

**CONSERVATION PRIORITIES
AND MANAGEMENT
RECOMMENDATIONS FOR THE
ERONGO REGION COASTAL
ZONE, NAMIBIA**

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TERMS OF REFERENCE

The Danish Co-operation for Environment and Development (DANCED) contracted the Masters in Philosophy students from the Environmental and Geographical Science Department of the University of Cape Town to gather baseline information for an Integrated Coastal Zone Management Plan for the Erongo Region, Namibia. The information that was gathered, was produced in a baseline report that was submitted to DANCED in March 1996.

For fulfillment of the Masters degree in Environmental Science, each individual student has to submit a dissertation on a topic related to at least one of the environmental issues identified in the baseline report. All aspects of a human environment, namely the natural, social and economic aspects, need to be integrated into the topic that is discussed for the dissertation. This study represents this dissertation and relates to the issue of sustainable utilisation of the natural environment in the coastal zone.

The dissertation must be submitted to the Department of Environmental and Geographical Sciences of the University of Cape Town on 22 July, 1996.

SUMMARY

The most intensively used part of the Namib Coastline, the area between Walvis Bay and the Ugab river, contains some of the most important and most sensitive natural habitats. Apart from their ecological value, these habitats also attract large numbers of tourists. Tourism is one of the main sources of income in the coastal area of the Erongo Region, therefore it is in the interest of Namibians that these habitats are utilised in a sustainable way.

The Department of Resource Conservation of the Ministry of Environment and Tourism is responsible for managing the West Coast Tourist Recreation Area as well as the wildlife in all of Namibia. Conservation managers from this Department have identified sites in the study area that are important for maintaining healthy populations of rare, threatened or endemic species or species of international and regional importance. These sites must be managed in such a way that their conservation and tourism value is not detrimentally reduced.

In order to assist conservation managers with the allocation of resources, the sites that were identified are divided into three priority groups, namely imperative, urgent and desirable. The evaluation for priority rating was done according to the criteria of conservation value, tourism value and threats. Sites were compared using pair-wise comparison, and groupings were obtained through cluster analysis.

The sites that were identified, their main reason for conservation, most important threats and management recommendations are listed below according to the priority groupings. Management recommendations are only done for the two highest groupings, namely the imperative and important sites.

◆ IMPERATIVE**1. Walvis Bay wetland**

This wetland is a bird habitat of national and international importance. The most important threats are oil and other sources of pollution, development and siltation.

Management recommendations:

- Establish a single authority to be responsible for the management of the wetland as a Ramsar site.
- Namport should provide adequate storage facilities for bunker oil in the harbour.
- Namport should acquire equipment that will restrict oil and diesoline spills to the harbour and bay area as well as equipment to clean up and disperse oil spills.
- Action must be taken against vessels dumping oil in the bay area.
- Oil contaminated birds must be captured and rehabilitated.
- Train staff of Ministry of Fisheries and Marine Resources in the methods to treat oil contaminated birds.
- Acquire equipment for treating and rehabilitating contaminated birds.
- Contain spillages of paints and other chemicals and fouled water in the harbour and treat the water before it is returned to the sea.
- Stop the disposing of sewage and solid waste from ships into the harbour and bay area.
- Appoint an officer to do water quality monitoring in the harbour.
- The Department of Water Affairs must address the lack of strict effluent standards as well as regular monitoring of effluent.
- Namibia should become party to and ratify conventions addressing a healthy marine environment.
- All developments (including Government projects) in and around the lagoons must be accompanied by environmental assessments.

- Hold a workshop to discuss placing of heavy industry zone and reach the best situation that will satisfy environmentalists and industry.
- Strict pollution standards should be introduced to mitigate the effect of industrial development next to the bay.
- Walvis Bay lagoon and bay area, mudflats and Pelican Point must be included in the list of sensitive areas in the Environmental Assessment Act which is presently drafted.
- The Townships Board and the Namibia Planning Advisory Board must be responsible for taking the environment into consideration when assessing a development application.
- Gain comments on the ecological impact of development plans from the Directorate of Resource Conservation.
- An above-ground powerline crossing the lagoon to supply power to a desalination plant at Paaltjies must never be allowed.
- Find ways to reduce the silt levels reaching the lagoon from dredging in the harbour.
- Low flying aircraft over the wetland should be banned or at least restricted to the minimum.
- The salt works must not be allowed to expand into the lagoon.
- The Ministry of Fisheries and Marine Resources must determine the maximum lagoon area that can be set aside for mariculture.

