Wetlands of the Namib Coast

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ABSTRACT

There are 14 areas of sheltered shallow saline waters along the Namib coast between, and inclusive of, the mouths of the Orange and Cunene Rivers. We describe the coastal wetlands, review available biological data on the wetlands and comment on their present conservation status and predictable future changes which may affect them. Of great conservation significance are the coastal birds as these wetlands support subcontinentally and globally important bird populations notably of intra-African migrant species. Five of the permanent wetlands warrant registration under the Ramsar convention as being of international importance for wetland birds. These are, in order of diminishing importance, Walvis Bay wetland, Sandwich Harbour, Swakopmund saltworks, the Orange River Mouth and Cape Cross lagoons. Recommendations are made for formal protection of some areas by the Department of Nature Conservation.

INTRODUCTION

The Namib coast is here considered to be the shoreline between the mouths of the Orange and Cunene Rivers, the intertidal zone to the seaward side of the shore, and that part of the mainland which regularly or irregularly comes under the direct influence of seawater. The total area of the Namib coast as so defined is about 300 km^2 or less than 1% of the total area of Namibia and the Walvis Bay enclave combined.

For most of its length this is a high energy coastline swept by swells from the South Atlantic ocean. Less than 1% of the length and 17% of the area of the Namib coast consists of sheltered shallow waters (Williams 1988) - the coastal wetlands,which are the focus of this review. Protected from deep wave action these wetlands permit the settling of fine sediments and so serve as nutrient traps. The benthos of these sediments rapidly recycle the nutrients and form detritus. This forms a rich environment for plant growth and provides food for animals higher in the food-chain, notably shore-birds and sea-birds. Wetland birds are here considered to be those species which utilise wetlands for feeding or breeding (see Williams 1991b, this volume).

Coastal wetlands, because of their sheltered nature, attract both commercial and recreational human activities. Some are used for salt formation, some for mariculture, while at two wetlands, guano platforms have been erected. Because they are of small extent these highly productive wetlands are very vulnerable to pollution, and to encroachment by housing or industrial development.

The wetlands along the Namib coast are few in number and they support unique, rich communities, thus all are in need of conservation consideration to ensure wise future use of this limited resource. In this review we (i) provide a brief physical description of the coastal wetlands; (ii) review the available knowledge of their biota; (iii) comment on their current conservation status and on predictable changes in their condition. The wetlands are considered from south to north along the coast (see Fig. 1).

THE ORANGE RIVER MOUTH

The Orange River mouth includes all natural and artificial wetlands within the river-affected area seaward of the Sir Ernst Oppenheimer Bridge which is approximately 10 km inland (Williams 1986). This covers an area of approximately 18 km^2. The following physical description of the river mouth is derived from the Orange River Environmental Task Group (O.R.E.T.G. 1990) and Day (1981).

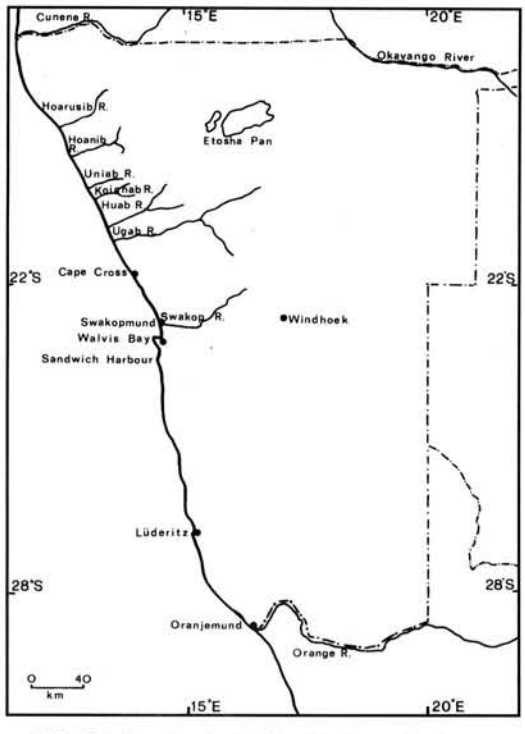

FIGURE 1: Coastal wetlands of Namibia discussed in the text.

Northward longshore drift creates a sandbar which blocks off river flow to the sea. When the bar is closed (an unusual event in the past 30 years) a brackish lagoon develops on the inland side, consisting of water from the river with, presumably, some through-bar seepage of seawater. The bar is breached during flood surges, which usually occur annually during periods of average to above average rainfall in the catchment area; the breach generally does not close before the following flood surge. For the past 20 years it has been the practise to artificially breach the sandbar if an opening has not been maintained by floods. When the bar is open the lower reaches of the river come under tidal influence, revealing mudflats at low tide. Most areas can be reached by terrestrial predators at low tide, but low sandy islands, possibly the remains of an old bar, are sometimes developed on the south side of the riverine area just inland of the bar. There is also an artificial island in the canal dug in a former river channel immediately adjacent to the town of Alexander Bay. These islets provide breeding places for coastal birds, safe from mammalian predators.

