# A Review of Fauna and Flora Associated with Coastal and Inland Saline Flats from Namibia with Special Reference to the Etosha Pan

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**Abstract** Coastal saline flats are often frequented by a plethora of migratory birds, mainly waders, and mammals such as the elusive Brown Hyaena (*Hyaena brunnea*) and Black-backed Jackal (*Canis mesomelas*). Inland saline flats, particularly Etosha Pan, which is fringed by broad- and fine-leafed arid savanna woodlands, teem with a variety of game. Greater Flamingo (*Phoenicopterus ruber*) and Lesser Flamingo (*Phoeniconaias minor*) also occasionally breed on the Etosha Pan depending on local rainfall. Only vegetation adapted to halophytic conditions occur in association with saline systems in Namibia. Grasses such as *Sporobolus salsu* and *Sporobolus spicatus* may occasionally occur on the Etosha Pan while the succulent-like perennial herbs such as *Salicornia natalensis* and *Anthrocnemum africanum* may grow in the coastal saline conditions. Although no fauna and flora are exclusively known to be associated with saline flats in Namibia, these habitats are important for wildlife mainly due to the vegetation (i.e. source of food and shelter) surrounding these flats, fountains (i.e. source of water) often associated with these flats and breeding/feeding/resting sites for migrant waders and other birds.

## 1 Introduction

Saline flats are widely distributed throughout Namibia with numerous relatively small flats located between "dune streets" or in open dry woodland areas from the Kalahari Desert, in the east, to coastal saline flats to one of the largest and most well known flats such as the Etosha Pan in the central north of Namibia.

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### 1.1 Etosha Pan

The Etosha Pan is a flat saline depression approximately 120 km long × 55 km wide and covers an area of 6,133 km² at an altitude of 1,100 m (Berry 1972) and one of the most remarkable geomorphological landforms in the world (Buch 1997). The pan is situated in the north of Namibia (Lat. 19°S, Long. 16°E) mostly within the Etosha National Park which covers a total area of 22,270 km² and is the largest protected saline wetland in Africa (Lindeque and Archibald 1991). The Etosha Pan is classified as a wetland of international importance and listed as a Ramsar site (Kolberg).

The Etosha Pan forms part of the Cuvlai drainage system that drains the Sierra Encoco Mountains – some 300 km inside Angola – and eventually ends up in the Etosha Pan under exceptional flood years. The saline wetlands of the Etosha Pan are ephemeral in nature (Berry 1972; Clarke 1998; Lindeque and Archibald 1991; Lowery 2001), holding water for several months after extensive flooding although usually rarely more than a month. The pan holds large sheets of shallow water, usually not exceeding 1 m in depth and when dry the area is a hostile stretch of salt-crusted wasteland. Flooding of the lower reaches of the pan seldom occurs while the main inlet on the eastern side of the pan – Fishers Pan – is flooded almost every year although the amount of water received and the duration of the wetland varies annually. Water entering the pan turns brackish towards the end of the rainy season through

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evaporation and contact with previous evaporites with a suspected salinity gradient increasing from north to south (Lindeque and Archibald 1991).

The climate is semi-arid and harsh with highly unpredictable rainfall mainly between October and April varying from 300 mm in the west to 500 mm in the east (Berry 1972; Clarke 1998; Mendelsohn et al. 2000). The average maximum temperature for December is 39°C and the lowest mean temperature of 6°C occurs during July (Baker 1996). Mendelsohn et al. (2000) states that September to December have the highest maximum temperatures followed by slightly cooler months associated with greater cloud cover and rain. Evaporation is high as Mendelsohn et al. (2000) and Wellington (1938) measured annual evaporation of between 2,500 mm and 2,700 mm per year, respectively, while wind speeds of up to 30 knots have been measured on the pan.

The vegetation associated with the Etosha Pan is broadly classified as Saline Desert with a Dwarf Shrub Savannah fringe (Giess 1971) and surrounded by salt-tolerant shrubs and spiny grasses (Strohbach 1996).

The wetlands in northern Namibia are most important in terms of supporting human populations and biodiversity as approximately 60% of Namibia's total population lives in this area of which 75% live alongside the perennial and/or ephemeral wetlands (Hines and Kolberg 1996). About 44% of the people living adjacent to the wetland system live within the Cuvelai drainage system, where a mixed economy is dependant on the flood regime for water, grazing and food – mainly in the form of fish. The Etosha Pan is also important as a tourist destination as the Etosha National Park is the most visited conservation area in Namibia (Baker 1996) with more than 140,000 visitors recorded annually (Berry 1997). The starkness of the Etosha Pan during the dry season(s) does not decrease the importance of the area as wildlife habitat and tourist attraction.

