BONTEBOK NATIONAL PARK
STATE OF KNOWLEDGE

Contributors: T. Kraaij[1], R.M. Randall[1], P.A. Novellie[2], I.A. Russell[1] & N. Kruger[1]

[1] SANParks Scientific Services, Garden Route (Rondevlei Office), PO Box 176, Sedgefield, 6573
[2] SANParks, Head Office, PO Box 787, Pretoria, 0001

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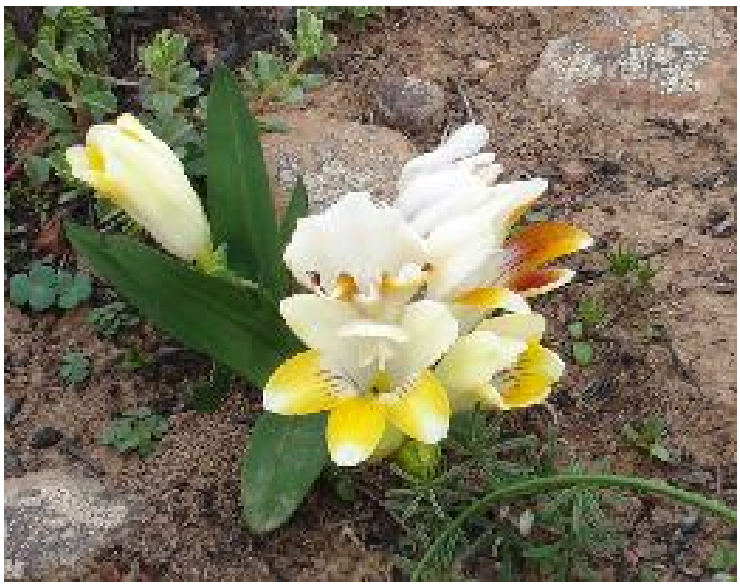

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1. ACCOUNT OF AREA

1.1 Location

Bontebok National Park (BNP) (34º02'S, 20º25'E) is situated 212 km from Cape Town and 6 km from Swellendam (Baron 1981). It lies on the coastal plateau between the Langeberg Mountain range (5 km away) and the Indian Ocean (50 km away).

1.2 Proclamation & Size

The first Bontebok National Park (722 ha) was established in 1931 near Bredasdorp on the norther portion of the farm Bushy Park, known as "Quarry Bos", specifically to save the few remaining bontebok from extinction (Barnard & Van der Walt 1961; Van Rensburg 1975). At the time, a mere 17 bontebok *Damaliscus pygargus pygargus* remained from a known population of 20 animals in the area. Initially the bontebok thrived under this protection, but later inadequate grazing (Novellie 1986), parasite infestations, trace element deficiencies (Barnard & Van der Walt 1961; *cf.* Zumpt & Heine 1978) and the wet marshy conditions in the area again threatened the survival of this species. The animals were subsequently transferred to the park at its current location in the Swellendam District around 1960 (Barnard & Van der Walt 1961). Communal land from the Swellendam municipality and a few privately owned farms were obtained for the new park (1462 ha) and proclaimed on 24 March 1961 (Van der Merwe 1968). In December 1965 two additional pieces of land were acquired by the State and proclaimed, bringing the park to a total of 2797 ha (Van der Merwe 1968). BNP at this stage comprised Erven 1699, 23, 153, and Portions 3 and 8 of Farm 254, Swellendam (National Parks Act No. 57 of 1976, p. 26). In 2004, two more areas, known as 'Die Stroom' (Erf 5338, Swellendam) and the 'airfield' (Erf 5339, Swellendam), together approximately 639 ha, were proclaimed (Government Gazette 25924, Notice No. 41, 23 January 2004) as part of BNP, hence totalling 3435 ha. The park as it was prior to acquiring Die Stroom will hereafter be referred to as the 'old park'.

1.3 Boundaries

BNP is bordered in the north by municipal land and the Swellengrebel airfield, in the east by private farms, and in the south and west by approximately 6.5 km of the Breede River (Russell 2001).

1.4 Controlling Authority

The controlling authority for BNP is South African National Parks (SANParks). Portions of the Swellengrebel airfield are managed by BNP under contractual agreement. Although this land is not particularly valuable from a floristic perspective, it serves as a buffer zone between the park and its surroundings.

1.5 Legislation

BNP was proclaimed a national park in terms of the National Parks Act (Act 57 of 1976) as a "Schedule I" national park. Land listed in Schedule I may only be alienated or excluded from the park by resolution of parliament (s2(3)).

Management by SANParks must comply with national policies, legislation, and international conventions of which the following may be relevant to BNP:

National Legislation:

- Mountain Catchment Areas Act 63 of 1970
- Expropriation Act 63 of 1975
- National Parks Act No 57 of 1976
- Conservation of Agricultural Resources Act 43 of 1983
- Environmental Conservation Act 73 of 1989
- Physical Planning Act 125 of 1991
- Development Facilitation Act 67 of 1995
- Constitution of the Republic of South Africa Act No 108 of 1996
- National Water Act 36 of 1998

- National Forest Act 84 of 1998
- Veld and Forest Fire Act 101 of 1998
- National Environmental Management Act 107 of 1998
- National Heritage Resources Act 25 of 1999
- National Environmental Management: Protected Areas Act 57 of 2003

International Conventions & Treaties:
- Convention on International Trade in Endangered species of Wild Fauna and Flora, 1973
- Convention on Biological Diversity, 1992

2. ABIOTIC CHARACTERISTICS

2.1 Geology

2.1.1 Geology

More than 90 percent of the old park encompasses alluvium and gravel terraces, with outcrops of consolidated rock (belonging to the Witteberg series) occurring only along the Breede River (Theron 1967). Gravel terraces of three ages can be recognized comprising roll-stones of quartz-like sandstone, and sandy gravel. The north and central parts of the park consist of high-level silcrete and ferricrete, while the southwestern flats comprise an alluvial belt of loam and sandy loam (probably an old meander of the river which was gradually filled by sand). The most recently acquired area in the west (Die Stroom) is characterized by shales and siltstone with occasional sandstone beds along the Breede River (Chief Director of Surveys and Land Information 1993).

2.1.2 Soils / Sediments

Soils are immature brown earth and podzols, shallow lithosols and deep alluvial sand. Glenrosa and/or Mispah forms, with lime rare or absent in upland soils but generally present in low-lying soils, occur in the southern part of Die Stroom. Prismacutanic and/or pedocutanic diagnostic horizons dominate the soils of the remainder of the park (Department of Agriculture 1984).

2.2 Physiography

2.2.1 Topography

BNP lies between 60 and 197 masl on the coastal plateau between the Langeberg mountain range and the Indian Ocean. The topography comprises a series of gently undulating gravel terraces descending from a rocky plateau in the northeast through sand and boulders to an alluvial plain. The flats in the southeast are surrounded by low hills and the perennial Breede River (Grobler & Marais 1967; Theron 1967).

2.2.2 Drainage

The sandy character of the former wave terrace on which the park is situated, requires a management policy that ensures the highest degree of vegetation cover in order to reduce runoff and maximise water preservation (Robinson et al. 1981).

2.2.3 Bathymetry

No information available.

2.3 Physics

2.3.1 Climate

The mean annual rainfall (1961-2005) is 528 mm of which most (59 %) falls during the winter months (April to October). According to Novellie (1986), two main peak rainfall periods are evident, one in April-May and the other in August, while the driest months are normally December and January. Temperature ranges between a summer maximum of *c.* 40 ºC and a winter minimum of *c.* 0 ºC, whereas the annual average temperatures are between 6 ºC and 32 ºC. Snow occurs on the Langeberg Mountains. Prevailing winds are southeasterly in summer and northwesterly (dry warm bergwinds) or southwesterly

(associated with cyclonic systems) in winter (Grobler & Marais 1967). Rainfall records have been kept since 1961 and min/max temperatures since 1991. The rainfall data are held by the South African Weather Service under weather station name "[0008813 X] - SWELLENDAM BONTEBOKPARK" (location 34º03'20"S, 20º28'20" E). In addition, estimates of cloud cover, wind speed and direction are recorded daily by the park (N. Grootendorst pers. comm. 2003).

2.3.2 Hydrology (flow / flooding / mixing)

The Breede River in BNP runs in a series of long (>1 km), broad (50 m – 150 m) channels with deep (>2 m) pools, separated by narrow rapids and stony runs (Russell 2001). The substratum in channels and pools consists predominantly of sand and silt, with some small stony patches. In rapids and runs the substratum consists predominantly of cobble and sand, with the bedrock exposed in places (Russell 2001).