Little is known of the biota of the Orange River mouth area; the available knowledge on the physical environment of the river mouth and the aquatic community has been summarised by Day (1981). Day concludes that there is no real estuary as conditions within the mouth vary from wholly marine to wholly estuarine. The high turbidity and these extreme fluctuations in salinity are the reasons given by Brown (1959) for the general paucity of aquatic fauna, and the almost complete absence of estuarine animals in the river mouth.

The only community about which some quantitative information is available is the avian component (Brown & Jarman 1978; O.R.E.T.G. 1990). Counts of wetland birds indicate that during the austral summer this wetland is the sixth richest coastal wetland in southern Africa in terms of the overall numbers of birds supported (Ryan & Cooper 1985; Williams 1986). Fourteen species of birds listed in either one or both of the Red Data lists for Namibia or South Africa occur regularly in the wetland and the abundance of three species endemic to southwestern Africa - the Cape cormorant *Phalacrocorax capensis*, Damara tern *Sterna balaenarum*, and Hartlaub's gull *Larus hartlaubii* exceed 1% of their global population (Williams 1986). In terms of the wetland bird community which it supports, the Orange River mouth area meets the requirements of the Ramsar Convention as a wetland of international significance at least when bar-open conditions apply (Williams 1986). Application for registration of the wetland under the Ramsar convention was made in 1990.

Currently, and for about the last fifty years, access to the Orange River mouth wetland has been severely restricted since it is flanked by areas under the strict security control of diamond organisations; Consolidated Diamond Mines (PTY) Ltd (CDM) on the north bank and State Alluvial Diggings (SAD) on the south bank. Because access has been restricted and the river forms an international border, no conservation plan has been drawn up for this wetland.

The Orange/Vaal river system is already extensively regulated, although significant flooding may still occur (Swart et al. 1988). Control over the amount of water which reaches the mouth of the Orange River will be further restricted with the development of the Lesotho Highlands Water Scheme and envisaged additional extraction of water from the Orange River for human consumption, industrial and agricultural purposes. The effect this will have on the Orange River mouth wetland will depend on the amount of flow which is regularly permitted to reach the wetland area (O.R.E.T.G. 1990).

THE LÜDERITZ LAGOON

The rocky-shored Lüderitz peninsula provides protection for the Lüderitz lagoon, a north-facing and thus swell free bay, with no freshwater inflow. Around the lagoon are several areas of intertidal wetland, characterised below the median sea level by fine sands with a high biotic content and in the upper tidal areas by several species of salt marsh vegetation. Additional areas flood only during the equinoctial spring tides. The total wetland area is estimated to be 5 km^2 .

The salt marsh vegetation from the Lüderitz lagoon wetland has not been documented, but samples identified by the Windhoek Herbarium include *Zygophyllum elavatum, Chenolea diffusa, Sarcocornia pillansiae* and *Salsola nollothensis*.

Counts of shore- and sea-birds in the wetland components of Griffiths Bay, the head of the lagoon and Radford Bay (Hockey 1982; A.J. Williams unpublished data), indicate that these wetlands support a maximum 7 270 wetland birds, excluding Cape cormorants (A.J. Williams unpublished MS).

The sheltered shallow waters have considerable potential for mariculture. An oyster farm has been developed near the head of the lagoon and the Directorate of Fisheries has designated further sites along the eastern shore of the lagoon. The current mariculture development appears to have no detrimental effect on the biota of the lagoon. However, mariculture ventures in the natural saltpan at the head of the lagoon could endanger the adjacent wetland areas. The effect of the present commercial collection of the seaweed *Gracilaria verrucosa* from beaches around the lagoon for production of agar, is not known.

The development of mariculture around Lüderitz could threaten local biota through the introduction of exotic species, especially of bivalve parasites. It also restricts areas available for recreational use in this tourist resort. The lagoon as a whole and especially the peripheral wetlands, are vulnerable to pollution from the harbour and associated industrial development at Lüderitz.

Currently the wetlands around the lagoon have no conservation status and already a large area of Radford Bay has been reclaimed for housing and sports fields. Serious consideration should be given to declaring some of the wetlands, particularly the extensive salt marsh and adjacent tidal flats at the head of the lagoon, as a local nature reserve. Such a reserve could serve an important role as a control against which developments affecting other wetland areas around the lagoon could be measured. The salt marsh represents an area of biotic diversity which could also have educational value.