### *1.2 Coastal Flats*

Namibia is well endowed with coastal saline flats along its entire coast from the Orange River mouth (bordering South Africa) in the south to the Kunene River mouth (bordering Angola) in the north. These flats vary in size from approximately 10,000 $m^2$ to 60 $km^2$ (Grűnert 2000) with most of the flats occurring close to the sea. The Namibian coastline is extremely arid (Namib Desert), however the shallow, brackish or saline wetlands make a major contribution to the ecology of the coastal zone. Three of these sites (Walvis Bay lagoon, Sandwich Harbour and mouth of the Orange River) have been registered as wetlands of international importance under the Ramsar Convention (Kolberg n.d.). The Namib Desert is one of the oldest deserts with most of the area protected by either the Namib-Naukluft Park or the Skeleton Coast Park (Baker 1996). The Desert biome is an extreme desert with highly irregular precipitation – mean annual varying between 5 and 85 mm annually – while fog is experienced throughout the year and a crucial life-support system (Lovegrove 1993). The region is generally cold and windy with a mean annual temperature of 16.3°C (Baker 1996). The vegetation is characterized by a dominance of therophytes and lichens (Lovegrove 1993). Very little work has been conducted on the fauna and flora associated with these coastal and inland saline flats within Namibia. This paper attempts to collate the known information on this subject.

## 2 Methods

An extensive literature survey was conducted on the fauna and flora associated with saline flats – with special reference to the Etosha Pan as an inland saline system as well as coastal flats – from Namibia. Personal observations as a result of numerous field excursions throughout the country over a number of years added to this information, as did anecdotal information gathered from people currently living and working in close proximity to the saline flats.

## 3 Results and Discussion

### *3.1 Fauna*

#### 3.1.1 Etosha Pan

##### 3.1.1.1 Mammals

No mammal species are specifically associated and/or unique to the Etosha Pan system although a wide variety

of species make use of the pan in some or other way. Etosha National Park – which includes the largest portion of the Etosha Pan system – has 114 mammal species (Baker 1996) with most of these (especially the water dependant species) congregating at waterholes at the edge of the pan during the dry season, which usually extends from May to September. Mendelsohn et al. (2000) states that the grass and dwarf-shrub plains surrounding the Etosha Pan are favoured by grazing antelope and zebra with high densities of wildlife generally found to the east, south and west of the pan. Mammals utilize the pan in the following ways:

- Obtain water at natural seepage's associated with the edge of the pan
- Source of food
- Movement and migration routes
- Shelter and resting
- Natural licks

Ungulate species that frequent these natural waterholes (seepage) include most of the herd forming "plains game" such as Blue Wildebeest (*Connochaetes taurinus*), Burchell's Zebra (*Equus zebra burchelli*), Oryx (*Oryx gazella*) and Springbok (*Antidorcas marsupialis*) (C. Brain Pers. comm., B. Kötting Pers. comm. and W. Versveld Pers. comm.). Elephant (*Loxodonta africana*) also frequent this seepage at the edge of the pan. Predator species such as Lion (*Panthera leo*) use these waterholes as ambush sites especially during the dry season. Although many species are water independent they do utilize water when available and are subsequently attracted to the waterholes at the edge of the pan. According to Griffin and Grobler (1991) the following mammal species – all water dependant i.e. require permanent drinking water – are associated with the seasonal wetlands of Owambo and Etosha: Elephant, Black Rhino (*Diceros bicornis*), Burchell's Zebra, Blue Wildebeest, Black-faced Impala (*Aepyerus melampus petersi*), Kudu (*Tragelaphus strepsiceros*) with the Serval (*Felis serval*) not verified, but expected. Buffalo (*Syncerus caffer*) also used to occur on the eastern fringes of the pan during the 1950s although currently do not occur in the region (Berry et al. 1997).

