelo et al. 2006). The sands are heavily leached and nutrient deficient podzolic soils of the Lamotte form. The climate is dry temperate, receiving a mean annual precipitation of 580 - 980 mm, with strong winter dominance, including precipitation as mists (Rebeo et al. 2006). On average, less than 10 mm of rain falls per month between November and March. Mean annual temperatures are 16.2°C, with mean summer daily maximum of 27°C in February and mean winter daily minimum of 7°C in July (Rebelo et al. 2006). Frosts occur on about three days per year.

Distribution

Cape Flats Sand Fynbos is restricted to the Western Cape Province of South Africa (latitude 33° 55' S, longitude 18° 22' E), almost entirely within the limits of the City of Cape Town (Fig. 3, Rebelo et al. 2006). Its distribution extends from Blouberg and Koeberg Hills west of the Tygerberg Hills to Lakeside and Pelican Park in the south near False Bay, from Bellville and Durbanville to Klappmuts and Joostenberg Hill in the east, and to the southwest of the Bottelary Hills to Macassar and Firgrove in the south.

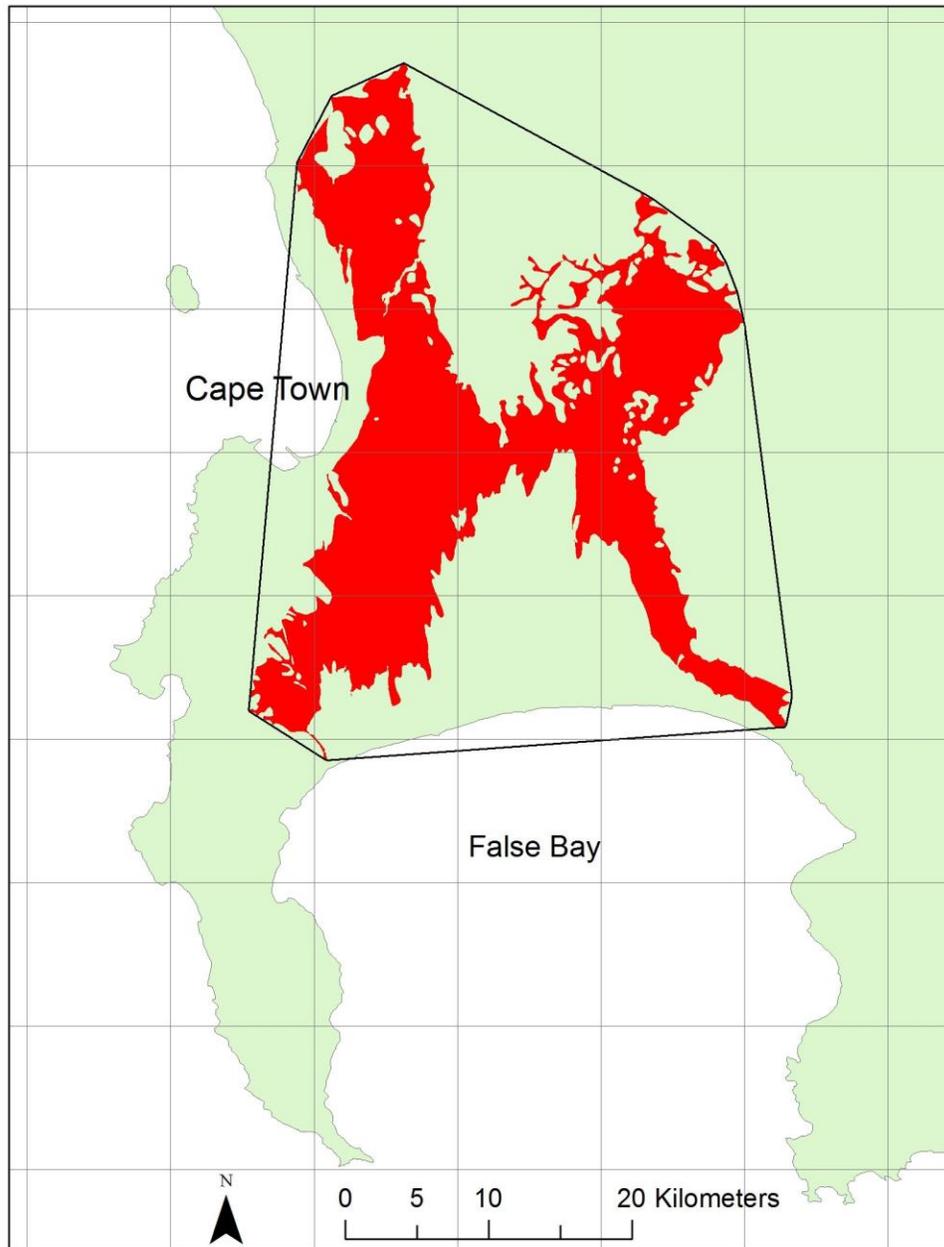


Figure S13. 3. Geographic distribution of Cape Flats Sand Fynbos near the Cape of Good Hope, South Africa. Map shows the historical distribution, projected from occurrences remnants and distribution of soil types (source: Mucina & Rutherford 2006), within minimum convex polygon and 10 km grid.

Key processes and interactions

Soil nutrient deficiency determines much of the functional character of this and other fynbos ecosystems (Stock & Allsopp 1992). Key characteristics of fynbos vegetation that are linked to nutritional poverty include sclerophyllous foliage, low nutrient concentrations in foliage and reproductive tissues, high concentrations of fibre and phenolic compounds in foliage, specialised mechanisms for nutrient uptake such as cluster roots and mycorrhiza, high root:shoot mass ratios, high rates of nitrogen and phosphorus withdrawal from senescent leaf tissues, slow rates of leaf turnover litter production and decomposition, low rates of herbivory and high rates of nectivory among birds and

Keith et al. (2013). Scientific foundations for an IUCN Red List of Ecosystems. PLoS ONE in press
Supplementary material

mammals (Low 1983; Rebelo et al. 1984; Mitchell et al. 1986; Stock & Allsopp 1992; Lambers et al. 2003).