SANDWICH HARBOUR

Sandwich Harbour is an area of water and wetland between the high dunes of the Namib sand sea and the Atlantic ocean. Protected behind a sand barrier beach is an extensive 5 km^2 area of intertidal sandflats at the south of the Harbour. To the north of the central lagoon is an area of salt marsh and adjoining intertidal flats. Small, but biotically important brackish water wetlands, caused by underground seepage of fresh water, occur at the edge of the dunefield (Plate 4).

Sandwich Harbour is in geomorphic terms one of the most active areas along the Namib coast. In the late 1800's there was no northern barrier beach and so no protected wetland, while the southern barrier beach provided shelter for an otherwise open harbour (Schultze 1907). Northward extension of the southern barrier beach cut off a tidal lagoon system which remained largely stable through the twentieth century until the early 1960s. Subsequently, an additional lagoonal area has been "captured" by the southern barrier beach and the northern barrier has been breached and is now moving towards the dune field, so reducing the northern wetland area (Wilkinson et al. 1989).

The northern intertidal wetland includes one of the most extensive areas of salt marsh vegetation along the Namibian coast. This salt marsh and adjacent brackish waters supports four communities - the *Typha capensis, Sarcocornia (Arthrocnemum) affine, Sporobolus virginicus* and the *Odyssea paucinervis* communities, whose distribution is determined by the salinity gradient between the fresh water seepage and the marine system (Robinson 1976).

Sandwich Harbour has been the subject of more research than any other wetland along this coast. In addition to the vegetation

survey two faunal lists of the marine animals of Sandwich Harbour are available (Stuart 1975; Kensley & Penrith 1977). The biological survey carried out by Kensley & Penrith (1977) is more comprehensive and includes a description of each habitat and of the lagoon environment in 1974. A study on the steenbras *Lithognathus aureti* in Sandwich Harbour lagoon was carried out by Lucks (1970). A list of the fish fauna of Sandwich Harbour recorded by G.E. Venter from 1986 to 1989 is given in Bethune & Roberts in this volume.

Four surveys have documented the status of wetland birds at Sandwich Harbour (Prozesky 1963; Berry & Berry 1975; Whitelaw et al. 1978; A.J. Williams unpubl. MS). Counts indicate use of the wetlands by between 11 000 and 22 000 birds at any one time. Peak counts per species suggest that this wetland supports up to 70 000 birds overall (excluding cormorants). Of the peak figures Palearctic waders form 62% and intra-African migrants 32%. This is the only breeding locality of the great crested grebe *Podiceps cristatus* in Namibia. Sandwich Harbour seasonally supports up to 25% of the estimated world population of the chestnutbanded plover *Charadrius pallidus*. It also supports more than 3% of the subcontinental populations of the blacknecked grebe *Podiceps nigricollis*, greater flamingo *Phoenicopterus ruber* and lesser flamingo *P. minor*. In terms of overall numbers it is the second most important wetland along the Namib coast and the sixth most important coastal wetland in southern Africa (Cooper & Hockey 1981; Namibian Department of Nature Conservation [NDNC], unpubl. data).

Sandwich Harbour is a specially protected area within Namibia's largest nature reserve the Namib-Naukluft Park. Tourist access is allowed under permit to the northern wetlands only and even park officials rarely visit the main wetland area in the southern part of the "harbour". Should current geomorphic processes eradicate the northern wetland and create an open harbour, which is what happened in the early part of the century (Bremner 1985), there will be pressure to permit water recreation in the harbour area. Any plans for the area must take cognisance that the most important area for birds is the southern end of the harbour and this will remain irrespective of the fate of the northern wetland.

WALVIS BAY

The Walvis Bay wetlands comprise the natural areas of Walvis Bay lagoon, the "second lagoon" and the eastern half of Pelican Point as far as its extreme northern tip and the adjacent intertidal areas. It also includes the artificially flooded Walvis Bay salt works; and the occasionally, naturally flooded areas to the south of the salt works (Williams 1987a). There is no terrestrial vegetation in this wetland. No maps indicate the current extent of flooding but the total area is between 35 and 40 km^2.

This area is the most important wetland along the Namib coast and, in terms of bird numbers, it is probably one of the ten most important coastal wetlands in Africa. Most birds which use the wetland are non-breeding migrants. The number which breed within the wetland is small, probably because most places are accessible to the local blackbacked jackal *Canis mesomelas* population.

