Plant species of the Naute Game Park – an annotated inventory

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Abstract
This paper presents an inventory of plants of the Naute Game Park, based on field surveys and information from databases. The park extends over two quarter degree squares and 159 terrestrial plant species have to date been recorded. Deciduous dwarf shrubs comprise the majority of the flora. The rare, small tree Elephantorrhiza rangei and populations of quiver tree (Aloe dichotoma), Nama corkwood (Commiphora namaensis), Nama resin-tree (Ozoroa namaensis) and black-winged twin-leaf (Zygophyllum cretaceum) are of conservation importance on the inselbergs. Also of conservation importance are the Namibian endemics Euphorbia lignosa, Geigeria brachycephala, Indigofera pechuelii, Phyllanthus dinteri, Salsola arborea and kinkelbos (Tetragonia schenki) as well as unidentified dwarf stem-succulent Apocynaceae (Stapeliod) and Hoodia species. Invasive alien mesquite (Prosopis) trees may locally pose a threat to indigenous plants. More stringent track control in the recreational part of the park would limit the disturbance of natural habitat.

Keywords: Conservation, Karas, Löwen River, natural resources, Naute dam, new discoveries

Introduction
The Naute Game Park adjoins the Naute Dam, some 50 km south-west of Keetmanshoop. The dam was built on the Löwen River and has been in operation since 1972 while the park was proclaimed in 1988. The area around the dam is open to the public for recreational purposes (angling, boating, camping), but the majority of the game park adjoining the recreation areas to the east and south is not accessible to the public. Here populations of gemsbok, springbok and smaller antelope such as steenbok and duiker roam the grassy plains. To date no inventory of plants has been compiled and this paper addresses this gap. This information can be used by conservation staff in this area to manage the plant resources.

Methods
Study area
The park initially covered 235 km² and is located in the Karas Region in southern Namibia. Recently the farm Ghoggab to the northeast has been added, increasing the total park area to 345 km². Four main landscape units can be distinguished: the Naute and Gawachab plains, the Löwen River and inselbergs (Figure 1).

The climate is arid with the mean annual rainfall ranging between 100 and 150 mm, increasing along a south-west to north-east gradient. Rains fall mainly in the summer months (January-April). Mean annual temperatures range between 18 and 22°C increasing along a west-east gradient (Mendelsohn et al. 2002).

The majority of the park is level to gently southwest sloping plain, with a few isolated mountains (inselbergs) in the northwest section adding some relief (Figure 2). These inselbergs rise not much more than 100 m above the surrounding plains. The Löwen River...
crosses the central area of the park, generally in a northeast to south-westerly direction. The river is ephemeral and usually flows during the rainy season for short periods, depending on rainfall in the upper catchment.

Figure 1. Landscape units and position of the Naute Game Park in Namibia (adapted from Burke 2013).

Karoo Group sedimentary rocks, largely shale and sandstone, underlie most of the park area, with the exception of a west-east running dolerite ridge (also of Karoo Group origin) providing the southern boundary of the dam. All these rocks are 300 to 180 million years of age (Swart 2008). Much younger Quaternary sand deposits cover some areas and form small patches of dunes between the inselbergs.

The vegetation is Karas dwarf shrubland (Burke et al. 2002), dissected by denser shrubland, and localised woodland along the Löwen River (Figure 3). The area falls within the Nama Karoo Biome (Rutherford 1997).
Figure 2. The Naute plains (view towards the Klein Karas Mountains to the southeast) are dissected by a dense network of shallow washes draining towards the Löwen River (recognised by a broad band of denser vegetation). The area to the left of the fence is the recent addition to the park.

Figure 3. Not only dwarf shrubs, but occasional trees, such as this fig (*Ficus cordata*) grow on the Naute inselbergs.