When stands of *Sporobolus salsus*, a short-lived micro-perennial grass, occur on the pan after good rains, grazers converge on the pan to feed on these grasses (Berry et al. 1997). A small island aptly named "Haas Eilande" (Hare Island) refers to Scrub Hare (*Lepus saxatilis*) that are found on these grassy shrubland islands located in the pan (Berry et al. 1997). Few predatory animals venture far out into the pan (Berry 1972). Other than waterholes used as ambush sites, predators such as Black-backed Jackal (*Canis mesomelas*) and Spotted Hyena (*Crocuta crocuta*) venture out onto the pan to feed on Greater Flamingo (*Phoenicopterus ruber*) and Lesser Flamingo (*Phoeniconaias minor*) chicks and eggs (Brain Pers. comm., Kötting Pers. comm. and Versveld Pers. comm.). Flamingo breeding does not however occur on an annual basis, but rather only in years of good rainfall. Lion have also been known to venture out onto the pan to prey on ungulates that utilize grass growing at the edge of the pan, especially after good rains. A spring on the western tip of a peninsula named "Leeunes" (Lion Den) is due to lions using a copse of *Salvadora persica* as an ambush site (Berry et al. 1997).

Animal footpaths are often located out on the pan often as far as a few hundred meters from the edge of the pan. It would seem that these footpaths are used as a result of predator pressure close to the edge of the pan (e.g. predators lying up in denser vegetation at the edge of the pan) and/or easier walking (Brain Pers. comm., Kötting Pers. comm. and Versveld Pers. comm.). Ungulate species known to utilize these footpaths include Blue Wildebeest, Burchell's Zebra, Oryx and occasionally Giraffe (*Giraffa cemelopardalis*). Elephant often cross the pan following age old migration routes especially across some peninsula's although they also cross the pan during the wet season when the pan may be flooded (Brain Pers. comm., Kötting Pers. comm. and Versveld Pers. comm.). Giraffe are also known to cross the pan regularly in certain areas.

Many animals use the pan as a lying up place due to the precise nature of the area – i.e. makes the approach of predators obvious. Species known to utilize the pan as a resting-place include Blue Wildebeest, Burchell's Zebra, Oryx and Springbok. Oryx even go so far as to leave their young (predator avoidance) on their own – often several hundred meters from the edge of the pan – whilst foraging in the area. This even occurs during the hottest part of the day during summer (Brain Pers. comm., Kötting Pers. comm. and Versveld Pers. comm.). Predators such as lion and cheetah (*Acinonyx jubatus*) are also known to hide their young in the sparse vegetation at the pan's edge whilst the adults are away foraging. The saline clays associated with the

pan is often used by ungulates as a natural lick to supplement their salt requirements (Brain Pers. comm., Kötting Pers. comm. and Versveld Pers. comm.).

#### 3.1.1.2 Birds

According to Baker (1996) 340 bird species are in the Etosha National Park area although not all are associated with the pan. Although no bird species are specifically associated and/or unique to the Etosha Pan system, birds frequent the pan after the rains. Birds utilize the pan in the following ways:

- Breeding
- Feeding
- Migratory stopover

The Etosha Pan is the only known breeding reservoir of Greater and Lesser Flamingo in Southern Africa (Berry 1972). Up to a million or more birds have been known to congregate at the pan when sufficient water allows for breeding. Berry (1972) supplies a detailed report on the breeding of flamingo's at the Etosha Pan including a rescue operation conducted to save some of the chicks when the water dried up prior to them fledging. Interesting enough it has been determined that flamingos migrate between the coastal saline flats on the west coast of Namibia and the Etosha Pan depending on water availability in the latter location. The largest island on the pan (2.5 km × 700 m in size) is named Pelican Island due to White Pelicans (*Pelecanus onocrotalus*) occasionally breeding on this island and foraging in the vicinity after good rains (Berry et al. 1997).

Other species known to breed at the pan, often in association with flamingos, include Grey-headed Gulls (*Larus cirrocephalus*), Grey Heron (*Ardea cinerea*), Sacred Ibis (*Threskiornis aethiopicus*) and Glossy Ibis (*Plegadis falcinellus*). Spoonbill (*Platalea alba*) has also been documented as breeding on a small island on the pan albeit away from the flamingo colony. A variety of duck species and Dabchick (*Tachybaptus ruficollis*) have been documented as breeding on the pan depending on the water level (Brain Pers. comm., Kötting Pers. comm. and Versveld Pers. comm.). According to Williams (1991) it is probable that species such as the Whiskered Tern (*Chlidonas hybridus*) and Openbilled stork (*Anastomas lamelligerus*), which breed in seasonally flooded wetlands in Bushmanland (eastern Namibia), also breed in the seasonally flooded wetlands in Owamboland (includes Etosha Pan). It is expected that some of the smaller waders (e.g. plovers and sandpipers, etc.) also nest in the vicinity of the pan. Globally near-threatened species that occur at Etosha Pan include the Slaty Egret (*Egretta vinaceigula*), Lesser Kestrel (*Falco naumanni*), Wattled Crane (*Bugeranus carunculatus*) and Blue Crane (*Anthropoides paradiseus*) (Simmons et al. 1998).