Wetland birds at Walvis Bay have been comprehensively surveyed in 1977 (Underhill et al. 1977; Whitelaw et al. 1978), and twice annually since 1983 (Williams 1987a, 1987b & unpubl. data). Overall populations range between 37 500 and 78 200. Peak counts per species indicate use by up to 150 000 wetland birds (excluding Cape cormorants) of which 50% are intra-African migrants, 45% are Palearctic migrants and the remainder resident coastal species. The wetland supports up to 50% of the estimated world population of the chestnutbanded plover, up to 18% of the estimated world population of the southern African subspecies of the blacknecked grebe *Podiceps nigricollis gurnevi*, and 5% of that of the Hartlaub's gull. Of southern African subcontinental populations the wetland supports 60% of the lesser flamingos, 38% of the greater flamingos, and 10% of the great white pelicans *Pelecanus onocrotalus*. It supports populations of eleven species, including the six abovementioned, nominated for inclusion in the regional Red Data List (Williams & Brown 1985).

The salt work at Walvis Bay, although it developed and destroyed areas of natural tidal flooding, provides large areas of permanently flooded shallow water with extensive shorelines. This artificial section of the wetland regularly supports half the birds in the wetland and more than compensates for the lost habitat. The entire area, except for the most saline pans of the salt works, has been designated for registration under the Ramar Convention. The wetland falls within the newly (February 1991) gazetted Cape Provincial Walvis Bay Nature Reserve.

SWAKOP RIVER MOUTH

A wetland exists at the boundary between the South African enclave of Walvis Bay and Namibia at the mouth of the Swakop River. The Swakop River flows into the sea only during irregular floods. In most years the lower river bed is dry. Material washed out to sea during flood events is pushed landwards by onshore waves and forms a lagoon behind a beach bar. The lagoon diminishes in size as the waves push the beachbar landwards and may disappear altogether. Dry conditions may last for a number of years, and are probably dependent on the long term wet-dry cycles inland. Flooding has also been reduced by the erection of a series of major dams near the headwaters of the Swakop River.

When flooded this wetland attracts a variety of birds which are in turn attractive to tourists, but overall numbers of birds are low and, apart from Hartlaub's gulls (Brown, C.J. pers. comm.), little breeding occurs. Due to its ephemeral nature and variable salinity (caused by bar overwash at high tide), wetland associated vegetation is restricted in both area and variety. This ephemeral wetland, while locally important when flooded, is of minor national conservation importance.

SWAKOPMUND SALT WORKS

The wholly artificial salt pans about 6 km north of Swakopmund, were created by excavation of a low-lying dry saltpan and the constant pumping of seawater into the depressions. The pans are shallow and of varying salinity. A large wooden commercial guano platform has been built in one of the northern pans and supports up to 250 000 pairs of Cape cormorants (Berry 1976a; Cooper et al. 1982). Substantial quantities of guano either fall into the pans or are washed off the birds when they bathe. The effect of this guano enrichment on productivity of microorganisms in the pan has not been assessed. An oyster farm has been created in one of the pans.

The only biotic data available for the salt pans concerns the numbers of wetland birds which occur there (A.J. Williams unpubl. MS). Counts indicate that in addition to the Cape cormorants, the salt works support upwards of 20 000 wetland birds including populations equivalent to or exceeding 1% of the subcontinental populations of greater and lesser flamingos and of the estimated world population of chestnutbanded plo-

vers. Species which have been recorded breeding include whitebreasted cormorant *Phalacrocorax carbo*, swift tern *Sterna bergii*, kelp gull *Larus dominicanus* and Hartlaub's gulls, chestnutbanded plover and avocet *Recurvirostra avosetta*. The shallow pans are also an important foraging area for the Damara tern. Great crested grebes, currently among the most endangered species within Namibia, regularly occur in the pans where oysters are cultured.

The proprietors of the salt works have registered the entire wetland area as a private nature reserve.

CAPE CROSS LAGOONS

Several lagoons were created by northward longshore drift extension of a barrier beach which eventually connected the former islands which now form Cape Cross. Progressive drying up of the lagoons has created extensive salt deposits. The remaining pans are fed by seepage through, or swash over, the barrier beach. Three sets of guano platforms have been erected over the lagoons. Guano from these platforms probably serves to enrich the micro-flora and -fauna of the lagoons. There is an irregular fringe of salt marsh vegetation along the coastal edge of the lagoons; the species composition of this vegetation has not been documented.