**Compilation of the plant species list and plant attributes**
The current list of terrestrial plant species was compiled following a field survey during April 2013; distribution records from the Specimens Database of Namibia’s National Botanical Research Institute (NBRI) and the tree atlas (Curtis & Mannheimer 2005) (quarter degree squares 2618CC and 2617DD). This excludes species still awaiting identification by specialists. Voucher specimens from field surveys were lodged at the NBRI. The nomenclature follows Klaassen & Kwembeya (2013). Grazing and browse value of individual species was reviewed in published literature (van Breda & Barnard 1991; Esler et al. 2006).
The conservation status of plants was reviewed using Namibia’s red-list (Loots 2005 and recent updates), Cites (Convention on International Trade of Endangered Species) status, as well as protection by national legislation (Nature Conservation Ordinance No. 4 of 1975 and No. 272 of 1977, Forest Ordinance No. 37 of 1952 and Forest Act No. 72 of 1968).

Results and Discussion

The current species list comprises 159 terrestrial plant species, including introduced, non-indigenous species (Appendix 1). Although the list is a good approximation, it is not complete. Aquatic plants are not represented and few semi-aquatic plants were collected so far. Also, no surveys were undertaken during an exceptionally good rainy season which is likely to add more plant species.

The majority of plants in the park are deciduous shrubs, followed by herbs, grasses and then evergreen shrubs (Table 1). Only ten geophytes have so far been recorded and this group is likely underrepresented. The low portion of leaf- and stem-succulent is expected, as the park is well beyond the boundaries of the Succulent Karoo Biome, where these growth forms are more prevalent.

Table 1. Growth forms and palatability of plant species in the Naute Game Park.

<table>
<thead>
<tr>
<th>Palatability</th>
<th>Number of species</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>15</td>
<td>Berkheya spinosissima, Limeum aethiopicum, Polygala leptophylla, Montinia caryophyllacea, Salsoila aphylla</td>
</tr>
<tr>
<td>Low</td>
<td>21</td>
<td>Aristida adscensionis, Cyperus marginatus, Enneapogon scaber, Kleinia longiflora, Rhigozum trichotomum, Tamarix usneoides, Tribulus terrestris</td>
</tr>
<tr>
<td>Toxic</td>
<td>3</td>
<td>Datura inoxia, Geigeria alata, Geigeria pectidea</td>
</tr>
</tbody>
</table>

Growth forms

- Dwarf stem-succulents: 3 Euphorbia lignosa
- Evergreen shrubs: 17 Calicorema capitata
- Grasses: 21 Aristida adscensionis, Stipagrostis uniplumis
- Geophytes: 10 Eriospermum rautanenii
- Herbs: 32 Cleome suffrutcosa, Tribulus cristatus
- Leaf-succulents: 6 Zygophyllum rigidum
- Shrubs: 51 Grewia tenax, Rhus burchellii
- Stem-succulents: 4 Aloe dichotoma
- Trees: 15 Acacia erioloba, A. karroo, A. mellifera, Boscia albitrunca

Published information on grazing and browse value was retrievable for 39 species. Fifteen species are highly palatable which includes the trees Acacia karroo and Pappea capensis, the evergreen shrub Cadaba aphylla, and many shrubs (Monechma incanum, M. spartioides, Nymania capensis), and grasses (e.g. Cenchrus ciliaris, Centropodia glauca, Phragmites australis and Stipagrostis ciliata) – the remaining highly palatable species are listed in Table 1.

Two invasive alien plants were recorded, one of which (Datura inoxia) is toxic. Pods of the invasive mesquite tree (Prosopis glandulosa), although the tree is overall classified of low browse value, are believed to provide nutritious fodder for livestock. More intensive surveys may add more arid land invasive plants such as Argemone ochroleuca, other Datura species, Nicotiana glauca and Ricinus communis.

One Oxalis species is still awaiting identification by specialists and it may be a new species (Dreyer pers.comm.) (Figure 4). Another plant of interest is the tree Elephantorrhiza rangei which is only known from the Naute dam and immediate surroundings, thus one of the rarest plants in Namibia.
Of conservation importance are populations of *Aloe dichotoma*, *Commiphora namaensis*, *Ozoroa namaensis* and *Zygophyllum cretaceum* on the inselbergs – the latter three are Gariep endemics – and the Namibian endemics *Euphorbia lignosa*, *Geigeria brachycephala*, *Indigofera pechuelii*, *Phyllanthus dinteri*, *Salsola arborea* and *Tetragonia schenkii*. Unidentified Stapeliod (dwarf stem-succulent Apocynaceae) and *Hoodia* species occurring in the park are protected species. These were unfortunately only present in vegetative state and could thus not be identified. *Geigeria brachycephala* is only known from five quarter degree squares and thus considered a restricted-range species which deserves attention. On the red data list are *Elephantorrhiza rangei*, classified as “endangered”, *Ozoroa namaensis* as “rare” and *Zygophyllum cretaceum* as “near-threatened (Loots 2005).