A species that breeds on the pan, but not necessarily dependant on water to do so is the Ostrich (*Struthio camelus*) (Berry 1972; Brain Pers. comm., Kötting Pers. comm. and Versveld Pers. comm.). Berry (1972) even mentions an Ostrich nest as far as 10 km from the edge of the pan on raised ground surrounded by water. Vulture species are also known to breed in trees on the vegetated islands in the pan (Brain Pers. comm., Kötting Pers. comm. and Versveld Pers. comm.).

Wetland associated birds (to numerous to mention here) including the species breeding at the site migrate to the Etosha Pan after good rains to feed on aquatic invertebrates. Predatory and scavenger avian species – usually associated with the flamingo breeding attempts – such as Tawny Eagle (*Aquila rapax*), Grey-headed Gull, Pied Crow (*Corvus alba*), Black Crow (*Corvus corvus*) and Lappet-faced Vulture (*Torgos tracheliotus*) have been known to prey on flamingo nestling and eggs (Berry 1972).

A wetland such as Etosha Pan – albeit temporary of nature – would serve as a stopover for migratory bird species. This has been documented for flamingos (Berry 1972) and would be expected for any other aquatic migratory species, of which many different species visit Namibia annually.

#### 3.1.1.3 Herpetofauna

According to Baker (1996) 110 reptile species and 16 amphibian species are in the Etosha National Park area although not all are associated with the pan. According to Griffin and Channing (1991) relatively few (only eight species) Namibian reptiles are dependent on wetlands due to the country being primarily arid and semi-arid in nature. Furthermore Griffin and Channing (1991) state that 12 species (verified) and 4 species (not verified, but expected) of reptiles and amphibians are associated with the seasonal wetlands of Owambo and the Etosha Pan area. Of these, six (verified) and three (not verified, but expected) belong to the

Bufonidae and Ranidae (Amphibians). Jurgens (1979) states that of the 127 anuran species found in Southern Africa only 10 are found within the boundaries of the Etosha National Park. This scarcity of anuran species is probably as a result of the low number of different habitats and also the chemical composition of the water (pH levels vary from 8.92 to 10.3 in Etosha with high concentrations of dissolved chemicals making the water unsuitable for anuran use) (Jurgens 1979).

A Namibian endemic, *Agama etoshae* (Etosha Agama), occurs in sandy areas in the Etosha National Park area although not specifically associated with the pan. A Botswana endemic, *Agama makarikarica* (Makgadikadi Spiny Agama), on the other hand is restricted to the Nata and Makgadikadi salt flats in northeastern Botswana (Branch 1998). Other than the occasional *Psammophis* (Sand Snake) species crossing the pan no retiles are specifically associated with the pan itself (M. Griffin Pers. comm.).

#### 3.1.1.4 Fish

According to Baker (1996) only one fish species occurs in the Etosha National Park area. Bethune and Robberts (1991) state that at least 49 species of fish are present – albeit temporarily after flooding episodes – in the Owambo and Etosha area. Fish of these temporary pans in northern Namibia are dominated by the genera *Barbus*, *Clarias* and *Oreochromis* (Van der Waal 1991). Fish species that do enter the Etosha Pan under flood conditions are usually located in the Ekuma area (north central part of the pan) which is the major inlet from the Cuvelai drainage system further north and usually consist of *Barbus* species (Brain Pers.comm., Kötting Pers.comm. and Versveld Pers.comm.). According to S. Bethune (Pers. Comm.) only the hardiest species survive the "migration" during occasional flooding episodes into the Etosha Pan and don't survive for long either due to the temporary nature of the pan.