The platforms support up to 14% of the world population of Cape cormorant (Cooper et al. 1982), and counts indicate that, in addition to the cormorants, these lagoons support up to 11 000 birds (Williams 1991a this volume). This includes between 6% and 16% of the nonbreeding population of the endemic southern African subspecies of the blacknecked grebe *P. nigricollis gurneyi*, and between 1% and 3% of the subcontinental populations of greater and lesser flamingos (Williams 1991a). This wetland warrants registration as a wetland of international importance under the Ramsar Convention (Williams 1991a). Currently the wetland is a registered private nature reserve. The purpose of this registration was to restrict access to the public who might disturb the birds on the guano platforms and, incidentally, protects the birds.

RIVER MOUTHS ALONG THE SKELETON COAST

Along the northern Namib coast, within the Skeleton Coast Park, which extends from the Ugab River in the south to the Cunene River in the north, ephemeral wetlands form irregularly at the mouths of a number of normally dry rivers after flooding. Such wetlands occur at or near the mouths of the Ugab, Huab, Koichab, Hoanib and Hoarusib rivers. The Uniab River does not produce a lagoonal wetland at its mouth because it crosses higher coastal terrain and falls through a small canyon to the sea, but it does have several small permanent pools within 5 km of the coast. The lagoonal mouths are so ephemeral and so irregular in size that it is impossible to give their area; at maximum, however, the combined area is unlikely to exceed two or three square kilometers.

Since these wetlands are ephemeral, bird counts are not separated from counts along the coastline during long term monitoring of coastal bird numbers in the Skeleton Coast Park (Ryan et al. 1984a; Tarr & Tarr 1987). It is therefore impossible to indicate their importance although the irregularity of occurrence and small size suggests that overall numbers are small and relatively unimportant. A variety of bird species may breed at these wetlands but for the most part only on a highly irregular basis dependent upon the degree of flooding (Ryan et al. 1984b).

Although ephemeral, these wetlands support some vegetation including reeds (*Phragmites australis, Typha capensis*) and other wetland species such as *Scirpus dioicus, S. littoralis* and *Juncellus laevigatus* (Giess 1968).

The Skeleton Coast Park was created in 1971 and the public has access to only two areas namely Torra Bay and Terrace Bay (Schoeman 1984). Human disturbance of the wetlands within the park is thus minimal. Threats to the wetlands lie outside the boundaries of the park where potential water schemes could alter the natural flow regime of the rivers flowing into the park.

THE CUNENE RIVER MOUTH

The Cunene River, like the Orange River, forms an east-west linear oasis of permanent freshwater which crosses the Namib desert to the sea. The recent poor security situation and the isolated nature of the area has prevented adequate recent surveying of the Cunene River mouth. This account is based on a report by Braine (1990); see also van Zyl, this volume.

The mouth wetland is considered to be the lower part of the river within 4 km of the coast. Sandbars developed from both northern and southern shores narrow the mouth of the river, except during or just after large-scale flood surges, but do not close off river flow to the sea. Nevertheless, at high tide the river is dammed back and forms a lagoon of up to 2 km wide and 1 km upstream. Tidal influence is felt up to 4 km upstream (Braine 1990).

At least 80 species of wetland birds have been recorded at the Cunene River mouth. The maximum counts of intra-African migrants is 440 and of Palearctic waders is just over 2 000 individuals (Braine 1990). Numbers are generally lower than at the Orange River but this may reflect the infrequency of counts, the time available for counting, the degree of access, as well as the small overall area.

The linear oasis effect has enabled populations of Nile crocodiles *Crocodylis niloticus*, Nile monitors *Varanus niloticus* and Nile soft-shelled terrapins *Trionyx triunguis* to reach this coastal wetland which is also used by marine green turtles *Chelonia mydas* (Braine 1990; Tarr 1987; Branch 1988). A variety of terrestrial mammals including elephant *Loxodonta africana*, blackbacked jackal and brown hyaena *Hyaena brunnea* are attracted to the area (Braine 1990).

The most significant conservation feature of this wetland is the regular use of the area by Damara terns, a species which is listed in the African Red Data Book (Clinning 1978; Collar & Stuart 1985). The maximum numbers occurring in the wetland were 2 000 individuals (Braine 1990), equivalent to half of the estimated world breeding population.

The existence of this wetland, and of some of the unique fauna which it supports, is threatened by a proposal to build a dam on the Cunene River. During the period which it is expected for the dam to reach operational level (possibly four years) the resulting reduced, or possibly zero, water flow at the Cunene River mouth would have a drastic effect on this wetland.

DISCUSSION

Surveys

This review clearly indicates that our knowledge of the biota, other than birds, of the wetlands along the Namib coast is inadequate for proper assessment of their conservation status.