2. Wlotzkasbaken lichen field

This is the largest single lichen field in the world containing endemic lichen species. Threats are urban expansion, non-residential development and off-road driving.

Management recommendations:

- General recommendations:
- Demarcate popular access routes and trails as acceptable routes and close off other tracks.
- Set aside areas for uncontrolled off-road driving.

- Educate the people of Namibia on the sensitivity of the Namib desert.
- Erect information boards next to the main roads at the sensitive sites.
- Proclaim a regulation that prohibits the driving of any vehicle in any other place than a public road.
- The Ministry of Mines and Energy must draft policy for mining in the West Coast Recreation Area that address the protection of the natural environment.
- Mining in the west coast tourist recreation area must be listed in the Environmental Assessment act as an activity for which an assessment is required.
- Strict guidelines for protecting the environment during mining in the recreation area as well as rehabilitation afterwards must be included in the licence conditions of all new prospecting and mining licenses.
- The Ministry of Environment and Tourism must be allowed to comment on the mining or prospecting proposal and proposed license conditions.
- Force mine owners or managers to fence off work areas or properties and prohibit driving off public routes outside these fenced-off areas.
- Developments and structure plans must take the sensitivity of the lichen fields into account.
- The directorate of resource conservation must comment on any development plans or structure plans.
- Specific recommendations:
- This lichen field must be listed as a sensitive site in the proposed Environmental Assessment act.
- The town of Wlotzkasbaken must not be allowed to expand in a northern and eastern direction across the road to leading to Henties Bay.

3. Lagunenberg lichen field

This is a particularly diverse lichen field which is elevated, containing endemic lichen species. The main threat is from off-road driving.

Management recommendations:

- General recommendations for lichen fields are also applicable here.
- This lichen field must be listed as a sensitive site in the proposed Environmental Assessment Act.

4. Damara tern breeding sites

The Damara tern is endemic to southern Africa and 90% of the world population is found in Namibia. The breeding birds are mainly threatened by off-road driving and development.

Management recommendations:

- The same solutions to the problem of off-road driving can be recommended as for lichen fields.
- Acceptable routes to the beach can be marked out.
- Routes should only go through colonies where these cover large areas and detours will be unacceptably long.
- Post signboards disclosing information about the birds where popular tracks are closed off, explaining why it was done.
- Take action against vessels dumping oil at sea.
- Capture and rehabilitate oil contaminated birds.
- Chicks must be hand reared if oil spills occur during the breeding season.
- Research the necessary information and techniques to rear and rehabilitate these birds.
- The breeding sites must be mapped out in the finest detail possible.
- These sites must be reserved in the minerals act to protect them from mining.

- When any work is to be done during the breeding season in the vicinity of breeding sites, the sites must be temporarily fenced off to avoid traffic through and other disturbances to the sites.
- Coastal towns and resorts should not expand in the direction of breeding sites and a buffer zone must be kept open between the breeding site and the town.

5. Patryberg

This area hosts a particularly large number of waders and is also a breeding site for whitefronted plovers and Damara terns. The main threats are development, off-road driving and pedestrians and their dogs.

Management recommendations:

- Launch a campaign to make the public aware of the value of the site to birds in an attempt to pressurise the municipality into caring about the birds.
- The municipality must proclaim by-laws that disallow vehicles from this stretch of beach.
- The old railway line may be demarcated as an accepted route if necessary with specific access routes between it and the tar road that do not cross the main area of the damara tern breeding colony.
- The main part of the damara tern breeding colony must be fenced off with an aesthetically attractive and durable fencing.
- People and dogs must not be allowed inside the fenced-off breeding area during the breeding season.
- Information boards must be erected around the perimeter of the fenced area.
- Dogs must not be allowed on the beach north of Langstrand.
- A shelter can be built from which people can observe the birds.
- Oil spills should be dispersed at sea before they reach the coast.
- Oil contaminated birds that land here must be captured and rehabilitated.