### 3.1.2 Coastal Saline Flats

#### 3.1.2.1 Mammals

Mammals are not common along Namibia's extremely arid coastal areas more commonly known as the Namib Desert, including the northern section aptly termed the "Skeleton Coast". Rainfall is irregular with as little as 15–100 mm precipitating annually (Baker 1996). Mammals that do occur and that undoubtedly utilize the saline flats whilst foraging include predators such as the Black-backed Jackal, Brown Hyaena (*Hyaena brunnea*) and occasionally Lion – in the far northern reaches of the Namibian coast (Baker 1996; Lovegrove 1993; O'Toole 1996). Cape Fur Seals (*Arctocephalus pusillus*) have breeding colonies at Sandwich Harbour and Cape Cross (both areas well endowed with saline flats) and consequently support high densities of Black-backed Jackal and Brown Hyaena. Black-backed Jackal's are masters at foraging for beached prey originating from the sea and very rarely rely on the desert for food (Lovegrove 1993). Oryx and Springbok are two ungulate species also often seen along the inhospitable Namibian coast and obtain their water at springs emerging close to the coast at the mouth of some of the westward flowing ephemeral rivers. The authors personally observed tracks of the above-mentioned species crossing coastal flats probably in search of food or moving from one area to another.

#### 3.1.2.2 Birds

The combination of nutrient rich ocean waters, tidal shoreline and coastal wetlands along the Namibian coast provides a habitat and feeding ground for many species of seabirds and waders, that congregate in very large numbers at certain times of the year (Lowery 2001). The coastal region south of Swakopmund, including Walvis Bay and Sandwich Harbour (both including saline estuaries and flats situated in the central western part of Namibia's coastline), offers sanctuary to hundreds of thousands of wading birds (Baker 1996). Of the 21 sites identified as important for birds in Namibia, 10 are along the Namibian coast and all someway associated with the saline flats systems (Simmons et al. 1998). The Greater and Lesser Flamingos – which occasionally migrate to and breed at the Etosha Pan – extensively use these coastal wetlands for feeding (Berry 1972). It has been estimated that the Swakopmund coastal salt flats support at least 1% of the Southern African population of the aforementioned two species and up to 250,000 pairs of Cape Cormorants (*Phalacrocorax capensis*) (Lowery 2001). The artificial saltworks (salt extracted by means of

evaporation of seawater) at Swakopmund supports more than 20,000 shore-birds (Williams 1988). Globally near-threatened species that occur at the Swakopmund saltworks include the Lesser Flamingo, Damara Tern (*Sterna balaenarum*) and African Black Oystercatcher (*Haematopus moquini*) (Simmons et al. 1998).

Overall populations of wetland birds range between 37, 500 and 78,200 (peak counts up to 150,000) at the Walvis Bay saline flats (Noli-Peard and Williams 1991). Globally near-threatened species that occur at the Walvis Bay saline flats include the Lesser Flamingo, Damara Tern, African Black Oystercatcher and Bank Cormorant (*Phalacrocorax neglectus*) (Simmons et al. 1998).

Sandwich Harbour seasonally supports up to 25% of the estimated world population of the Chestnutbanded Plover (*Charadrius pallidus*) and >3% of the sucontinental populations of the Blacknecked Grebe (*Podiceps nigricollis*) (Noli-Peard and Williams 1991). Globally near-threatened species that occur at Sandwich Harbour saline flats include the Lesser Flamingo, Damara Tern, African Black Oystercatcher and Bank Cormorant (Simmons et al. 1998).

There is also a rich variety of waders in the Cape Cross Seal Reserve further north (saline flats are common throughout this area) with the endemic and rare Damara Tern breeding in the vicinity (Baker 1996) as well as other localities along the Namibian coast, often in conjunction and/or close to saline flats (Clinning 1978) although more commonly on gravel plains (Frost 1976). Williams (1991) shows that the Cape Cross saline lagoons support between 6–16% of the non-breeding populations of the endemic Southern African race of the Blacknecked Grebe (*Podiceps nigricollis gurneyi*) and between 3,000 and 7,500 birds of any 30 species at any time. Globally near-threatened species that occur at the Cape Cross saline flats include the Lesser Flamingo and Damara Tern (Simmons et al. 1998).

The Namibian feeding grounds are essential to the survival of a large variety of Palearctic migrants, which include species such as the Ruff (*Phylomachus pugnax*) and the Curlew Sandpiper (*Calidris ferruginea*) (Lowery 2001).