The extent and species composition of the vegetation of all the coastal wetlands needs to be documented. An indication of the necessity of such surveys is the total loss of vegetation from Walvis Bay wetland, probably due to increased salinity associated with the development of salt works on the lagoon. There is a need for surveys of the invertebrate fauna notably at Walvis Bay, the southern intertidal flats at Sandwich Harbour, the Cape Cross lagoons and the Cunene River mouth. Utilisation of the wetlands by vertebrates other than birds has only been documented for the Cunene River mouth (Tarr 1987; Braine 1990).

Until such time as our knowledge of other faunal elements is improved, decisions on the conservation status of coastal wetlands will have to be taken using the avian component as an indicator of species richness.

The combined area of the wetlands of the Namib coast is less than 150 km^2. Most of the animals which use these sheltered saline areas have specific requirements which restrict them wholly or largely to the wetlands. It follows that in terms of their distribution they are probably geographically limited, if not numerically rare, in Namibia. Furthermore, their concentration in only a few wetland areas makes them vulnerable to local or national extinction if such areas experience significant environmental changes through human development or pollution (see below).

Most of the 250 000+ birds which use the Namib coast wetlands are migrants which breed elsewhere. These come from two distinct regions. The flamingos, chestnutbanded plovers and blacknecked grebes are intra-African migrants which breed on seasonally flooded pans inland in southern Africa, and migrate to coastal wetlands when inland waters dry up. The Namib coastal wetlands are the most important refuges for these intra-African migrants and more than 50% of the estimated world population of the chestnutbanded plover occur there. Measures to conserve breeding populations of flamingos at Etosha Pan and in Botswana cannot be fully successful unless the refuges of these birds at the coast are also protected. The second major group of migrants are those which breed in the northern Palearctic region. These are mostly waders (Charadriidae) and terns. Most of these birds breed in reserves or protected areas in northern Europe and Siberia and, as with intra-African migrants, these reserves are only meaningful if the birds have safeguarded areas in the nonbreeding season. The Namib coastal wetlands, therefore, form essential elements in an international network of wetland reserves.

Problems

The principal threats facing these wetlands are human development, disturbance and pollution. Human development has already affected the Walvis Bay wetland and the Cape Cross lagoons. A positive aspect is the creation of a wetland at the Swakopmund salt works. However, major inland water schemes have or will have potentially drastic effects on the Orange and Cunene River mouths. The only wetlands not yet significantly affected by man are Sandwich Harbour and the ephemeral wetlands of the Skeleton Coast Park. It is essential that any future developments likely to affect coastal wetlands are subject to full integrated environmental impact assessment to determine and minimise the likely adverse affects of development upon the communities.

The coast attracts human recreational use, but areas of totally or partially restricted public access (diamond and conservation areas) limit the sections of the Namib coast that are affected. As a result, human recreational disturbance is focused on the central Namib coast near the wetlands of Sandwich Harbour, Walvis Bay, Swakop River mouth, Swakopmund Salt Works and the Cape Cross lagoons. Even so, disturbance has had little impact since most wetlands, and especially those where birds breed, remain inaccessible to the general public. Human disturbance is a problem largely when birds using the wetlands breed outside the protected area. This is the case with Damara terns (Frost & Shaughnessy1976; Clinning 1978; NDNC unpubl. data) and Hartlaub's gull and swift tern colonies at Lüderitz (Komen et al. 1986).

Pollution has not been a problem in Namib coastal wetlands, largely because of the limited degree of industrial and human development. Nevertheless, the small number and the small total area of Namib coastal wetlands renders them highly vulnerable to pollution. Of particular concern is the Walvis Bay wetland, the largest and most important on the coast, because of its location in the immediate vicinity of the main port and coastal industrial centre. The only significant, documented marine pollution to date was the death of a number of cormorants from fish oil released into Walvis Bay (Berry 1976b). An adult great white pelican found dead at Walvis Bay in 1988 had high levels of organochlorines which may have been the cause of death (NDNC unpubl. data). This pollution was not necessarily acquired at the coast.

Conservation status

The growing awareness of the importance of wetlands along the Namib coast is reflected in the protection of Sandwich Harbour as an area of special conservation concern within the Namib-Naukluft Park, and the inclusion of Walvis Bay wetland within the newly proclaimed Walvis Bay (Cape Provincial) Nature Reserve. The protection of the Cunene River mouth and ephemeral river mouth wetlands within the Skeleton Coast Park further reflects this national awareness. In addition, the Cape Cross lagoons and the Swakopmund Salt Works are private nature reserves, albeit for commercial reasons.