- Damara tern chicks should be hand-reared if large numbers of adult birds are oiled during the breeding season.
- Northern expansion of Langstrand must never be allowed.
- The environment must play a bigger role in decision making about projects and the comments of the directorate of resource conservation should be taken more seriously.

◆ **IMPORTANT**

6. Lichen fields (general)

The lichen fields host a variety of endemic lichen species. These areas are very fragile and are threatened by off-road driving, development and mining.

Management recommendations:

- General recommendations for lichen fields are applicable here.

7. Cape Cross seal colony

This is the only breeding colony in the study area and is the largest land-based breeding colony in the world. About 19% of the pups that are annually born, are born at this site. The seals are threatened by oil spills.

Management recommendations:

- The culling of seals must never take place in December when the peak tourist season starts.
- Action must be taken against vessels dumping oil at sea.

8. Birdrock platform

This platform is the only one in the world built in the open sea and is an important breeding site for cormorants. It is the only breeding site for great white pelicans in Namibia. The birds are mainly threatened by oil spills.

Management recommendations:

- Pelican chicks should be rescued and hand-reared if severe oil spills occur during their breeding season.

- The pollution prevention measures suggested for the Walvis Bay wetland will also benefit the birds on the platform.

9. Swakopmund salt works

This artificial wetland is of international importance as a wetland bird habitat, and also houses a guano platform. This platform supports 25% of the world population of Cape cormorant. The birds are mainly threatened by oil spills.

Management recommendations:

- If tourism is developed, the numbers and activities of people should be limited.
- Disperse oil spills at sea.
- Rehabilitate oil contaminated birds.

10. Cape Cross Lagoons

These are the only natural saline lagoons in Namibia that are not connected to the sea. It is a bird habitat of international importance and also houses a guano platform on which cormorants breed. The main threat to the birds are oil spills.

Management recommendations:

- Rehabilitate oil contaminated birds.
- Take action against vessels dumping oil at sea.
- No further development should occur in the lagoons.
- If tourism to the lagoons is increased, the numbers of people as well as their movements in the area should be restricted.

◆ DESIRABLE

11. Messum Crater

This crater has lichens, *Welwitschia* trees, bushman paintings as well as large game. It provides a fascinating, isolated experience to visitors. It is mainly threatened by off-road driving.

12. Rivers

Rivers are linear oases supporting various organisms, including humans. Expansion of human settlements and activities has led to the over abstraction of water, with resulting die-off of plants.

13. Hummock dunes

These dunes stabilise mobile beach sand and provide a habitat for specific plants and animals. They are threatened by off-road driving.

14. Dolerite dykes

These dykes provide the only habitat for *Lithops* and other succulent plants. These plants are mainly threatened by off-road driving.

15. Bird Paradise

This artificial habitat is a source of fresh water for flamingos as well as ducks and geese. This increases the bird diversity in the study area. Large scale re-use of the sewage water will lead to the destruction of this habitat.

16. The dunes between Walvis Bay and Swakopmund

These dunes host specialised desert organisms, but are more important for their scenic and recreation value than for conservation value. Plans exist to mine most of the dunes for heavy minerals.

Due to their low conservation value, the dunes between Walvis Bay and Swakopmund are not presently considered as a priority for conservation management.

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1. INTRODUCTION

Namibia is richly endowed with a wide variety of habitats that supports a wealth of unique and interesting flora and fauna. Such habitats also provide vistas and scenic beauty. The area encompassed by this study, the coastal strip of the Erongo region, is no exception. In fact, it is a special area due to the transition from sandy to rocky desert that takes place in the area, the presence of sheltered bays and lagoons, the especially rich upwelling taking place off-shore and the presence of stretches of rocky coastline. These natural features attract many tourists who provide a strong boost to the economy of the region. Tourism along the Namibian coast is concentrated in the coast of the Erongo region due to the fact that the coastline south of Sandwich Harbour, apart from a small area around Luderitz, is inaccessible to tourists. Furthermore, tourism in the Skeleton Coast Park is highly controlled and seasonal due to closed seasons for fishing.