**Implications for research and management**

1. The plant species list needs more additions, and plant collecting during a good season should be undertaken;
2. Mesquite (*Prosopis* sp.) invasions around the dam and habitations require some control. Although valuable shade trees in some places, these should be replaced with indigenous trees, and then eradicated. These measures are particularly important near the inselbergs and rocky outcrop areas where plants of conservation importance may be affected by the *Prosopis* trees’ invasions;
3. The extremely rare *Elephantorrhiza rangei* deserves particular protection to avoid inadvertent damage;
4. A lot more habitat than necessary is disturbed in the recreational part of the park around the dam. Clear demarcation of tracks and picnic areas and enforcing track discipline would help to minimise these disturbances.
Acknowledgements: This work would not have been possible without the help of Ministry of Environment and Tourism and National Botanical Research Institute’s staff. My hearty thanks go to many staff at these institutions who worked behind the scenes issuing permits, extracting data (thanks to the NBRI for the use of data from the Specimens Database) and processing and identifying specimens. Funding from Nam-place covered the fieldwork. Jonas Heita encouraged biodiversity zonation work in the Greater Fish River Landscape and Max Witbooi assisted in the field. Many thanks to all.

References


## Appendix 1. Plant species of the Naute Game Park and their growth forms.

<table>
<thead>
<tr>
<th>Plant species</th>
<th>Growth form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia erioloba E.Meyer</td>
<td>tree</td>
</tr>
<tr>
<td>Acacia karroo Hayne</td>
<td>tree</td>
</tr>
<tr>
<td>Acacia mellifera (Vahl) Benth. subsp. detinens (Burch.) Brenan</td>
<td>tree</td>
</tr>
<tr>
<td>Adenolobus garipensis (E.Mey.) Torre &amp; Hillc.</td>
<td>shrub</td>
</tr>
<tr>
<td>Albuca sp.</td>
<td>geophyte</td>
</tr>
<tr>
<td>Aloe dichotoma Masson</td>
<td>stem-succulent</td>
</tr>
<tr>
<td>Aiptosimum spinosenscens (Thunb.) Weber</td>
<td>geophyte</td>
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<tr>
<td>Aristida ascensionis L.</td>
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<tr>
<td>Asparagus denudatus (Kunth.) Baker</td>
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</tr>
<tr>
<td>Asparagus suaveolens Burch.</td>
<td>geophyte</td>
</tr>
<tr>
<td>Augea capensis Thunb.</td>
<td>leaf-succulent</td>
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<tr>
<td>Barleria papillosa T.Anderson</td>
<td>shrub</td>
</tr>
<tr>
<td>Barleria rigida Nees</td>
<td>shrub</td>
</tr>
<tr>
<td>Bergia anagalloides E.Mey. ex Fenzl</td>
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</tr>
<tr>
<td>Berkhaya spinosissima (Thunb.) Wild. subsp. spinosissima</td>
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<td>Blepharis grossa (Nees) T.Anderson</td>
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<td>Blepharis obmitrata C.B. Clarke</td>
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<tr>
<td>Boscia albitrunca (Burch.) Gilg &amp; Gilg-Ben.</td>
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<tr>
<td>Boscia foetida Schinz subsp. Foetida</td>
<td>evergreen</td>
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<tr>
<td>Cadaba aphylla (Thunb.) Wild</td>
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<td>Calicorema capitata (Moq.) Hook.f.</td>
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<td>Catophractes alexandr D.Don</td>
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<td>Cenchrus ciliaris L.</td>