2.4 Chemistry

2.4.1 Water chemistry

De Villiers and Thiart (2007) analysed long-term (1973-2004) water quality data of the Department of Water Affairs and Forestry, sampled from the Breede River at Swellendam (34.066 ºS, 20.404 ºE). The intensively cultivated Breede system showed increasing [NO_3^- + NO_2^-] and [PO_4^{3-}] levels during this period, with [NO_3](µg N^{-1}) ranging from 40 – 1450 with a median of 134, and [PO_4^{3-}](µg P^{-1}) ranging from 5 – 96 with a median of 15. Seasonal nutrient concentration profiles exhibited winter (July) peaks coincident with river runoff, which is indicative of diffuse pollution in the catchment (De Villiers & Thiart 2007).

2.4.2 Pollution

The invertebrate fauna and algal growth potential were studied at 18 sampling points in the Breede River in order to calculate values for Chutter's biotic index (Coetzer 1986; O'Keeffe 1986). Values decreased (i.e. pollution increased) downstream due to agricultural effluents in the middle reaches and enrichment from the Kogmanskloof tributary some 35 km above Swellendam, as well as at Swellendam. Pollution (mineralization and eutrophication (Gaigher et al. 1980)) of the Breede River as well as visual and noise pollution from activities in peripheral areas was identified as one of four key threats to BNP. The Breede River constitutes a classic example of diffuse pollution with nutrient concentrations peaking during high runoff conditions (De Villiers & Thiart 2007). Unfortunately conservation authorities have little influence over the quantity or quality of water in the Breede River, which are significantly modified by upstream influences (Russell 2001).

2.4.3 General chemistry

Trace element deficiencies were amongst the motives for translocating bontebok from the initial park close to Bredasdorp to the current position at Swellendam (Barnard & Van der Walt 1961). Bontebok kept at the initial park was diagnosed with 'swayback' (a copper deficiency), supported by the wellknown fact that the southwestern coastal belt is deficient in copper (*cf.* Zumpt & Heine 1978), and that severe worm infestation aggravates the condition (Barnard & Van der Walt 1961). Joubert & Stindt (1979) considered the vegetation of the Swellendam region to be deficient in certain nutrients, including protein, phosphorous, zinc, manganese and copper. At the park at Swellendam, Turkstra and others (1978) determined the concentration levels of various trace elements in liver tissue of blesbok and bontebok, while the same was done for bontebok at the Cape of Good Hope Nature Reserve by Zumpt & Heine (1978).. It was advised that blood samples from culled bontebok be tested for deficiencies of several trace elements, i.e. Cu, Co, Se, Zn, and vitamins A, D and E.

3. BIOTIC CHARACTERISTICS

3.1 Bacteria

See 5.4.

3.2 Virusses

See 5.4.

3.3 Fungi

No information available.

3.4 Flora

3.4.1 Non-vascular (Algae, Diatoms, Bryophytes)

The only work that was done on non-vascular flora was that cited in O'Keeffe (1986) on algal growth potential at several sites in the Breede River for use as an indicator of river health status (see 2.4.2).

3.4.2 Vascular (Pteridophytes, Spermatophytes)

Both banks of the Breede River are bounded by beds of *Phragmites australis* and *Typha capensis*, with limited growth of other aquatic species (Russell 2001). The south bank comprises scrub-covered hills with occasional rock outcrops and the north bank consists of gently sloping sandy soils, supporting mature woody vegetation in a well-established riparian strip. The protection of riparian and aquatic vegetation to provide suitable habitat for indigenous fish species is one of the few measures that can be taken to ensure survival of the endangered indigenous ichthyofauna (Russell 2001).

Apart from the aquatic and riparian vegetation, BNP protects two vegetation types or Broad Habitat Units (BHUs) as defined by Cowling and Heijnis (2001), i.e. Suurbraak Grassy Fynbos and Overberg Coast Renosterveld. Both these lowland vegetation types are globally considered to be of high conservation priority (Cowling et al. 1999). Coastal Renosterveld is the most altered vegetation type of the fynbos, 85 % being lost mainly to agriculture (Moll & Bossi 1984). Due to the virtual destruction and extremely fragmented nature of South Coast Renosterveld (especially towards the west (Kemper et al. 2000)), this vegetation type is regarded as critically endangered (Cowling et al. 1986; Von Hase et al. 2003). The high conservation status of South Coast Renosterveld thus raises the conservation importance of BNP.

BNP may, however, perhaps be regarded more unique than representative as most of the vegetation in the park is not true renosterveld, which generally occurs on shales, but rather a type of lowland fynbos (also threatened), characteristic of boulder scree and conglomerates (Kraaij 2011). Accordingly, Rebelo et al. (2006) classified the vegetation of BNP as Swellendam Silcrete Fynbos, considering it a poorly known vegetation unit exhibiting floristic features of both fynbos and renosterveld. The national status is Endangered with a conservation target of 30 % (this means that 36 % of the original extent of this vegetation type needs be protected in order to capture 75 % of the species occurring in it). Only 4 % is statutorily conserved, largely in BNP, whereas 40 % is already transformed for cultivation and pine plantations. Overgrazing converts this vegetation to graminoid fynbos on the northern slopes and to a species-poor renosterveld elsewhere, whereas it appears to be easily converted to pasture by frequent burning (and liming) (Rebelo et al. 2006). Vlok and De Villiers (2007) classified the vegetation of the park as types of Proteoid Fynbos, Asteraceous Fynbos, Inland Pans and River/Floodline vegetation in their regional (1:50 000 scale) vegetation map for the Riversdale Plain.

At park level, only a sketchy description (and associated map) of the terrestrial vegetation communities of the western half of the old park exists (Grobler & Marais 1967). This study has been done prior to instigation of the short-cycle fire regime (see 5.1.1), and has identified 12 vegetation communities belonging to three main groups, i.e. riparian/tree-group, sweet veld/ renosterbos-group (Acocks Type 46), and mixed grass veld/*Leucadendron*-group (Acocks Type 70). Luyt (2005) subsequently mapped the vegetation of the old park and has not detected substantial changes in the plant communities over the intervening period (1967 – 2004). However, a detailed vegetation study was not the aim of his work, and species-level assessments have not been done.

Despite the rudimentary vegetation description, a comprehensive (though unpublished) plant species list has been kept in concurrence with maintaining a park-based herbarium collection. An updated list is provided by Kraaij (2011) listing 650 plant species indigenous to the park from 280 genera and 85 families (Appendix 7.1). Various popular articles extol the flora of the park (e.g. Von Kaschke 1994; Strydom 1995; Rodrigues 1996; Van der Walt 2003).

3.5 Fauna

3.5.1 Protozoa

No information available.

3.5.2 Invertebrates

No comprehensive list of aquatic invertebrates exists for the park. The only work done on aquatic invertebrates was that of Coetzer (1986) surveying the benthic invertebrates of the Breede River for use as an indicator of river health status (see 2.4.2). Twenty-eight taxa were collected during two sampling efforts (March 1975 & 1976; Appendix 7.2) at a site that borders onto the park, i.e. at the national road bridge across the Breede River at Swellendam. The habitat type sampled was described as “stones in a shallow slow-flowing river stretch” (Coetzer 1986). In terms of relative abundance of invertebrate functional feeding groups at this site, collector-filterers were most abundant, followed by comparable numbers of collector-gatherers and scrapers, with very few shredders and predators/piercers (Coetzer 1986). The high proportion of collector-filterers in the lower reaches of the Breede River was attributed to large amounts of return-flow of irrigation water because ersion-zone features occurred at sampling localities in this section (Coetzer 1986).

Coates (1970) compiled a checklist of the Collembola of South African parks, listing three *Seira* species (*S. mathewsi*, *S. grisea*, and *S. marephila*) for BNP and the plants on which they occur. No other inventories of the park’s terrestrial invertebrates exist.

3.5.3 Fish

A total of 380 fish from 12 species was recorded during sampling of six sites in the Breede River in BNP during 1999 and 2000 (Russell 2001). Fish species collected included one indigenous freshwater species, two indigenous catodromous species, three indigenous estuarine species, two species translocated from other South African rivers, and four alien species. Among these were the red-data listed *Barbus andrewi* (Vulnerable) and the previously red-data listed *Myxus capensis* (Rare), although the domination of alien and translocated species (7 alien fish species) is of conservation concern (Russell & Cambray 2008). Braack’s (1981) records of surveys done between 1961 and 1977 add one indigenous and two alien fish species to Russell’s (2001) list (see Appendix 7.3). At the regional scale, Barnard (1943) has done a revision of the indigenous freshwater fish of the southwestern Cape region.

3.5.4 Amphibians

Routine investigations have resulted in the discovery of ten frog species inhabiting BNP (Braack 1981). The eleventh species, *Breviceps* sp., can only be regarded as a likely inhabitant at this stage (see Appendix 7.4).

3.5.5 Reptiles

Surveys have confirmed the presence of 18 snake, six lizard, three tortoise and one terrapin species in BNP (Braack 1981). No additional tortoise or terrapin species are expected to be found, whereas the list of snakes and lizards is most likely incomplete (see Appendix 7.5). In addition to inventories, preliminary work has been done on resource partitioning and sympatry in land tortoises in the park (Rowlands 1988).