The high fibre and phenolic concentration, together with a climate characterised by seasonal drought predisposes fynbos vegetation to recurring fires, generally every 5 - 50 years. Fires have a profound effect on the evolution of plant life histories and on ecosystem dynamics (Bond & van Wilgen 1996). Plant life history traits that are well represented in the fynbos flora include resprouting and obligate seeding, serotinous seedbanks, myrmecochory, heat- and smoke-stimulated seed germination, pyrogenic flower production and post-fire seedling recruitment (Le Maitre & Midgley 1992). Variations in fire frequency, intensity and season drive changes in community composition and structure of fynbos through successive fire intervals, as different plant species are favoured by contrasting fire regimes (Bond et al. 1984; Bond & van Wilgen 1996).

Threatening processes

Habitat loss, through conversion of native vegetation to urban land use associated with the expansion of Cape Town, now with a population of almost 4 million people, is a major threat to Cape Flats Sand Fynbos (Wood et al. 1994). Eight locally endemic plant species are presumed extinct as a consequence of extensive vegetation clearing throughout the distribution of the ecosystem. Other taxa including birds, reptiles, amphibians and butterflies show similar patterns of threat (Rebelo 1992). Legislative protection of Cape Flats Sand Fynbos as a Critically Endangered ecological community (Department of Environmental Affairs 2011) is likely to have slowed clearing rates, however much of the remnant vegetation will undergo continuing loss of its biodiversity due to lagged effects of fragmentation, changed fire regimes, invasion of exotics, stochastic processes and Allee effects (e.g. Dures & Cumming 2010). Extraction of ground water for urban consumption is a related threat that is likely exacerbate fragmentation impacts on urban remnants of the ecosystem (Rebelo et al. 2006).

Invasion of alien plants is the most severe threat to the remaining area of Cape Flats Sand Fynbos (Rebelo et al. 2006). These include a range of annual herbs and grasses (Vlok 1988), but the most problematic species are woody plants, including *Pinus halepensis*, *P. pinaster*, *P. radiata*, *Acacia saligna*, *A. cyclops*, *A. longifolia*, *A. mearnsii*, *Hakea drupacea*, *H. gibbosa* and *H. sericea*. These species reduce native plant diversity through competition (Richardson & Cowling 1992) and also reduce diversity of avifauna through habitat modification (Dures & Cumming 2010). Some of the displacement of native vegetation by weeds is due to nutrient enrichment associated with runoff from urban development, as well as prior agricultural land use. Additional nutrients give some exotic plants a competitive advantage over native species, and may accelerate mortality in the latter due to toxicity effects (Stock & Allsopp 1992).