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<td>Centropodia glauca (Nees) Cope</td>
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<td>Chascanum garipense E.Mey.</td>
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<td>Cleome angustifolia Forsk. subsp. diandra (Burch.) Kers</td>
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<td>Cleome suffruticosa Schinz</td>
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<td>Coccinea rehmannii Cogn.</td>
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<td>Commiphora namaensis Schinz</td>
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<td>Commiphora pyracanthoides Engl.</td>
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<td>Corbichonia rubriviolacea (Friedrich) Jeffrey</td>
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<td>Cryptolepis decidua (Planch. ex Hook.f. &amp; Benth.) N.E. Br.</td>
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<tr>
<td>Cucumella cinerea (Cogn.) C.Jeffrey</td>
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<tr>
<td>Cynodon dactylon (L.) Pers.</td>
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<tr>
<td>Cyperus esculentus L. var. esculentus</td>
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<td>Cyperus longus L. var. longus</td>
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<td>Cyperus marginals Thunb.</td>
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<tr>
<td>Datura inoxia Mill.</td>
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<tr>
<td>Dichanthium annulatum (Forsk.) Stapf var. papillosum (A. Rich) De Wet &amp; Harlan</td>
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<td>Diclis petiolaris Benth.</td>
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<td>Dipoma capensis Less.</td>
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<td>Dicodi cf. crispum Baker</td>
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<tr>
<td>Dipodi sp.</td>
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<tr>
<td>Dyerophytm africanum (Lam.) Kuntze</td>
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<tr>
<td>Elephantorrhiza rangeli Harms</td>
<td>tree</td>
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<tr>
<td>Enneapogon scaber Lehm.</td>
<td>grass</td>
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<tr>
<td>Eriospermum rautanenii Schinz</td>
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<tr>
<td>Eriocephalus sp.</td>
<td>evergreen</td>
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<td>Euclia pseudobenus E.Mey. ex A.DC.</td>
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<td>Euphorbia glanduligera Pax</td>
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<td>Euphorbia gregaria Marloth</td>
<td>stem-succulent</td>
</tr>
<tr>
<td>Euphorbia lignosa Marloth</td>
<td>dwarf stem-succulent</td>
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<tr>
<td>Ficus cordata Thunb. subsp. Cordata</td>
<td>tree</td>
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</table>
Forsskaolea candida L.f. herb
Frankenia pulverulenta L. shrub
Gaillonia crocyllis (Sond.) Thulin shrub
Geigeria alata (DC) Benth. & Hook.f. ex Olivier & Hiern shrub
Geigeria brachycephala Muschli. herb
Geigeria pectidea (D.C.) Harv. herb
Gnaphalium confine Harv. herb
Grewia tenax (Forssk.) Fiori shrub
Gymnosporia senegalensis (Lam.) Loes. evergreen
Heliotropium curassavicum L. herb
Helichrysum zeyheri Less. shrub
Hermannia affinis K. Schum. shrub
Hermannia bicolor Engl. & Dinter shrub
Hermannia fruticulosa K.Schum. shrub
Hermannia gariepina Eckl. & Zeyh. shrub
Hibiscus elliottiae shrub
Hoodia sp. dwarf stem-succulent
Indigastrum argyroides E. Mey. herb
Indigofera auricoma E. Mey. herb