3.5.6 Birds

The first bird list for BNP was a preliminary one (Winterbottom 1962) comprising 103 species. This list underwent numerous additions (Winterbottom 1965, 1967a; Penzhorn 1977; Marais 1990) and revisions (Winterbottom 1967b; Martin et al. 1987), the most recent one (Baron 1981) listing 186 bird species of which 71 species were classified as residents, 10 as migrants and 95 as visitors (see Appendix 7.6). Whittington (2001), Ward et al. (2004) and Staegmann (2003) subsequently added three more species to the list. Endangered birds that occasionally appear in the park are the Black stork and Cape vulture (Greyling & Huntley 1984). The park's birds have also been publicised in the popular literature (e.g. Winterbottom 1961; Jackson 2001). A strip-count survey of bird densities in the renosterveld of BNP (Winterbottom 1968) gave an average density of 151 birds per 40 ha – the Grey-backed Cisticola (*Cisticola subruficapilla*) being the most numerous species, accounting for 23 % of all birds counted. Bird population size and diversity of the coastal renosterveld were compared to those of coastal fynbos (Winterbottom 1968). The fynbos was found to support 2 - 4 times the population, greater diversity and a smaller proportion of insectivorous birds compared to the renosterveld.

Comprising one of largest remaining renosterveld fragments in the Overberg, BNP represents an important foraging and breeding site for the Vulnerable Black harrier (*Circus maurus*) (Curtis 2005). 2004 surveys recorded four breeding pairs within in the park (Curtis 2005). This regional study concluded that Black harriers are highly sensitive to habitat fragmentation and that they are unable to persist in small, isolated patches, as they rely on natural veld for both breeding and foraging.

3.5.7 Mammals

Various accounts of historical mammal occurrence in the Swellendam area exist (Tomlinson 1943; Bateman 1961; Van der Merwe 1968; Van Rensburg 1975; Skead 1980; Boshoff & Kerley 2001), listing predators such as lion, leopard, hyaena, jackal, wild dog, and wild cat(s). Ungulates within historical range include bontebok, grey duiker, Cape grysbok, red hartebeest, grey rhebok, steenbok, and Cape mountain zebra (currently present in BNP), and buffalo, bushpig, eland, elephant, hippopotamus, black rhinoceros, and klipspringer (currently absent from BNP) (Boshoff & Kerley 2001). Extralimital species that were previously introduced but later removed are common reedbuck and springbok(Novellie & Knight 1994). A checklist of mammals is given by Stuart and Braack (1978) and Robinson et al. (1981). Rodents are listed by De Graaff (1974).

Among the specialized studies done on mammals in BNP, much emphasis was on the bontebok and grey rhebuck. Aspects particularly well-studied were bontebok life history, demography, population dynamics (De Graaff et al. 1976a; Novellie 1986), genetic purity/distinctiveness (Fabricius et al. 1989; Essop et al. 1991; Kumamoto et al. 1996; Van der Walt et al. 2001; Van der Walt 2002; Le Roux 2010), feeding ecology (Beukes et al. 1989), fecundity, reproduction (Skinner et al. 1980; Novellie 1981), territorial-, mating- and drinking behaviour (David 1970, 1971, 1973a&b, 1975a&b; Van Zyl 1978); grey rhebuck feeding- and general ecology (Beukes 1984, 1987, 1988); and life histories (De Graaff et al. 1976b; Van der Walt et al. 1976a&b), parasitology (see 5.4.2) and glandular secretions (Le Roux 1980; Nell 1992; Burger et al. 1999a&b) of various ungulates. The sex pheromones from the pedal gland of bontebok received special attention (Burger et al. 1976, 1977 ; Reddy & Vadav 1984; Kovalev et al. 1986; Fujimoto et al. 1991).

Bontebok is a preferred grazer of short- to medium grasses such as *Cynodon dactylon*, *Themeda triandra*, *Digitaria eriantha* and *Eragrostis* species (Beukes et al. 1989). Of the grass species in the park, 11 can be considered palatable, 18 acceptable and 23 unpalatable to bontebok, whereas only 5 % of shrubs are utilized (De Graaff et al. 1976a). Beukes (1984) showed that the quality of the bontebok's diet is higher during winter than during summer. Presumed poor reproduction in bontebok between 1960 and 1973 spurred several studies on the matter. Skinner et al. (1980) found males to be in fair breeding condition and concluded that a post-lambing seasonal lambing percentage of 54 % must be considered the norm for bontebok in BNP, permitting a satisfactory population growth. An

unknown factor was the extent and causes of lamb mortality. Lambing season is in spring, between August and end of October (80 % of lamb crop born), but stragglers sometimes appear up to the end of February (De Graaff et al. 1976a). Novellie (1986) showed that lambing percentage is correlated with rainfall of the 12 months preceding the mating season (mating season is early autumn, January to mid-March, Skinner & Smithers 1990), while Capellini (2006) found a positive correlation between mean annual rainfall and body size of bontebok (and the genus *Damaliscus* in general). Bothma (1986) recommended a sex ratio of 1 male to 2 females for natural bontebok populations, and for the maintenance of a healthy age structure, populations should consist of 30 – 40 % subadults. Watson et al. (1991) described a method of age determination from skull growth in blesbok, which may also be applied to bontebok.

Beukes (1987, 1988) showed that grey rhebuck are predominantly browsers (particularly shrubs and forbs lower than 250 mm), contrary to the common belief that they are grazers. Dicotyledonous shrubs and forbs (many of the genera *Disparago, Metalasia,* and *Aspalathus*) comprised 97 %, and graminoids 3 % of their diet, which has implications for the management of rare plant species in the park (see 5.1.4).
Life history descriptions of the red hartebeest- (Van der Walt et al. 1976a), eland- (De Graaff et al. 1976b), and Cape buffalo- (Van der Walt et al. 1976b) account for the removal of buffalo from BNP in 1974 due to great difficulty (and expenses) with keeping the animals in the park, and the removal of eland and red hartebeest in 1975 as a result of poor performance and low fecundity (mainly related to nutritional deficiencies and parasites). Selected studies were done at BNP on the genetics of animals other than bontebok/blesbok, i.e. geographic mitochondrial DNA variation in the rock hyrax (Prinsloo & Robinson 1992), and the role of cytogenetics in genetic conservation of mammals (Robinson & Elder 1993).

4. HISTORY

4.1 Archaeology

It is not certain who the earliest inhabitants of the area of BNP were, although many Stone Age tools of ancient civilizations are found between Riversdale and the Buffeljags River. Much evidence exists of the presence of nomadic San and Hottentot tribes (Van Rensburg 1975; see 5.3). Arthur (2008) studied the Khoekhoen of the Breede River, Swellendam area as part of an archaeological and historical landscape synthesis.

4.2 Paleontology

No information available.

4.3 Historical aspects

Of special importance to the Swellendam/Caledon area was the Hessekwas Hottentot tribe, who kept numerous sheep and cattle on the coastal lowlands, which they used for trading with the Cape settlers since 1660 (Van Rensburg 1975). Lang Elsie was a remarkable woman captain who lived between 1734 and 1800, with remainders of her kraal, only an open yard, next to the Breede River in BNP (now called “Lang Elsieskraal”) (Tomlinson 1943). Graves (covered in blue ironstone) of Nouga Saree, another Hottentot captain, and a few of his followers are still to be seen in the “Ou Tuin” along the Breede River in the park. His fat-tailed sheep and long-horned cattle grazed on what became the old racecourse, whereas Lang Elsie’s grazing-land likely constituted the remainder of the flats extending to the Buffeljags River. Since the early eighteenth century the white civilization started to encroach on the area. The combination of alcohol, tobacco and the smallpox epidemic of 1713 virtually obliterated the Hottentot tribes and only scattered Hottentots could be found on farms in the district by the end of the eighteenth century.

Wheat cultivation also commenced in the early eighteenth century, which marked the start of the eradication of the area’s natural vegetation (Van Rensburg 1975). According to Skead (1980), giving account of the Dutch farmers of the late 1700’s, deterioration in veld

condition and overgrazing have already been noticed by then. There are also records of farmers burning the veld and trying to get rid of the renosterbos (*Elytropappus rhinocerotis*). Between 1848 and 1904 a portion of the current park was used as a racecourse for horses, and between 1952 and 1960 part of it was used as a shooting range. Being part of the town commonage of Swellendam, it was also heavily grazed by domestic livestock prior to 1960 (Novellie 1987). The area was thus subject to intensive human use before the park was proclaimed.

5. MANAGEMENT

5.1 Management of vegetation

5.1.1 Burning

The rationale behind the burning regime and its application in the park since 1970 has been extensively discussed and debated, both internally and externally (Rebelo 1992; Kraaij 2010). A short-rotation (4-yr) fire cycle was instigated ten years after the park's proclamation at Swellendam, the main aim being to provide sufficient grazing (grass) for the bontebok in the management units comprising renosterveld (having "reasonable cover of grass"), and to promote a more even distribution of grazing pressure (Novellie 1987; Kraaij 2010). The remaining management units, those with less grass and more characteristic fynbos species, were burnt in rotation at longer intervals (10-12 years) (Novellie 1987; Kraaij 2010). Kraaij (2010) evaluated the fire regime at BNP over the period 1972-2009 in terms of fire return periods, season of burn, incidence of prescribed vs. accidental fires, and identified areas within the park which has successively burnt at immature veld ages.