#### 3.1.2.3 Herpetofauna

The herpetofauna associated with coastal saline flats is extremely limited at best with few reptiles specifically associated with any type of wetland from Namibia (Griffin and Channing 1991). The mouth of the Cunene River (river separating Angola from Namibia in the north western part of the country) is of particular interest due to it being the southernmost (disjunct) range of the Nile Softshelled Turtle (*Trionyx triunguis*) (Branch 1998; Griffin and Channing 1991). Green turtles (*Chelonia midas*) and even the Nile Crocodile (*Crocodylus niloticus*) have been reported in this same vicinity (Branch 1998; Griffin and Channing 1991) although not exclusively associated with the saline flats abounding in the area. A roadkill of a *Psammophis* (Sand Snake) species (unconfirmed) in the vicinity of Cape Cross, adjacent to coastal saline flats in the area, suggests that other reptiles do occur there although not necessarily specifically associated with these areas (Pers. obs.). Amphibians would generally not be expected in these saline areas due to them not typically being suited morphologically to inhabit saline areas (Loughland and Cunningham 2002).

#### 3.1.2.4 Fish

Although no fish species are exclusively associated with coastal saline flats in Namibia, the larger saline estuaries and flats occasionally inundated during high tides may hold fish temporarily. Bethune and Robberts (1991) have documented 36 estuarine and marine fish species occurring in coastal wetlands along the Namibian coast.

## 3.2 Flora

### 3.2.1 Etosha Pan

The high sodium content of most of the pans results in vegetation being non-existent or very rare with few species adapted to cope with halophytic soil conditions. According to Le Roux (1980) the Etosha Pan is largely without any vegetation due to the high sodium content. The whitish clay soils have a sodium contents in excess of 30,000 ppm and the pH varies between 8.8 and 10.2, which is also very high. In good rain years some grass species such as *Sporobolus salsus* and *Sporobolus spicatus* may occur on the pan (Berry et al. 1997; Le Roux 1980; Mendelsohn et al. 2000).

Along the pan margins the dominant perennial grasses are *Odyssea paucinervis*, *Sporobolus spicatus*, *S. ioclados*, *S. tenellus* and the sedge *Cyperus marginatus* (Mendelsohn et al. 2000). Woody species are generally absent but salt-loving woody dwarf-shrubs such as *Suaeda articulata* and *Sporobolus salsus* can be found on sand hummocks, which occur as little "islands" in the pan and on the pan margins (Le Roux 1980; Mendelsohn et al. 2000). *Salvadora persica* is occasionally found on some of the larger islands (Berry et al. 1997).

Several different vegetation types, in most cases well adapted to halophytic conditions, occur at the very edge of the pan. These vegetation types are classified by Le Roux (1980) as follows.

The **Andoni Veld** vegetation type is situated to the north east of the Etosha Pan. The vegetation in this vegetation type is dominated by an almost mono-specific stand of the perennial course grass species *Sporobolus spicatus*. Other prominent grass species in this vegetation type include *Crassipedorachis sarmentoasa*, *Digitaria setrivalva*, *Eragrostis sabine* and *Odyssea paucinervis*. Shrubs such as *Dichrostachys cinerea* are currently encroaching into this vegetation type.

To the southwest and south of the Etosha Pan, sweet grasses are associated with lime soils and classified as the **Sweet grass veld**. The vegetation in this area can generally be described as treeless plains although three tree species that do however occur in this area include *Acacia mellifera*, *Acacia nebrownii* and *Acacia reficiens*. *Albizia anthelmintica* may also be present in certain areas. Thickets of *A. nebrownii* occur on the southern side near the edge of the pan.

To the west of the pan small shrubs, such as *Monechma tonsum*, *Monechma qenistifolium* and *Petalidium enqelerianum* dominate the vegetation. Closer to the edge of the pan *Salsola* species such as *Salsola aphylla* and *Suaeda articulata* are found on the halophytic soils. Some perennial grass species such as *Cenchrus ciliaris* and *Stipagrostis hochstetteriana* may occur, but more common grasses such *Aristida adensionis*, *Enneapogon cenchroides*, *Enneapogon desvauxii* and *Eragrostis nindensis* are more typical for this vegetation type.

On the western side of the Etosha Pan shrubs such as *Leucosphera bainesii* and *Salsola tuberculatec* dominate the vegetation type known as **Ondeka Duneveld** and grow right up to the edge of the pan. Some of the important grasses are *Enneapogon desvauxii*, *Eragrostis sabinea* and *Eragrostis porosa*. Herbs such as *Monechma dwaricatum*, *Herpicium gazansoides* and *Zygophyllum simplex* also occur in this vegetation type.