Indigofera pechuellii Kuntze shrub
Jamesbrittenia canescens (Benth.) Hill. var. canescens herb
Juncus rigidus Desf. grass
Kissenia capensis Endl. evergreen
Kleinia longiflora DC. evergreen
Kohautia ramosissima Bremek. shrub
Lebeckia dinteri Harms shrub
Leuchophrys mesocoma (Nees) Rendle grass
Limeum aethiopicum Burm. subsp. namaense Friedrich var. namaense evergreen
Limeum dinteri Schellenb. shrub
Limosella africana Gluck var. africana herb
Lycium amoenum Dammer shrub
Lycium boscifolium Schinz shrub
Lycium villosum Schinz shrub
Maerua schinzii Pax tree
Microloma incanum Decne evergreen
Monechma cleomoides (S. Moore) C.B.Clarke shrub
Monechma genistifolium (Engl.) C.B.Clarke subsp. genistifolium shrub
Monechma incanum (Nees) C.B.Clarke shrub
Monechma mollissimum (Nees) P.G.Mey. shrub
Monechma spartioides (T. Anders.) C.B.Clarke shrub
Monsonia luederitziana Focke & Schinz shrub
Monsonia senegalensis Guill. & Perr. shrub
Montinia caryophyllacea Thunb. shrub
Myxopappus acutilobus (DC.) Kaellersjoe herb
Nolletia gariepina (DC.) Mattf. shrub
Nymania capensis (Thunb.) Lindb. shrub
Otoptera burchellii DC. shrub
Oxalis sp. nov. geophyte
Ozoroa namaensis (Schinz & Dinter) R.Fern. tree
Panicum arbusculum Mez grass
Pappea capensis Eckl. & Zeyh. tree
Parkinsonia africana Sond. tree
Pechuel-Loeschea leubnitziae (Kuntze) O.Hoffm. evergreen
Pegolettia senegalensis Cass. herb
Pelostomum leuorrhizum E. Mey. ex Benth. var. leuorrhizum herb
Pentatrichia petrosa Klatt shrub
Pergularia daemia (Forssk.) Chiov. var. leiocarpa (K.Schum.) H.Huber  evergreen
Petalidium setosum C.B.Clarke ex Schinz  shrub
Phaeoptilum spinosum Radlk.  evergreen
Phragmites australis (Cav.) Steud.  grass
Phyllanthus dinteri Pax  shrub
Phyllanthus pentandrus Schumach. & Thonn.  herb
Polygala leptophylla Burch.  shrub
Polygonum plebeium R.Br.  herb
Potamogeton pectinatus L.  herb
Prospis glandulosa Torr. var. glandulosa  tree
Pteronia acuminata DC.  shrub
Pteronia sp.  shrub
Ptycholobium biflorum (E. Mey.) Brummit subsp. biflorum  shrub
Pulicaria scabra (Thunb.) Druce  herb
Rhigozum trichotomum Burch.  shrub
Rhus burchellii Sond.ex Engl.  evergreen
Rhus lancea L.f.  tree
Rogeria longiflora (Royen) Gay ex DC.  shrub
Salsola aphylla L.f.  evergreen
Salsola arborea C.A.Sm. ex Aellen  evergreen
Salsola sp.  evergreen
Salvia garipensis E.Mey.ex Benth.  shrub
Scirpoideae dioecus (Kunth) J.Browning  grass
Senecio flavus (Decne) Sch.Bip.  herb
Sesamum sp.  herb
Setaria verticillata (L.) Beauv.  grass
Sisymbroto spartea E.Meyer ex Sonder  evergreen
Solanum multiglandulosum Bitter  shrub
Stapeloid  dwarf stem-succulent
Stipagrostis ciliata (Desf.) De Winter var. capensis (Trin. & Rupr.) De Winter  grass
Stipagrostis hochstetteriana var. secalina (Hern.) De Winter  grass
Stipagrostis namaquensis (Nees) De Winter  grass
Stipagrostis uniplumis (Licht.) De Winter var. uniplumis  grass
Talinum caffrum (Thunb.) Eckl. & Zeyh.  geophyte
Tamarix usneoides E. Mey. ex Bunge  tree
Tapinanthus oleifolius (Wendl.) Danser  shrub
Tetragonia schenkii (Schinz) Engl.  leaf-succulent
Thamnosma africana Engl.  shrub
Triglochin cristatus Presl  herb
Triglochin terestriris L.  herb
Tricholaena capensis (Licht. ex Roem. & Schult.) Nees subsp. capensis  grass
Tripteris micropatra Harv. subsp. micropatra  herb
Triphfris ramosissima Hack.  grass
Verbesina enceloides (Cav.) Benth. & Hook. var. enceloides  herb
Wellstedia dinteri Pilg.  shrub
Ziziphus mucronata Willd. subsp. mucronata  tree
Zygophyllum cretaceaum of Zyl  leaf-succulent
Zygophyllum decumbens Delile var. decumbens  leaf-succulent
Zygophyllum microcarpum Licht. ex Cham. & Schltr.  leaf-succulent
Zygophyllum rigidum Schinz  leaf-succulent