The effects of burning on the vegetation structure and the distribution of grey rhebuck and bontebok were investigated by Beukes (1987) and Luyt (2005). They found both antelope species to favour vegetation aged four years and less. Novellie (1987) found grasses to be the most heavily defoliated component of the vegetation especially in the first year after burning. No grass species was consistently avoided by herbivores, and no species was consistently favoured. In general, the tall, coarse species were favoured on new burns and the short species came into favour once the sward had grown taller. Heavy use of recently burnt vegetation was not deleterious to the grass component according to Novellie (1987).

However, the park has often been criticized by fynbos ecologists for being managed as a single-species park – the short fire cycle presumably being detrimental to the continued existence of the full spectrum of plant species in the park (Kraaij 2010, 2011). Fynbos (including renosterveld) is a fire-maintained ecosystem and the effects of fire on species composition, vegetation structure and successional patterns depend on the frequency, intensity and season of fire (Kruger & Bigalke 1984; Van Wilgen et al. 1992). Fire regimes according to which fynbos should be managed are mostly determined by the serotinous (regenerating from canopy-stored seed released after fire, e.g. Proteaceae) component of the vegetation. A general management guideline is that 50 % of the population of the slowest-maturing serotinous species should flower three times before the next fire (Vlok 1996; Van Wilgen et al. 1992). This approach indicates that fire frequencies in fynbos should be between 10 and 25 years to maintain species richness (Van Wilgen 1981; Van Wilgen et al. 1992). For the fynbos communities of BNP in particular, and based on the life history of the slowest-maturing serotinous species, *Protea repens*, experts (the Fynbos Biome meeting visited the park in 1988; Vlok in litt. 1991) recommended that the fire rotation should not be less than 11-12 years. Fire cycles, on the other hand, should not exceed the lifespan of reseeding plants (*ca.* 45 years) (Vlok 1996; Van Wilgen 1992). The season of fire that achieves optimal recruitment of fynbos is late summer/early autumn (i.e. February/March) (Midgley 1989) and fires need to be hot in order to stimulate substantial seed germination and seedling establishment (Bond et al. 1990).

Similar to the fynbos, the fire cycle in renosterveld is also determined by the long-lived, non-sprouting plant species (e.g. *Erica* spp., *Aspalathus* spp.). There is virtually no published literature on the matter, but the Fynbos Forum ecosystem-specific biodiversity guidelines

for the vegetation of the Cape Floral Kingdom (De Villiers et al. 2005) indicate that the optimum fire cycle for renosterveld in moderate rainfall areas (400 mm/annum; BNP mean = 511 mm) ranges between 10 and 15 years. Upon visiting BNP,Vlok (in litt. 1984) recommended that fires in the renosterveld vegetation of the park should not be more frequent than every 6-8 years. Historically the fire regime is likely to have been more random and a variable fire frequency is therefore preferable to a fixed fire cycle. Similarly, spatial variation (patchiness) in renosterveld and fynbos burns is considered important for maintaining diversity and ensuring system persistence (De Villiers et al. 2005). Autumn would have been the normal fire season in South Coast renosterveld in pre-settlement times (Van Wilgen 1984 cited in Cowling et al. 1986). Evidence suggests that autumn (February to April) fires in South Coast renosterveld would also be the most efficient and effective way of eliminating shrubs and promoting grassiness (Cowling et al. 1986). Van Wilgen et al. (2011) proposed a set of thresholds of potential concern to allow for the adaptive management of fire (in association with grazing) at BNP.

Grazing is another important determinant in renosterveld ecosystems (Krug et al. 2004) and interacts with fire in its effects on the vegetation (Cowling et al. 1986; Novellie 1987; Kraaij & Novellie 2010). While fire may be used as a management tool to promote grassiness, regular burning followed by intense grazing may lead to the destruction of the grass sward and a thickening up of shrubs (Cowling et al. 1986). Luyt (2005) observed a significant change in floristic composition due to heavy overgrazing of too small an area that was burnt in a particular year. In 2001 only 65 ha was burnt and the whole bachelor herd of bontebok concentrated on that area for about a year and effectively created one huge grazing lawn from an area that used to be structurally diverse, with effects still visible three years later. On the other hand, overgrazed veld should not be burnt until it is sufficiently rested and recovered.

Because of the small size of the park and the way in which fire and grazing interact, the two main management objectives of BNP are in constant conflict (; Kraaij & Novellie 2010). Conservation of the vegetation, implicating correct fire practice, has to be traded off against the maintenance of a viable bontebok population (viz. Novellie 1987; Kraaij & Novellie 2010). Taking the mentioned constraints and current understanding of vegetation ecology into account, a new burning regime (with implications for the stocking rate of bontebok; see 5.1.2) was adopted by BNP in 2004 (Kraaij 2004, 2010). The ammended fire plan is based on a rotation of not less than eight years in renosterveld vegetation and 16 years in fynbos, allowing for some variation, with burning done in late summer/early autumn. The original fire management blocks of BNP were retained but grouped into units of sufficient size, having considered the latest changes in service and tourist roads. Die Stroom was furthermore included in the plan and burnt for the first time by BNP management in late summer of 2005 (Kraaij 2010).

5.1.2 Herbivory

The former management plan for BNP (Robinson et al. 1981) set the maximum stocking rate of bontebok at 200 and grey rhebuck at 100. It has often been pointed out that monitoring needs to be done to ascertain whether grazing is having a deleterious effect on the vegetation over the long-term (Novellie 1987; Kraaij & Novellie 2010; Novellie & Kraaij 2010).

Prolonging the fire cycle under the new burning regime (see 5.1.1; Kraaij 2010) could in effect result in a reduction in the amount of forage available to bontebok (viz. Beukes 1984; Novellie 1986; Kraaij & Novellie 2010). Thus, in order to appropriately distribute grazing pressure in space and time, it was suggested that the bontebok population be reduced from a maximum stocking rate of 200 animals (Robinson et al. 1981) to fluctuating between 130 and 170 individuals (Kraaij 2004; Kraaij & Novellie 2010). As recommended by Novellie (1987), the proposed stocking rate of bontebok should continually be re-evaluated in view of vegetation condition. Vegetation monitoring should thus be done to determine if changes

in vegetation cover and composition occur as a result of the altered management (fire and stocking) regime (Kraaij & Novellie 2010; Novellie & Kraaij 2010).

Given that bontebok are concentrate grazers, the focus should be on monitoring the utilisation of preferred grass species (see 5.1.5; Novellie & Kraaij 2010). Grass species most heavily grazed are *Themeda triandra*, *Eragrostis curvula*, *Merxmuellera stricta, Pentaschistis eriostoma* and *Stipagrostis zeyheri* (Novellie 1987). Despite not being one of the most preferred species, *Cynodon dactylon* may be used as an indicator that bontebok will use a certain habitat (Luyt 2005). Utilisation of other graminoides, Cyperaceae and Restionaceae, were found to be negligible (Novellie 1987).

Another aspect that should be considered in monitoring the effects of herbivory is the dynamics of bontebok grazing lawns (Luyt 2005; Novellie & Kraaij 2010). Territorial males prefer those vegetation types that have small patches of either grazing lawns or naturally occurring *Cynodon dactylon* lawns regardless of the nature of the surrounding vegetation. Moreover, indications are that the territorial dung sites of these males may be responsible for initiating at least some of the grazing lawns (Luyt 2005). It is likely that a positive feedback loop starts with local enrichment of the soil caused by dung middens of territorial male bontebok, with trampling further decreasing shrub cover at the site. Increases in grass species and annuals that prefer soils high in nitrogen and that are usually higher in nutrional content themselves, would likely increase grazing, in turn resulting in grazing tolerant, but productive grass species such as *C. dactylon*, becoming dominant. These productive lawns would be able to sustain increased bontebok densities, in turn resulting in expansion of grazing lawns (Luyt 2005; Novellie & Kraaij 2010). If the park objective is overall biodiversity conservation, monitoring should serve to alert management to a situation where grazing lawns increase at the expense of other species.

In general, increases in some herbivore species have to be compensated for by reductions in others of the same feeding guild. Novellie suggested that competition from springbok negatively affected red hartebeest performance (Novellie 1987), and that competition among grazers, prior to the introduction of the rotational burning program, resulted in low lambing percentages in bontebok (Novellie 1986). Bontebok, feeding almost exclusively on grass (Beukes 1984; Novellie 1987), do not pose a direct threat to the rare plant species of BNP (unless grazing lawns result in significant transformation of other habitat), the majority being dicotyledons, whereas the opposite holds true for grey rhebuck (Beukes 1988). See 5.2.1 for habitat use of Cape mountain zebra. Whereas bontebok prefer recently burnt veld, forage theoretically only becomes acceptable to mountain zebra and red hartebeest at veld age of 20 months (Novellie 1987; Luyt 2005). However, Kraaij and Novellie (2010) have shown that all herbivores prefer young veld (particularly veld ages of three years or less) and thus potentially compete for this resource.