Apart from tourism, the main economic activities in the coastal area of the Erongo region are fishing and mining. Walvis Bay has the only deep water port in Namibia, houses a flourishing fishing industry and has potential for the development of an Export Processing Zone (EPZ). The rest of the region has a wealth of minerals which are being mined.

These economic activities unfortunately also have negative impacts on the natural environment. The desert environment in which conditions are harsh leads to slow recovery of the environment after disturbance. Uncontrolled tourism, mining and development can therefore spoil the scenic beauty of the area. The Namibian Government has realised this and has drawn up policies and plans to reduce the negative impacts of tourism and development. This is unfortunately still not enough and further actions are needed to protect the environment from abuse.

This study attempts to identify the areas of specific interest to the conservation authorities, as well as the threats that are posed to these areas. These areas are evaluated according to the criteria of conservation value, tourism value, and threats in order to determine priorities for the allocation of limited conservation management resources. Three priority classes are used, namely imperative, urgent and desirable. Management recommendations are made for the sites falling in the first two classes only, due to time constraints. The threats to the majority of the remaining sites are similar to those for which recommendations are made. Some of the recommendations are not very site specific and will alleviate some problems for those low priority sites without direct attention being given to them.

1.1 BOUNDARIES OF THE STUDY AREA

This study is based on the information gathered for the Baseline Report for a Coastal Zone Management Plan for the Erongo Region, Namibia (M.Phil Environmental and Geographical Science 1996). The whole study area of the Baseline Report, however, cannot be covered due to time constraints.. The area that this study will be covering is described below.

- The **northern boundary**: that of the Skeleton Coast Park on the southern bank of the Ugab River.
- The **eastern boundary**: that of the National West Coast Tourist Recreation Area; the Swakopmund magisterial district and the municipal area of Walvis Bay.
- **The southern boundary**: the southern municipal boundary of Walvis Bay.
- **The western boundary**: The low water mark on the beach, except for the Walvis Bay lagoon where a line is drawn between Pelican Point and the harbour to include the whole lagoon.

Figures 1 and 2 clearly illustrates the location of the study area and its boundaries.