While this situation is laudable, more should be done to ensure the long term existence of these coastal wetlands. We recommend that the Cape Cross lagoons should come under formal Nature Conservation protection, which need not preclude commercial working of guano platforms or of salt extraction. Formal protection should be extended to the wetlands of the Orange River mouth. In addition, some if not all the wetland areas near Lüderitz should be given some form of protection status by the Department of Nature Conservation and possibly also a form of local protection status for the Swakop River mouth wetland. In view of their situation close to major centres, the wetlands at Lüderitz and the Swakop River mouth are ideal for use in outdoor education programmes, a further incentive for conserving these areas.

The five wetlands which fulfill the requirements in terms of bird numbers and the high proportion of subcontinental bird populations which they support, should be registered under the International Ramsar Convention for the Conservation of Wetlands (see Lyster 1985; Williams this volume a). Application for the Walvis Bay and Orange River mouth wetlands to be registered under this convention has already been made. Application should be made to register Sandwich Harbour, the Cape Cross lagoons and (if wholly artificial commercially operated wetlands can be registered) possibly also the Swakopmund Salt Works. Such registration would enhance Namibia's international conservation reputation and status.

CONCLUSIONS

Surveys: There exists an important need for surveys of the vegetation, and the invertebrate and vertebrate faunas of these coastal wetlands notably at Walvis Bay, the southern intertidal flats at Sandwich Harbour, the Cape Cross lagoons and the Cunene River mouth. Bird surveys should be continued on a long term basis at selected wetlands. In particular more work is required at the Cunene River in view of the proposed dramatic changes in freshwater supply.

Protection: Formal Nature Conservation protection should be extended to cover the Orange River mouth wetlands and the Cape Cross lagoons. Sandwich Harbour and the Cape Cross lagoons should be registered under the Ramsar Convention.

REFERENCES

BERRY, H.H. & BERRY, C.U. 1975. A check list and notes on the birds of Sandvis, South West Africa. *Madoqua* 9: 5-18.

BERRY, H.H. 1976 a. Physiological and behavioural ecology of the Cape Cormorant *Phalacrocorax capensis*. *Madoqua* 9: 5-55.

BERRY, H.H. 1976 b. Mass mortality of Cape Cormorant, caused by fish oil, in the Walvis Bay region of South West Africa. *Madoqua* 9: 57-62.

BRAINE, S. 1990. Records of birds on the Cunene River. *Lanioturdus* 25: 38-44 .

BRANCH, B. 1988. Field guide to the snakes and other reptiles of southern Africa. Cape Town: Struik.

BREMNER, J.M. 1985. The coastline of Namibia. *University of Cape Town, Dept. Geology, Marine Geoscience Unit Tech. Rep.* 15: 200-206.

BROWN, A.C. 1959. The ecology of South African estuaries Part IX: Notes on the estuary of the Orange River. *Trans R. Soc. S. Afr.* 35: 463-473.

BROWN, A.C.& JARMAN, M. 1978. Coastal marine habitats. pp 1239-1277. In: Biogeography and ecology of southern Africa. Vol 2 (Ed.) Werger, M.J.A. The Hague: W. Junk

CLINNING, C.F. 1978. The biology and conservation of the Damara Tern in South West Africa. *Madoqua* 11: 31-39.

COLLAR, N.J. & STUART, S.N. 1985. Threatened birds of Africa and related islands. Cambridge, U.K.: ICBP/IUCN.

COOPER, J. & HOCKEY, P.A.R. 1981. The atlas and site register of South African coastal birds. Part 2: the atlas. Cape Town: Unpublished report, Percy Fitzpatrick Institute of African Ornithology, University of Cape Town.

COOPER, J., BROOKE, R.K., SHELTON, P.A. & CRAWFORD, R.J.M.1982. Distribution, population size and conservation of the Cape Cormorant *Phalacrocorax capensis*. *Fish. Bull. S. Afr.* 16: 121-143.

DAY, J.H. 1981. Summaries of current knowledge of 43 estuaries in southern Africa. pp 251-330. In: Estuarine Ecology - with particular reference to southern Africa. (Ed.) Day, J.H. Cape Town: A.A. Balkema.

HOCKEY, P.A.R. 1982. Waders (Charadrii) and other coastal birds in the Lüderitz region of South West Africa. *Madoqua* 13: 27-33.

KENSLEY, B.F. & PENRITH, M.J. 1977. Biological survey of Sandvis 1, introduction and faunal list. *Madoqua* 10 :181 - 190.

KOMEN, J., WILLIAMS, A.J. & MYER, E. 1986. Hartlaub's Gulls and Swift Terns at Lüderitz: a conservation problem. *Lanioturdus* 22: 3, & 10-12.