5.1.3 Alien plant control

There are no publications on alien plant control specifically applicable to the park. However, a wealth of general information is available on the subject. The Working for Water Program (WfW), implemented by SANParks' Invasive Species Control Unit (ISCU), currently runs a project within BNP. WfW alien clearing projects are dynamic and information on both the ecological and social aspects of the program is updated on a monthly basis in WfW's electronic database, WaterWorks. WaterWorks has a suite of unpublished reports querying all aspects of the database that can be run on a demand. Reports include statistics on hectares cleared, alien plant species (age and density per area), methods of clearing, herbicide usage, etc. WaterWorks reports can be requested through the ISCU's GIS Hub based at Rondevlei (N. Cole pers. comm. 2005).

5.1.4 Rare Plants

Although not specific to the park, the threatened status of renosterveld and lowland fynbos is well documented (e.g. Moll & Bossi 1984; Cowling et al. 1986) and emphasises the floristic importance of BNP, being one of the largest formally conserved fragments of South Coast Renosterveld (Von Hase et al. 2003). The park holds several rare and/or threatened

plant species, including a number of *Aspalathus*, *Diosma* (buchu), and *Gladiolus* species.. However, no single comprehensive publication exists on the park's rare/endangered flora. Monitoring of the populations of rare plant species has been proposed in the past and has recently commenced (see 5.1.5). Stocking rates of certain herbivore species, particularly browsers, are furthermore important in the management of rare plant species (see 5.1.2). The park has numerous *Aspalathus* species, a number of them with Red Data status. It is interesting that this genus, one of the few fynbos taxa to possess spines, also has nitrogen-fixing symbionts and may therefore have higher leaf nitrogen levels and palatability (Johnson 1992) and thus be more susceptible to the effects of herbivory.

5.1.5 Vegetation Monitoring

Vegetation monitoring requirements in BNP have largely centered on the burning regime. Key questions that needed to be addressed and associated monitoring proposals were as follows:

- Is the vegetation on the 4-yr cycle blocks being degraded by frequent burning and grazing? Vegetation cover (particularly palatable grass cover) and species composition were to be recorded in monitoring plots on recently burnt blocks.
- Is the burning program successful in dispersing grazing pressure? Records were to be kept of the numbers of animals sighted on each block.
- Have there been long-term trends in plant species composition? Wheelpoint survey sites were established to be monitored at 5-yr intervals.
- How successful are seed-regenerating Proteaceae in surviving fires and seed production? Post-fire seedling : adult ratios were to be obtained for *Protea repens* and *Leucospermum calligerum* in 1 m^2 quadrats, and individual plants to be inspected annually for flowers by means of the wandering quarter method.
- What is the status of the rare plant species and how do fires affect them? Distributions were to be mapped and total populations counted annually during flowering season if sufficiently rare and localized.
- Are there any long-term shifts in plant community boundaries? Best monitored by aerial photography.

Some years after monitoring had been initiated, it was thought that more plots and grazing exclosures were required in order to determine whether the grass component was being degraded, but that the existing research personnel were grossly inadequate to cover the necessary aspects.

A monitoring program has recently been instigated to evaluate the effects of the new management regime (i.t.o. burning and stocking, Kraaij 2004) on the grass component of the vegetation (Kraaij 2005a; Novellie & Kraaij 2010). Another monitoring project (in partnership with the Threatened Species Programme of SANBI) has recently commenced at BNP whereby Red Data plant species (mostly woody shrubs) occurring in the park will be located and the performance of some populations monitored over time (Kraaij et al. 2008). Such a project should, in addition to observations of habitat utilisation by herbivores (Kraaij & Novellie 2010), augment the grass monitoring project (Kraaij 2005a; Novellie & Kraaij 2010) in an attempt to evaluate the effects of the new management regime on a larger component of the vegetation of BNP.

5.2 Management of animals

5.2.1 Introductions / Translocations

Accounts of the translocation of bontebok from Bredasdorp to Swellendam are given by Van der Walt and Ortlepp (1960) and Barnard and Van der Walt (1961). At the time of establishment, the "new" park at Swellendam already contained grey rhebuck, steenbok and grey duiker. Buffalo, bushbuk and eland have been (re)introduced to the park, as well as the extralimital common reedbuck and springbuck, but all these species were subsequently removed or went extinct (Penzhorn 1971; Novellie & Knight 1994). The habitat available in BNP was deemed to be unsuitable for buffalo and bushbuck, but adequate for eland (Novellie & Knight 1994). Species within historical range (Boshoff & Kerley 2001) that are absent from the park are thus buffalo, bushpig, eland, elephant, hippopotamus, and black rhinoceros.

In 1986 Cape mountain zebra was introduced into BNP based on evidence that the Swellendam district was part of the species' historical distribution range (Skead 1980). Being a tall-grass grazer, it was anticipated that mountain zebra would compliment the habitat-use of bontebok (a short-grass grazer), resulting in more even grazing pressure on the vegetation. Eland may also be considered for reintroduction(Boshoff & Kerley 2001). However, they were attempted previously and did not perform very well (Novellie & Knight 1994) – their poor condition ascribed to nutritional deficiencies (De Graaff et al. 1976b). At that time, however, there were too many extralimital springbuck in the park and these may possibly have competed with other grazers such as the elandand red hartebeest (Novellie 1987;).

The following extract (Caughley & Walker 1983) based on the ideas of island biogeography theory may be very applicable to BNP: "Many reserves may presently contain more species than they can sustain and so run a high risk of losing those that are susceptible to the effects of confinement. In small reserves it may be unwise to try, by translocation, to build up a faunal community characteristic of a whole region. Small areas are unable to provide such a 'compressed' community, and the high management inputs needed to maintain it are likely to guarantee only ever-escalating management inputs. These considerations suggest that research is needed to provide a sound basis for determining the minimum size that a protected area should be in order to achieve its stated objectives."

5.2.2 Culling

Barkhuizen (1972) reports on good results achieved with Fentanyl and Azaperone at specified dosage levels for immobilization of bontebok.

5.2.3 Alien animal control

No information available apart from the fact that dogs entering the park from the neighbouring residential areas are shot (N. Grootendorst, pers. comm. 2003).

5.2.4 Rare animals

Since the earliest times the bontebok was limited to the southwestern parts of the Cape Province (Bigalke 1955). In 1931 the park came into existence to save the threatened subspecies from extinction. The bontebok is the least common antelope in the southern African subregion (Skinner & Smithers 1990) and was still classed as Rare in 1986 (Smithers 1986). At present, its status according to national IUCN assessments is Vulnerable (Friedmann & Daly 2004).

The bontebok is subspecifically different from the blesbok (*Damaliscus pygargus phillipsi*), with which it hybridizes readily. The bontebok differs from the blesbok mainly in its coat pattern, behaviour and social structure (Bigalke 1955; Fabricius et al. 1989). The phenotypic and genotypic distinctiveness of the two subspecies was studied to enable differentiation among the subspecies and hybrids. Fabricius et al. (1989) developed a discriminant function for identifying hybrid bontebok x blesbok populations based on physical dimensions and coat colouration; Essop et al. (1991) determined genetic distance between the subspecies, aiming to establish the distance in time since divergence from a common ancestor; and Van der Walt et al. (2001) characterized and compared the pattern of polymorphism at particular major histocompatiblity complex (MHC) loci between bontebok and blesbok, to assess the impact of population bottlenecks on bontebok genetic diversity. It was found that, compared to blesbok, bontebok suffered erosion of genetic (allelic) diversity, likely resulting from two severe bottleneck events caused by hunting pressure and parasitic infection. Van der Walt et al. (2001) recommended that the residual genetic variation unique to the bontebok be maintained through managed breeding and translocations between reserves so that alleles are not lost through genetic drift over time. They further suggested that MHC screening be used to monitor the genetic purity of both bontebok and blesbok populations.