Alterations to fire regimes pose a potential threat to persistence of biota within Cape Flats Sand Fynbos. Serotinous obligate seedling plant species are especially susceptible to elimination by high fire frequencies that may result from arson and accidental ignitions in urban landscapes (Bond & van Wilgen 1996). Conversely, the same species may also be eliminated by long intervals between fires, as standing plants senesce after 50 years of age and depend on fires for seedling regeneration. Some remnant patches of the ecosystem may be expected to experience reduced fire frequency due to the lack of vegetation connectivity, which inhibits fire spread. Seedling regeneration is also highly sensitive to fire season due to the seasonal variability in available climatic moisture, which is vital to seedling emergence and establishment (Le Maitre & Midgley 1992).

Climate change is a third major threatening process potentially affecting Cape Flats Sand Fynbos, with mean annual temperatures projected to increase by roughly 1.8°C by 2050. Modelled projections of species distributions suggest an eastward shift in bioclimatically suitable habitat for many fynbos plant taxa, with that much the Cape Flats will no longer be suitable for fynbos by 2050 (Midgley et al. 2003; 2006). Overall biome-level distribution models projected that bioclimatically suitable habitat for fynbos would contract by 51-65%, with 61% of fynbos habitat below 300 m elevation projected to be lost by

2050, including much of the Cape Flats (Midgley et al. 2003). Likely secondary effects of warming include changes to precipitation and fire regimes.

Ecosystem collapse

For assessment of criteria A and B, collapse was assumed to occur when the mapped distribution of Cape Flats fynbos declines to zero, signalling the replacement of upland swamp by developed areas. The relative abundance of exotic plant species would be suitable for assessing disruption of biotic processes and interactions under criterion D if sufficient data were available.

ASSESSMENT

Summary

Criterion	A	B	C	D	E	Overall
subcriterion 1	VU	CR EN	DD DD	DD DD	DD	CR
subcriterion 2	EN					
subcriterion 3	EN	VU	DD	DD		

Criterion A

Current decline: Limited data are available for estimating the reduction in distribution of Cape Flats Sand Fynbos over the past 50 years. However, Rebelo et al. (2011) estimate the trajectories of change in extent of native vegetation within the City of Cape Town, in which Cape Flats Sand Fynbos was the most widespread vegetation type (22% of the area). The extent of proclaimed reserves and unproclaimed vegetation, respectively, was approximately 132,000 ha and 3,000 ha in 1955, and 57,000 ha and 32,000 ha in 2005 (Rebelo et al. 2011, Fig. 3). The extent of native vegetation within the City area therefore declined from 135,000 ha to 89,000 ha. These estimates include three major protected areas, Table Mountain the Cape Peninsula and the Hottentots Holland mountains (part), each of which contains rocky, mostly steep landscapes and a negligible area of Cape Flats Sand Fynbos, as mapped by Mucina and Rutherford (2006). Subtracting the combined area of these reserves (37,000 ha), gives a change in the remaining vegetated area from 98,000 ha to 52,000 ha, a 47% decline over the past 50 years. Assuming that the decline in distribution of Cape Flats Sand Fynbos was proportionate to that in other vegetation types outside protected areas, suggests Vulnerable status under criterion A1.