LUCKS, D.K. 1970. Aspekte van die biologie van die witsteenbras *Lithognathus aureti* (Smith,1962) in die Sandvishawe strandmeer. University of Stellenbosch. Unpublished M.Sc. thesis.

LYSTER, S. 1985. International Wildlife Law. Cambridge, UK: Grotius Publications Ltd.

ORANGE RIVER ENVIRONMENTAL TASK GROUP 1990. Assessment of environmental water requirement for the Orange River mouth (Report on Orange River environmental workshop, Oranjemund 1989). Pretoria: Dept. Water Affairs, Directorate of design services.

PROZESKY, O.P.M. 1963. Ornithological results of the Transvaal Museum Namib Expedition May 1959, and the subsequent trip to Sandwich Harbour during January 1960. *Ostrich* 34: 78-91.

ROBINSON, E.R. 1976. Phytosociology of the Namib Desert Park South West Africa. University of Pietermaritzburg. Unpublished M.Sc. thesis.

RYAN, P.G., COOPER, J. & STUTTERHEIM, C.J. 1984 a. Waders (Charadrii) and other coastal birds of the Skeleton Coast, South West Africa, *Madoqua* 14: 71-78.

RYAN, P.G., COOPER, J., STUTTERHEIM, C.J. & LOUTIT, R. 1984 b. An annotated list of the birds of the Skeleton Coast Park. *Madoqua* 14: 79-90.

RYAN, P.G. & COOPER, J. 1985. Waders (Charadrii) and other coastal birds of the northwestern Cape Province, South Africa. *Bontebok* 4: 1-8.

SCHOEMAN, A. 1984. Skeleton Coast. Johannesburg: Macmillan.

SCHULTZE, L. 1907. Aus Namaland und Kalahari. Jena: Gustav Fischer.

STUART, C.T. 1975. Marine fauna collected at Sandwich Harbour, Namib Desert Park, South West Africa. *Madoqua* (Ser.II) 4: 101-102.

SWART, D.H., MORANT, P.D., MOLLER, J.P., CROWLEY, J.B. & DE WET, A. 1988. A record of events at the Orange River mouth during the March 1988 flood. *S. Afr. J. Sci.* 84: 881-889.

TARR, J.G. & TARR, P.W. 1987. Seasonal abundance and the distribution of coastal birds on the northern Skeleton Coast, South West Africa/Namibia. *Madoqua* 15 : 63-72.

TARR, P.W. 1987. Non-nesting emergence by Green Turtles *Chelonia mydas* at the Cunene River mouth, South West Africa/Namibia. *Madoqua* 15: 267-268.

UNDERHILL, L.G. & WHITELAW, D.A. 1977. An ornithological expedition to the Namib coast, summer 1976/77. Cape Town: Western Cape Wader Study Group.

WHITELAW, D.A., UNDERHILL, L.G., COOPER, J. & CLINNING, C.F. 1978. Waders (Charadrii) and other birds on the Namib coast: counts and conservation priorities. *Madoqua* 11: 137-150.

WILKINSON, M.J., BLAHA, J.E. & NOLI, D. 1989. A new lagoon on the Namibian coast of South Africa: sand spit growth documented from STS-29 Shuttle photography. *Geocarto International* 4: 63-66.

WILLIAMS, A.J. 1986. Wetland birds at the Orange River mouth and their conservation significance. *Bontebok* 5:17 - 23.

WILLIAMS, A.J. 1987 a. Conservation management of the Walvis Bay wetland with particular reference to coastal bird numbers and their conservation significance. Walvis Bay: Walvis Bay Round Table 36.

WILLIAMS, A.J. 1987 b. Walvis Bay bird count. *Lanioturdus* 23: 16-19.

WILLIAMS, A.J. 1988. Walvis Bay and other coastal gems. *African Wildlife* 42: 82-85.

WILLIAMS, A.J. 1991a. Numbers and conservation importance of coastal birds at the Cape Cross Lagoons, Namibia. In: Simmons, R.E., Brown, C.J. & Griffin, M. (Eds.). The status and conservation of wetlands in Namibia. *Madoqua,* 17: 239-243.

WILLIAMS, A.J. 1991b. Wetland birds and conservation in Namibia: an overview. In: Simmons, R.E., Brown, C.J. & Griffin, M. (Eds.). The status and conservation of wetlands in Namibia. *Madoqua,* 17: 245-248

WILLIAMS, A.J. & BROWN, C.J. 1985. A policy for bird conservation in South West Africa/ Namibia, Part 2: evaluation of conservation priorities for bird species. Windhoek: Unpublished report, Directorate of Nature Conservation.