Another red-listed species, Cape mountain zebra (CMZ) (*Equus zebra zebra*), was introduced into BNP in 1986. The species' status is Endangered according to international assessments (IUCN 2004), whereas it is indicated as Vulnerable according to a South African assessment (Friedmann & Daly 2004). In recent years, the population at BNP suffered tumour like growths, similar to equine sarcoids (Marais et al. 2007). Virological analysis of tumour material confirmed the presence of bovine papillomavirus (BPV 1 & 2) (Sasidharan 2006). Sasidharan (2005) compared the genetics of different populations to establish whether there is a genetic predisposition for these BPV-induced tumours, as is suspected in domestic horses. Compared to Hartmann's zebra (*Equus zebra hartmannae)*, CMZ populations had low levels of genetic diversity and polymorphism, and among the CMZ populations tested, sarcoid tumour has been expressed in populations with the highest levels of consanguinity / inbreeding. However, sarcoid tumour is a disease considered to have multiple causes, and other parameters, e.g. immune status and associated environmental variables, warrant investigation (Sasidharan 2005, 2006). In 2002, the prevalence of sarcoids in CMZ at BNP (53 % of population) was significantly higher than that at Gariep Nature Reserve (24.7 %), a control population of Burchell's Zebra at Kruger National Park (1.9 %), and domestic horses (0.5 - 2.0 %)(Marais et al. 2007). In CMZ, lesions most often occur on the ventral abdomen, head and neck, and limbs (in decreasing order of predilection)(Marais et al. 2007). There is evidence from BNP that sarcoid affected zebras have higher tick burdens than non-affected zebras (Sasidharan 2005, 2006). The establishment of a genetic database, incorporating information from genetic markers, was recommended to assist in the conservation management of isolated CMZ populations by providing the information necessary to increase allelic diversity (Sasidharan 2005).

Being so pertinent to the park, the management of rare animals has also been dealt with under various other headings (see 5.1.1, 5.2.1, 5.4.2, etc.). Bigalke's (1948, 1955) papers on the type locality, history and preservation of the bontebok are particularly relevant.

5.3 Resource utilization

5.3.1 Water supply / abstraction

The natural water supply of BNP consists of the perennial Breede River and a few ephemeral wells. In addition, a number of dams and a water reticulation system from the Breede River with associated drinking troughs have been constructed after 1974 (Robinson et al. 1981). Russell (2001) mentions that the park has very little control over the water quantity of the Breede River as a result of upstream water abstraction for agricultural purposes.

5.3.2 Plant harvesting

One of the conditions pertaining to the purchase of Die Stroom from the Swellendam municipality was the continued harvesting of *Protea repens* flower cones by a contractor for two years after the transaction took place (N. Grootendorst, pers. comm. 2003).

5.3.3 Invertebrate collecting (eg. bait)

Not applicable.

5.3.4 Fishing

Russell (2001) suggested that angling and removal of alien fish species be encouraged in the Breede River to temporarily reduce predation and competitive pressure on the endangered indigenous ichthyofauna, whilst preventing the removal of indigenous fish, particularly *Barbus andrewi*, which may be captured by anglers.

5.3.5 Vertebrate harvesting

BNP manages herbivore stocking rates (see 5.1.2) largely by means of harvesting (capturing and translocating) bontebok annually/biennually, informed by census data and assessments of vegetation condition (see 5.1.5).

5.4 Pathogens and diseases

5.4.1 Virology & Bacteriology

Sarcoid tumours frequently occur in the Cape mountain zebra population of BNP and there is strong evidence that the bovine papilloma virus plays an important role in causing equine sarcoids (Martens et al. 2001; Sasidharan 2006). The prevalence of the disease, as well as its distribution on the body, clinical appearance, histopathology, and the correlation between genetic factors and the expression of the disease have been studied at BNP (Sasidharan 2005, 2006; Marais et al. 2007) (see 5.2.4).

5.4.2 Parasitology

This is arguably the topic best studied in BNP and reflects what used to be the park's primary objective, i.e. the survival of the bontebok, having being threatened by parasites throughout the park's history. Barnard and Van der Walt (1961) reports on severe verminosis in bontebok while still kept at Bredasdorp, and that Conical fluke (*Paramphistomum* sp.), Wireworm (*Haemonchus* sp.), Brown stomachworm (*Ostertagia*) and Bankruptworm (*Trichostrongylus* sp.) were found in great numbers (*cf.* Zumpt & Heine 1978). Attention was further drawn to weakness and signs of ataxia in several animals in spite of them appearing to be in reasonable condition (Barnard & Van der Walt 1961).

A series of studies was done by the Onderstepoort Veterinary Research Institute, identifying the parasites (Helminths, Arthropods, Nematodes, Ixodid ticks) of mainly bontebok, blesbok and grey rhebuck in BNP at the Swellendam location (Ortlepp 1962; Verster et al. 1975; Boomker et al. 1981, 1983; Boomker 1990; Horak et al. 1982a, 1982b, 1986, 1997; Horak & Sheppey 1984; Boomker & Horak 1992; Horak & Boomker 1998). More than 35 % of scrub hares, grey rhebuck and bontebok were infested with immature ticks (Horak et al. 1987). A ten-year study of Ixodid tick infestations in the park showed that bontebok harboured eight species and grey rhebuck six species, none of which were alien species, despite translocations having occurred in the period and the presence of alien species outside the park (Horak et al. 1997). Seven species of lice were recovered from guinea fowls, the prevalence of infestations on the birds ranging from 99.2–100 %, and the numbers of lice per individual bird between 0 and 3619 (Louw et al. 1993). Another study established that first stage larvae of a fly species (a large *Gedoelstia* sp.) found in the nasal sinuses of bontebok can cause severe ocular lesions in the eyes of abnormal hosts, such as grey rhebuck (Horak et al. 1982). Zweygarth et al. (2002) established that some Cape mountain zebra at BNP were carriers of *Theileria equi*, and some tested seropositive for *Babesia caballi.*

5.5 Environmental modification

Environmental modification that took place prior to the proclamation of BNP is described under 4.3. Bank erosion along the Breede River within the picnic area of the park has been evident since the early 1980s.

5.6 Zonation

The Protected Areas Act requires SANParks to adopt a coherent spatial planning system in all national parks. The overall strategic spatial plan for a national park is what SANParks call a Conservation Development Framework (CDF), which is based on a standardised SANParks zoning scheme and is informed by a biophysical sensitivity-value analysis. A draft CDF has recently been produced for BNP.

5.7 Park expansion

BNP, being an island in a sea of agriculture, virtually has no opportunities for expansion (Ronbinson et al. 1981). However, securing the visual integrity of the park along the western bank of the Breede River (whether through acquisition or contractual agreement) should be regarded as a high priority (H. Langley pers. comm. 2003). What is furthermore probably the only remaining piece of natural vegetation bordering the park (in the northeast) should also be considered for acquisition. The acquisition of farmland (wheat fields)

adjacent to the park has also been suggested in the past to reduce both the grazing pressure and burning frequency on the natural vegetation.

5.8 Social ecology (people and tourism aspect)

5.8.1 Opinion surveys

6. REFERENCES / BIBLIOGRAPHY

Note: All the references in this list are not necessarily cited in the text or associated table.

Legend:
p = Popular literature
u = Unpublished literature
s = Specific to BNP
r = Relevant but not specific to BNP

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7. APPENDICES

7.1 Species list – Plants

See Kraaij (2011)

7.2 Species list – Invertebrates

7.2.1 Aquatic Invertebrates – Benthic invertebrates sampled during 1975/76 at the national road bridge across the Breede River at Swellendam (Coetzer 1986):

FAMILY	Group	Species	Functional Feeding Group*
COELENTERATA		*Hydra* sp.	Pr
TURBELLARIA		Unidentified sp.	Pr
ANNELIDA		Unidentified sp.	Cg
OSTRACODA		*Cypridopsis* sp.	Cf
PLECOPTERA		Unidentified sp.	Sh, Sc
EPHEMEROPTERA	Baetidae	*Baetis harrisoni*	Cg, Sc
		Centroptilum medium	
		Pseudocloeon maculosum	
	Caenidae	Unidentified sp.	Cg
	Tricorythidae	*Neurocaenis discolor*	Cf
ODONATA		*Aeschna/Sympetrum sp.*	Pr
HEMIPTERA		Unidentified sp.	Pr
TRICHOPTERA		*Cheumatopsyche afra*	Cf
		Cheumatopsyche thomasseti	
		Macronema capense	
		Hydroptila sp.	Sc, Pr
		Orthotrichia sp.	Cg, Pr
		Ecnomus sp.	Cg
COLEOPTERA	Dryopidae	Unidentified sp.	Sh, Sc
DIPTERA	Chironomini	Unidentified sp.	Cg
	Tanytarsini	Unidentified sp.	Cf, Cg
	Orthocladiinae	Unidentified sp.	Cg, Sc
	Tanypodinae	Unidentified sp.	Pr
	Simuliidae	Unidentified sp.	Cf
	Other	Unidentified sp.	
PELECYPODA		Unidentified sp.	Cg
GASTROPODA	Ancylidae	Unidentified sp.	Sh
	Other	Unidentified sp.	