Future decline: Midgley et al. (2003) modelled bioclimatically suitable habitat for the Fynbos Biome using five bioclimatic variables: mean minimum temperature of the coldest month; annual sum of daily temperatures exceeding 18 °C; annual potential evaporation (PE); the number of winter days on which soil moisture is above a critical level for plant growth in winter; and in summer. They then projected the model using a future climate change scenario, assuming atmospheric CO₂ would reach 550 ppm by 2050, generated by the general circulation models CSM and HadCM2 (including two sulphate amelioration scenarios), downscaled and interpolated for South Africa (Hewitson, 1999; Schulze & Perks, 1999). They found an overall contraction to the south, with total bioclimatically suitable area of the Fynbos Biome declining by 51-65% between the present and 2050. Spatially explicit projections show the eastern portion (50-60%) of the distribution of Cape Flats Sand Fynbos becoming climatically unsuitable by 2050 (Midgley et al. 2003, Fig. 1). In addition, the area climatically suitable for fynbos was estimated to decline by approximately 60% within the altitudinal band occupied by this ecosystem (0 - 300 m ASL). These estimates suggest a future decline in distribution of 50-65%, and hence Endangered status under criterion A2.

Historic decline: The principle sources of spatial data on the impact of clearing include a map showing the reconstructed historic distributions of vegetation types (Mucina & Rutherford 2006) and a map of the extant native vegetation based on 2005 aerial photography ground truthed in 2007-2008 (Fig. 1 in Rebelo et al. 2011). These suggest that the extent of Cape Flats Sand Fynbos has declined from 54,448

ha to 8,467 ha, a decline of 84.4% (Stipinovich & Holmes 2009). It is assumed that almost all of this decline occurred since 1750, although it had been occupied by Europeans a century earlier (Rebelo et al. 2011). The status of the ecosystem is therefore Endangered under criterion A3.

Criterion B

Extent of occurrence: A minimum convex polygon enclosing all mapped occurrences of Cape Flats Sand Fynbos has an area of 1,427 km² (Fig. 3). There is a continuing decline in distribution of the ecosystem, with loss of unproclaimed vegetation accelerating from the 1990s (Rebelo et al. 2011). The remaining distribution is highly fragmented, with many of the remnants undergoing invasions from exotic plants and associated declines in diversity of avifauna. This, together with the large number of Red Listed plant taxa (92), including 4 extinct species (Raimondo et al. 2009; Rebelo et al. 2011), suggest continuing declines in ecosystem diversity and degradation of biotic processes, as well as future threats. The status of the ecosystem is therefore Critically Endangered under criterion B1a,b.

Area of occurrence: Superimposing a 10 km grid over the mapped polygons of Cape Flats Sand Fynbos indicates that no more than 12 grid cells contain more than 1 km² of the ecosystem (Fig. 3). This, together with evidence of declines in distribution and function described under 'Extent of occurrence' supports Endangered status under criterion B2.

Number of locations: The most severe threat to the ecosystem is habitat destruction associated with urban development. Occurrences of ecosystem that are currently within proclaimed reserves are protected from this threat. However, these stands are threatened by invasion of exotic plants. As the entire distribution of the ecosystem is within the City of Cape Town, the unproclaimed remnant vegetation is subject to the same development pressures, regulatory regimes and planning authority. Given that all remaining vegetation occurs within an urban landscape, all is exposed to similar pressures from invasive exotics. The distribution is therefore interpreted as two semi-independent locations; one outside protected areas (threatened by habitat destruction and invasive plants) and one within protected areas (threatened by invasive plants, but not habitat destruction). Given the severe and immediate nature of the threats (Rebelo et al. 2011), the ecosystem is prone to the effects of human activity or stochastic events such that it is capable of collapse or becoming Critically Endangered within a very short time period. The status of the ecosystem is therefore Vulnerable under criterion B3.

Criterion C

There are currently no time series data available enabling an assessment of the rate of degradation in the abiotic environment of Cape Flats Sand Fynbos. The status of the ecosystem is therefore Data Deficient under criterion C.

Criterion D

There is evidence of ongoing decline in ecosystem function through disruption of biotic processes and interactions. Remnant patches of the ecosystem are fragmented and undergoing loss of plant species diversity, as indicated by the large number (92) of species listed as threatened on the South African Red List (Raimondo et al. 2009; Rebelo et al. 2011). In addition, remnant patches are becoming increasingly degraded by invasion of exotic plants and there is an associated loss of diversity in avifauna (Dures & Cumming 2010). At present, however, there are insufficient data to quantify these trends. The status of Cape Flats Sand Fynbos is therefore Data Deficient under criterion D.

Criterion E

No quantitative assessment is available for this ecosystem, so under criterion E its status is Data Deficient.

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