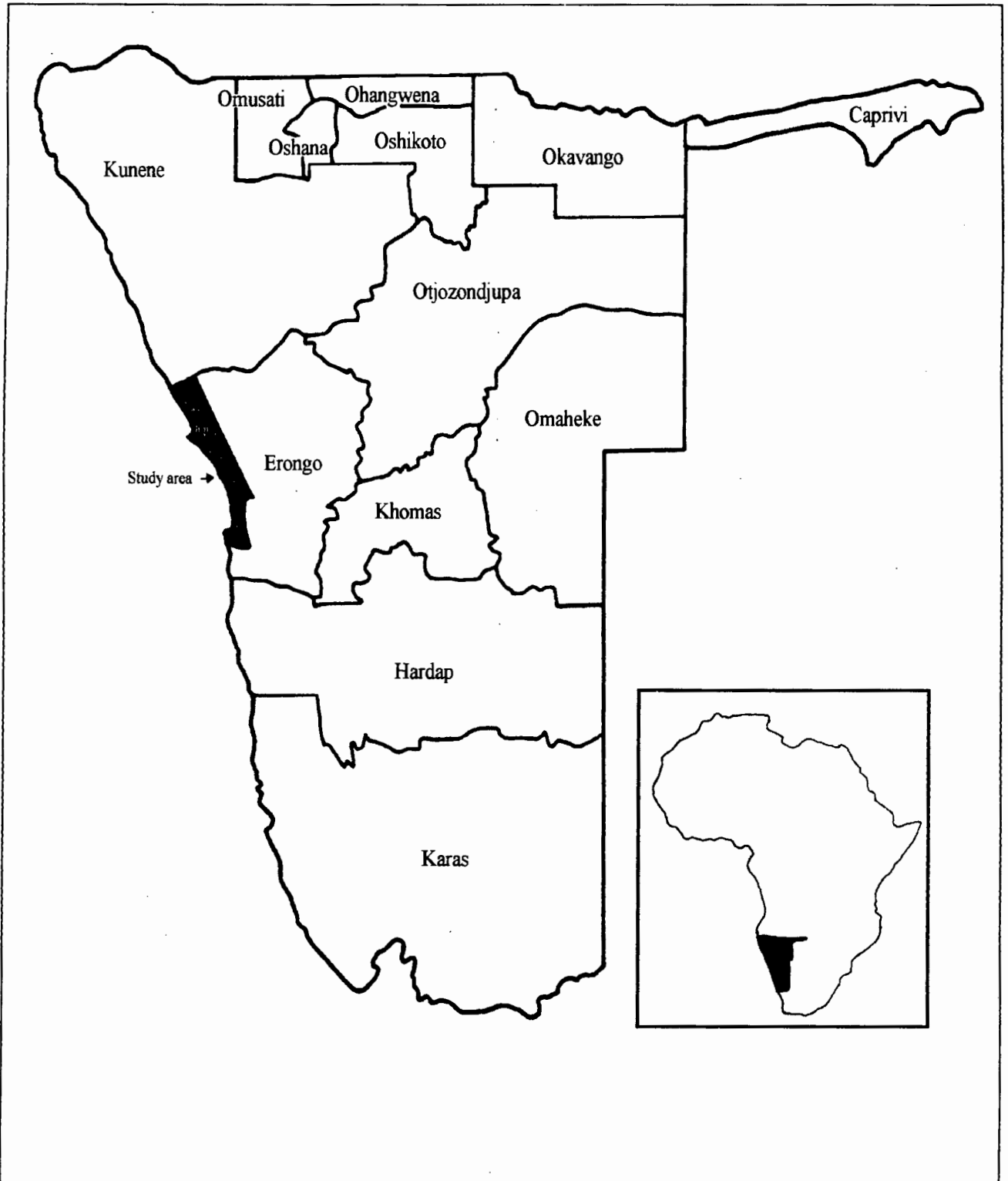


Figure 1. Regions of Namibia.