***** Cf = collector-filterer
Cg = collector-gatherer
Pr = predator/piercer
Sc = scraper
Sh = shredder

7.3 Species list – Fish

After Russell (2001):

Indigenous species:
Barbus andrewi (freshwater) (Vulnerable)
Anguilla mossambica (catodromous)
Myxus capensis (catodromous) (Rare)
Gilchristella aestuaria (estuarine)
Monodactylus falciformis (estuarine)
Mugil cephalus (estuarine)

Indigenous species with potential to occur in BNP:
Sandelia capensis (National Parks Board 43rd Annual Report 1968/69, p. 111)
Pseudobarbus burchelli

Species translocated from other South African rivers:
Tilapia sparrmanii
Clarias gariepinus

Alien species:
Tinca tinca
Lepomis macrochirus
Micropterus salmoides
Micropterus dolomieu

Additional species recorded by Braack (1981):
Anguilla nebulosa
Cyprinus carpio (alien)
Salmo trutta (alien)

One specimen of *Anguilla marmorata* ("bontpaling") was caught in 1970/71 according to the 45th Annual Report of the National Parks Board (1970/71).

7.4 Species list – Amphibians

After Braack (1981):

Breede River:

Xenopus l. laevis	Common Platanna
Bufo rangeri	Raucous Toad
Rana fuscigula	Cape Rana
Rana g. grayi	Spotted Rana

Permanent & semi-permanent dams and pools:

Xenopus l. laevis	Common Platanna
Bufo rangeri	Raucous Toad
Rana fuscigula	Cape Rana
Rana g. grayi	Spotted Rana
Rana f. fasciata	Smith's Striped or Long-toed Rana
Cacosternum boettgeri	Common Dainty Frog
Kassina wealei	Long-toed Running or Vlei Frog

Flooded veld:

Xenopus l. laevis	Common Platanna
Bufo angusticeps	Cape or Sand Toad
Tomopterna d. delalandei	Striped Pyxie
Rana fuscigula	Cape Rana
Rana g. grayi	Spotted Rana
Cacosternum boettgeri	Common Dainty Frog
Cacosternum n. nanun	Coastal Dainty Frog

Sandveld along Breede River:

? *Breviceps* sp.

7.5 Species list – Reptiles

After Braack (1981):

Order Sauria (Lacertilia):

Pachydactylus geitjie	Ocellate or Eyed Gecko
Agama atra	South African Rock Agama
Mabuya capensis	Cape Three-striped Skink
Acontias m. meleagris	Golden Sand Skink
Tetradactylus t. tetradactylus	Whip Lizard
Eremias lineo-ocellata	Ocellated Sand Lizard

Order Serpentes (Ophidia):

Typhlops lalandii	Delalande's Blind-snake
Leptotyphlops nigricans	Black Worm-snake
Lycodonomorphus r. rufulus	Olive-brown Water-snake
Lamprophis inornatus	Olive-brown House-snake
Prosymna s. sundevallii	Southern Shovel-snout
Duberria l. lutrix	Southern Slug-eater
Dasypeltis s. scabra	African Egg-eating Snake
Crotaphopeltis h. hotamboeia	Herald Snake
Amplorhinus multimaculatus	Cape Reed-snake
Dispholidus typus	Green Tree-snake; Boomslang
Psammophylax rhombeatus	Rhombic Skaapsteker
Psammophis notostictus	Dapple-backed Sand-snake
Psammophis crucifer	Corss-marked Grass-snake
Elaps lacteus	Southern Dwarf Garter-snake
Hemachatus haemachatus	South African Spitting Cobra; Rinkhals
Naja nivea	Cape Cobra
Causus rhombeatus	Common Night-adder
Bitis a. arietans	African Puff-adder

Order Testudines (Chelonia):

Geochelone pardalis babcocki	Leopard Tortoise
Chersina agulata	Angulate Tortoise
Homopus areolatus	Parrot-beaked Tortoise; Padloper
Pelomedusa subrufa	Cape Terrapin

7.6 Species list – Birds

After Baron (1981):

6	*Tachybaptus ruficollis*	Dabchick
47	*Phalacrocorax carbo*	White-breasted cormorant
50	*Phalacrocorax africanus*	Reed cormorant
52	*Anhinga rufa*	Darter
54	*Ardea cinerea*	Grey heron
55	*Ardea melanocephala*	Black-headed heron
57	*Ardea purpurea*	Purple heron
58	*Casmerodius albas*	Great white egret
60	*Egretta intermedia*	Yellow-billed egret
61	*Bubulcus ibis*	Cattle egret
72	*Scopus umbretta*	Hamerkop
79	*Ciconia nigra*	Black stork
80	*Ciconia ciconia*	White stork
81	*Threskiornis aethiopicus*	Sacred ibis
84	*Hagedashia hagedash*	Hadeda
85	*Platalea alba*	African spoonbill
88	*Plectropterus gambensis*	Spurwinged goose
89	*Alopochen aegyptiacus*	Egyptian goose
90	*Tadorna cana*	South African Shelduck
94	*Anas smithii*	Cape shoveler
95	*Anas sparsa*	Black duck
96	*Anas undulata*	Yellow-billed duck
97	*Anas erythrorhyncha*	Red-billed teal
98	*Anas capensis*	Cape teal
102	*Netta erythrophthalma*	Red-eyed pochard
105	*Sagittarius serpentarius*	Secretary bird
106	*Gyps coprotheres*	Cape vulture
114	*Falco biarmicus*	Lanner
115	*Faco subbuteo*	Hobby
119	*Falco amurensis*	Eastern redfooted kestrel (Whittington 2001)
123	*Falco tinnunculus*	Rock kestrel
125	*Falco naumanni*	Lesser kestrel
129	*Milvus aegypticus*	Yellow-billed kite
130	*Elanus caeruleus*	Black-shouldered kite
142	*Polemaetus bellicosus*	Marial eagle
149	*Haliaeetus vocifer*	Fish eagle
152	*Buteo rufofuscus*	Jackal buzzard
154	*Buteo buteo*	Buzzard
156	*Accipiter rufiventris*	Red-breated sparrow hawk
160	*Accipiter tachiro*	African goshawk
165	*Melierax canorus*	Pale chanting goshawk (Staegmann 2003)
167	*Circus ranivorus*	African marsh harrier
168	*Circus macrourus*	Pallid harrier
169	*Circus maurus*	Black harrier
176	*Francolinus africanus*	Grey-wing francolin
181	*Francolinus capensis*	Cape francolin
189	*Coturnix coturnix*	African quail
192	*Numida meleagris*	Crowned guinea-fowl
194	*Turnix hottentotta*	Hottentot button-quail
210	*Gallinula chloropus*	Moorhen
212	*Fulica cristata*	Red-knobbed coot
216	*Anthropoides paradisea*	Blue crane
219	*Otis denhami*	Stanley bustard
225	*Eupodotis afra*	Black korhaan
233	*Charadrius hiaticula*	Ringed plover
237	*Charadrius pecuarius*	Kittlitz's sandplover
238	*Charadrius tricollaris*	Three-banded sandplover
242	*Stephanibyx coronatus*	Crowned plover
245	*Hoplopterus armatus*	Blacksmith plover
250	*Gallinago nigripennis*	Ethiopian snipe
258	*Tringa hypoleucos*	Common sandpiper
259	*Tringa ochropus*	Green sandpiper
262	*Tringa stagnatilis*	Marsh sandpiper
263	*Tringa nebularia*	Greenshank
270	*Himantopus himantopus*	Stilt
274	*Burhinus vermiculatus*	Water dikkop
275	*Burhinus capensis*	Dikkop
276	*Cursorius rufus*	Burchell's courser
287	*Larus dominicanus*	Southern black-backed gull
304	*Chlidonias leucoptera*	White-winged black tern
307	*Pterocles namaqua*	Namaqua sandgrouse
311	*Columba guinea*	Rock pigeon
312	*Columba arquatrix*	Rameron pigeon
314	*Streptopelia semitorquata*	Red-eyed turtle dove
316	*Streptopelia capicola*	Cape turtle dove
317	*Stigmatopelia senegalensis*	Laughing dove
318	*Oena capensis*	Namaqua dove
321	*Turtur chalcospilos*	Emerald-spotted wood dove
322	*Aplopelia larvata*	Cinnamon dove
343	*Cuculus solitarius*	Red-chested cuckoo
351	*Chrysococcyx klaas*	Klaas duckoo
352	*Chrysococcyx caprius*	Diederik cuckoo
356	*Centropus superciliosus*	White-browned coucal
359	*Tyto alba*	Barn owl
368	*Bubo africanus*	Spotted eagle owl
373	*Caprimulgus pectoralis*	Fiery-necked nightjar
380	*Apus barbatus*	Black swift
383	*Apus caffer*	White-rumped swift
385	*Apus affinis*	Little swift
386	*Apus melba*	Alpine swift
390	*Colius striatus*	Speckled mousebird
391	*Colius colius*	White-backed mousebird
392	*Urocolius indicus*	Red-faced mousebird
394	*Ceryle rudis*	Pied kingfisher
395	*Megaceryle maxima*	Giant kingfisher
396	*Alcedo semitorquata*	Half-collared kingfisher
397	*Corythornis cristata*	Malachite kingfisher
402	*Halcyon albiventris*	Brown-hooded kingfisher
404	*Merops apiaster*	European bee-eater
412	*Coracias garrulus*	European roller
418	*Upupa africana*	African hoopoe
432	*Tricholaema leucomelas*	Pied barbet
440	*Indicator indicator*	Greater honeyguide
442	*Indicator minor*	Lesser honeyguide
445	*Geocolaptes olivacues*	Ground woodpecker