On the northern side of the pan a geographic feature known as Poachers Peninsula – peninsula extending southwards into the pan – is dominated by shrubs such as *Catophraetes alexanderii* and *Dichrostachys cinerea* while the grass layer is dominated by *Stipagrostis uniplumis*.

To the east of Poachers Peninsula a relative small vegetation type known as the **Ekuma grass lands** extends down to the edge of the pan from the north. The vegetation can be described as a tall grass veld with palatable grasses such as *Anthephora pubescens*, *Cenchrus ciliaris*, *Schmidtia pappophoroides* and *Stipagrostis uniplumis*. The most important shrub in this area is *Leucosphera bainesii*.

On the northeastern side of the pan the vegetation is characterized by a **Sandveld vegetation type**. The vegetation in this area is dominated by tree species such as *Acacia erioloba*, *Acacia mellifera*, *Philenoptera nelsii*, *Terminalia sericea* and *Terminalia prunioides*. Several *Grewia* species for example *Grewia flava* are typical of the shrub components that occur in this area. The grass layer is poorly developed with *Schmidtia kalaharienses* as the most prominent species.

Clarke (1998) describes the vegetation associated with saline pools and flats slightly to the north of the Etosha Pan, but still in the Cuvelai drainage basin, as sparse and poorly vegetated. Species that are characteristic of saline pools in this area include the small grass *Sporobolus coromandelianus* and large clumps of *Sporobolus ioclados*. Sandy edges support *Odyssea paucinervis* and *Sporobolus spicatus*. Trees are absent possibly due to the waterlogged and saline soils in this area.

### 3.2.2 Coastal Saline Flats

The coastal saline flats are devoid of vegetation (except for some algae species) except on the edges of the flats. Similar to the Etosha Pan, only vegetation adapted to halophytic conditions occurs around these flats. In general the density of vegetation is low in the coastal areas, but does increase further away from the flats.

Species such as *Anthrocnemum africanum* and *Sarcornia natalensis* are succulent-like perennial herbs (small ±30 cm in height) that succeed in growing in these very saline conditions. Small shrubs such as *Galenia papulasa*, *Lycium cinereum*, *Salsola* species, *Suaeda* species, *Psilocaulon* species, *Tamarix usineoides* and *Zygophyllum* species occur slightly further away (i.e. inland). Members of the grass family that succeeded in establishing themselves in this area are *Odyssea paucinervis*, *Sporobolus nebulosus* and the well-known reed, *Phragmites australis*, which occur in these halophytic conditions especially near an area called "Jakkalsputs" north of Swakopmund. The salt marsh and adjacent brackish waters at Sandwich Harbour support four communities – *Sarcocornia natalensis* var. a*ffinis*, *Sporobolus virginicus*, *Typha capensis* and the *Odyssea paucinervis* communities, whose distribution is determined by the salinity gradient between the fresh water seepage and the marine system (Robinson 1976).

In many cases the vegetation grows on sand hummocks created by the wind. On the gravel/gypsum plains the most prominent plant is a perennial shrub (±30–40 cm high) known as *Arthraerua leubnitzii*. A large number of endemic lichens are also found on these gravel plains. These plants are a symbiosis between fungi and algae and are dependent on the fog-regime along the coast for their moisture requirements.

## 4 Conclusion

As far as could be determined no specific fauna (mammals, birds, reptiles and fish) and flora are specifically associated with inland and coastal saline flats in Namibia. This however, should not detract from the immense importance such systems have in terms of supporting a wide variety of life especially in an arid country such as Namibia. Not only are the saline flats important from a national perspective such as the tourism potential of Etosha National Park, Cape Cross Seal Reserve, Walvis Bay lagoon, etc., but also from an international perspective. The fact that these saline flats especially the coastal flats host Palearctic waders, underscores its international importance.

The ecological importance of saline flats in Namibia is often overlooked and certainly not well understood and usually deemed worthless from a farming and tourism perspective. Secondary benefits of these saline flats such as the importance for migratory waders that in their turn attract tourists (birders) should be encouraged. The importance of these saline flats should not be underestimated and it is suggested that an awareness campaign, similar to the awareness campaigns regarding lichens and Damara Terns, should be initiated in Namibia. Further research into the saline flats system(s) from Namibia is warranted especially regarding the invertebrates, which form the basis of the food chain for migratory birds. This little understood and unique landform deserves further attention.

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