450	*Dendropicos fuscescens*	Cardinal woodpecker
463	*Calendula magnirostris*	Thickbilled lark
466	*Mirafra apiata*	Clapper lark
475	*Certhilauda curvirostris*	Long-billed lark
488	*Calandrella cinerea*	Red-capped lark
493	*Hirundo rustica*	European swallow
495	*Hirundo albigularis*	White-throated swallow
498	*Hirundo dimidiata*	Pearl-breasted swallow
502	*Cecropis cucullata*	Greater striped swallow
506	*Ptynoprogne fuligula*	Rock martin
509	*Riparia paludicola*	African sand martin
510	*Riparia cincta*	Banded sand martin
511	*Psalidoprocne holomelaena*	Black saw-wing swallow
517	*Dicrurus adsimilis*	Fork-tailed drongo
522	*Corvus albus*	Pied crow
523	*Corvus capensis*	Black crow
524	*Corvultur albicollis*	White-necked raven
525	*Parus afer*	Grey tit
543	*Pycnonotus capensis*	Cape bulbul
551	*Andropadus importunus*	Sombre bulbul
553	*Turdus olivaceus*	Olive thrush
560	*Monticola explorator*	Sentinel rock-thrush
570	*Cercomela familiaris*	Familiar chat
572	*Cercomela sinuata*	Sickle-wing chat
576	*Saxicola torquata*	Stone chat
581	*Cossypha caffra*	Cape robin
583	*Erythropygia coryphaeus*	Karoo scrub robin
599	*Phylloscopus trochilus*	Willow warbler
600	*Eremomela icteropygialis*	Yellow-bellied eremomela
604	*Calamocichla gracilirostris*	Cape reed warbler
606	*Acrocephalus baeticatus*	African marsh warbler
609	*Bradypterus baboecalus*	African sedge warbler
618	*Sphenoeacus afer*	Grassbird
621	*Sylvietta rufescens*	Cormbec
622	*Apalis thoracica*	Bar-throated apalis
631	*Cisticola textrix*	Cloud cisticola
637	*Cisticola fulvicapilla*	Neddicky
638	*Cisticola subruficapilla*	Grey-backed cisticola
646	*Cisticola tinniens*	Le Vaillant's cisticola
651	*Prinia maculosa*	Karoo prinia
654	*Muscicapa striata*	Spotted flycatcher
655	*Muscicapa adusta*	Dusky flycatcher
658	*Parisoma subcaeruleum*	Tit babbler
665	*Sigelus silens*	Fiscal flycatcher
672	*Batis capensis*	Cape batis
678	*Stenostira scita*	Fairy flycatcher
682	*Terpsiphone viridis*	Paradise flycatcher
685	*Motacilla aguimp*	African pied wagtail
686	*Motacilla capensis*	Cape wagtail
692	*Anthus novaeseelandiae*	Richard's pipit
694	*Anthus leucophrys*	Plain-backed pipit
703	*Macronyx capensis*	Orange-throated longclaw
707	*Lanius collaris*	Fiscal flycatcher
709	*Laniarius ferrugineus*	Boubou
713	*Tchagra tchagra*	Tchagra
722	*Telophorus zeylonus*	Bokmakierie
733	*Sturnus vulgaris*	European starling
735	*Creatophora cinerea*	Wattled starling
745	*Onychognathus morio*	Red-winged starling
746	*Spreo bicolor*	Pied starling
749	*Promerops cafer*	Cape sugarbird
751	*Nectarinia famosa*	Malachite sunbird
753	*Anthobaphes violacea*	Orange-breasted sunbird
758	*Cinnyris afer*	Greater double-collared sunbird
760	*Cinnyris chalybeus*	Lesser double-collared sunbird
775	*Zosterops virens capensis**	Cape white-eye
784	*Passer domesticus*	House sparrow
786	*Passer melanurus*	Cape sparrow
787	*Passer diffusus*	Greyheaded sparrow (Whittington 2001; Ward et al. 2004)
799	*Ploceus capensis*	Cape weaver
803	*Ploceus velatus*	Masked weaver
808	*Euplectes orix*	Red bishop
810	*Euplectes capensis*	Cape widow
825	*Coccopygia melanotis*	Swee waxbill
843	*Estrilda astrild*	Common waxbill
844	*Ortygospiza fuscocrissa*	Quail finch
846	*Vidua macroura*	Pin-tailed whydah
857	*Serinus canicollis*	Cape canary
863	*Crithagra sulphurata*	Bully seed eater
865	*Crithagra albogularis*	White-throated seed-eater
866	*Crithagra flaviventris*	Yellow canary
867	*Poliospiza gularis*	Streaky-headed seed-eater
871	*Fringillaria impetuani*	Lark-like bunting
873	*Fringillaria capensis*	Cape bunting

The following species require confirmation:

436	*(Pogoniulus pusillus)*	Red-fronted tinker barbet
458	*(Mirafra africana)*	Rufus-naped lark
461	*(Certhilauda albescens)*	Karoo lark
474	*(Certhilauda albofasciata)*	Spike-heeled lark
531	*(Anthoscopus minutus)*	Cape penduline tit

The following species constitutes an addition to the list:
([1]sampled by J. Fuchs):

Crithagra sulphuratus[1]	Brimstone canary

* Previous name was *Zosterops pallidus*

7.7 Species list – Mammals

After Stuart & Braack (1978):

Order INSECTIVORA	
Myosorex varius (Smuts, 1832)	Forest shrew
Crocidura cyanea (Duvernoy, 1838)	Reddish-grey musk shrew
Chrysochloris asiatica (Linnaeus, 1758)	Cape golden mole
Order CHIROPTERA	
Eptessicus capensis (A. Smith, 1829)	Cape serotine
Order CARNIVORA	
Vulpes chama (A. Smith, 1833)	Silver fox
Ictonyx striatus (Perry, 1810)	Striped polecat
Aonyx capensis (Schinz, 1821)	Cape clawless otter
Genetta genetta (Linnaeus, 1758)	Small-spotted genet
Herpestes ichneumon (Linnaeus, 1758)	Cape ichneumon
Herpestes pulverulentus (Wagner, 1839)	Cape grey mongoose
Atilax paludinosus (G. Cuvier, 1777)	Marsh mongoose
Cynictis penicillata (G. Cuvier, 1829)	Yellow mongoose
Proteles cristatus (Sparrman, 1783)	Aardwolf
Felis libyca (Forster, 1780)	Cape wild cat
Felis caracal (Schreber, 1776)	Caracal
Canis mesomelas (Schreber, 1778)	Black-backed jackal
Otocyon megalotis (Desmarest, 1822)	Bat-eared fox (Source: Park records)
Mellivora capensis (Schreber, 1776)	Honey badger (IA Russell pers. obs.)
Order HYRACOIDEA	
Procavia capensis (Pallas, 1766)	Cape dassie
Order ARTIODACTYLA	
Sylvicarpa grimmia (Linnaeus, 1758)	Grey duiker
Raphicerus campestris (Thunberg, 1811)	Steenbok
Raphicerus melanotis (Thunberg, 1811)	Cape grysbok
Pelea capreolus (Forster, 1790)	Grey ribbok
Antidorcas marsupialis (Zimmermann, 1780)	Springbok
Damaliscus dorcas dorcas (Pallas, 1776)	Bontebok
Order PERISSODACTYLA	
Equus zebra zebra (Linnaeus, 1758)	Cape mountain zebra
Order LAGOMORPHA	
Lepus saxatilis (F. Cuvier, 1823)	Scrub hare
Order RODENTIA	
Cryptomys hottentotus (Lesson, 1826)	Common mole-rat
Hystrix africaeaustralis (Peters, 1852)	Cape porcupine
Saccostomus campestris (Peters, 1846)	Pouched mouse
Aethomys namaquensis (A. Smith, 1834)	Namaqua rock rat
Praomys verreauxi (A. Smith, 1834)	Cape mouse
Rattus rattus (Linnaeus, 1758)	Black rat
Rhabdomys pumilio (Sparrman, 1784)	Striped mouse
Mus minutoides (A. Smith, 1834)	Dwarf mouse
Mus musculus (Linnaeus, 1758)	House mouse
Dendromus melanotis (A. Smith, 1834)	Grass climbing mouse
Otomys irroratus (Brants, 1827)	Vlei rat
Tatera afra (Gray, 1830)	Cape gerbil

8. SUMMARY OF AVAILABLE INFORMATION

The summary of available information can be downloaded as an independent file from www.sanparks.org.

9. MAPS

The following maps can be downloaded as independent files from www.sanparks.org:

9.1 Map: Area

9.2 Map: Geology

9.3 Map: Hydrology

9.4 Map: Soils and Landtypes

9.5 Map: Vegetation