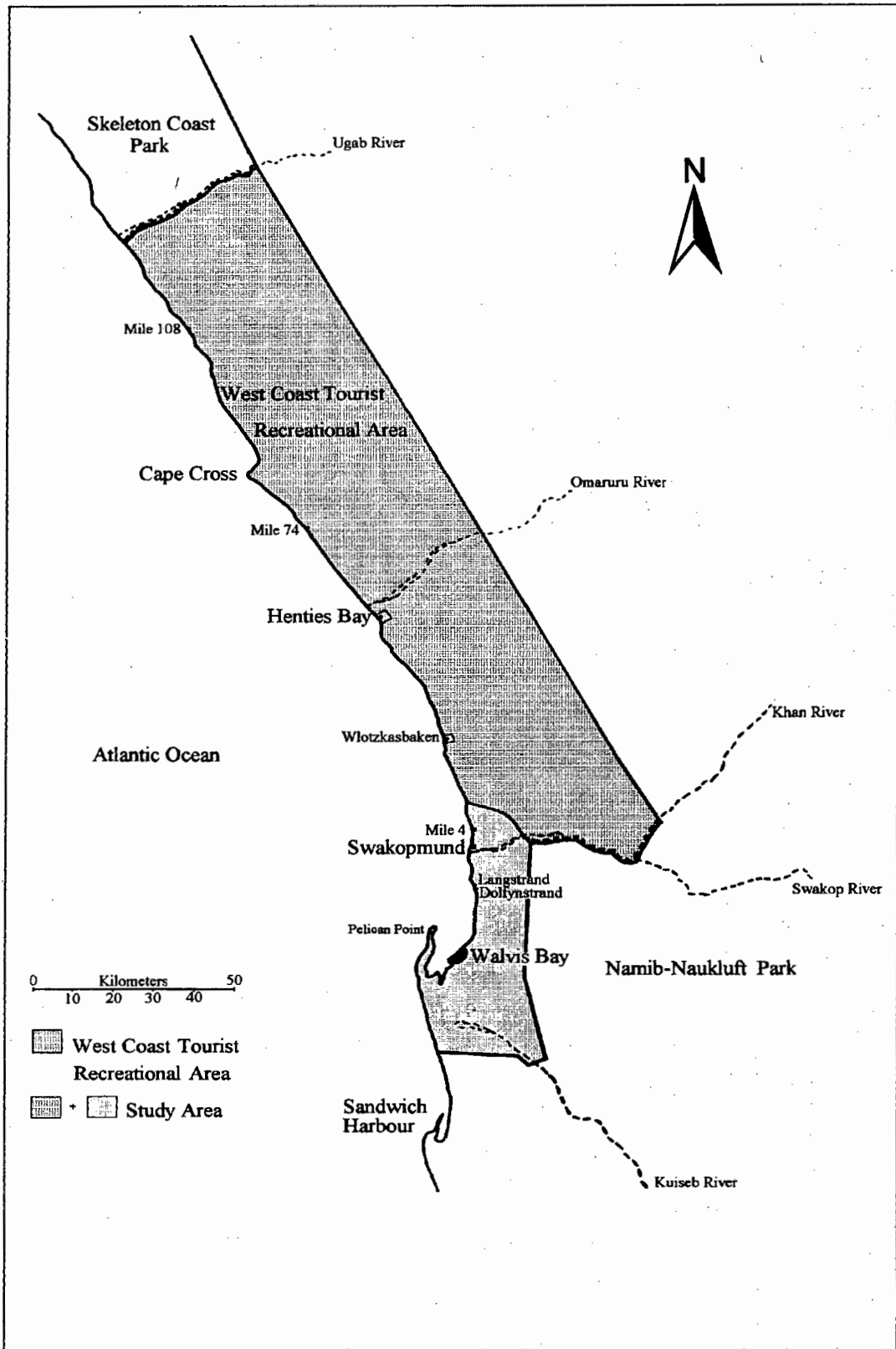


Figure 2. Boundaries of the Study Area.

The towns that are included in the study area are Walvis Bay, Swakopmund, Wlotzkasbaken and Henties Bay.

1.2 AIMS OF THE STUDY

The aim with this study is to assist the Ministry of Environment and Tourism in the management of the natural environment of the study area. This will be done by:

- identifying and describing sites that are of conservation importance
- identifying activities that threaten these sites
- prioritising identified sites
- suggesting some management options

1.3 BACKGROUND TO THE PROBLEM

Namibia's constitution promotes a policy of sustainable use of natural resources for the benefit of both present and future generations. Namibia is in fact one of the countries in the world with the highest percentage land area dedicated as nature reserves (fifteen percent of the country's area). This, however, does not mean that other areas are utilised on a sustainable basis, and there are many unique and sensitive habitats outside nature reserves. Conservation authorities have little control over the location, type and scale of human developments outside protected areas (M.Phil Environmental and Geographical Science 1996).

Most of the Namibian coastline is either closed off (Sperrgebiet) or falls inside nature reserves. The greatest part of the study area falls outside nature reserves and is therefore the only part of the coastline that is open for general tourism and recreation. Unfortunately there are also very sensitive habitats inside the study area, like the lichen fields and bird breeding sites. These habitats have been and are being damaged through township and infrastructure development, mining and tourism. Large scale damage has

already occurred and recovery will take a long time. There is therefore a need to manage these habitats for conservation while people are still allowed to enjoy the desert landscape in a responsible manner. This study tries to address these problems and suggest methods for management of the natural environment for the benefit of both the environment and the people who live in it or spend large amounts of time and money to enjoy it.

1.4 METHODOLOGY

Information gathering for the Baseline Report for a Coastal Zone Management Plan for the Erongo Region, Namibia was done by the entire Masters in Environmental Science (1995/6) group. The information was gathered through personal interviews during two visits of two weeks each to Namibia, personal observation as well as literature review. During a visit to Swakopmund, a conservation manager was asked to draw special areas on a set of 1:50 000 topocadastral maps. These areas, as well as others that were identified in literature, form the base of this study. Further literature review was, however, required to expand on the information that is available from the Baseline Report.

1.5 ASSUMPTIONS AND LIMITATIONS

It is assumed that the timespan for which the priorities and recommendations will be relevant will be about 5 years. Factors such as the building of a harbour at Cape Cross or Möwe Bay, the closing down of the Rössing Uranium mine and changing climate and sea levels is not taken into account. These factors will have serious repercussions for the study area and will change the threats to sites and management options substantially.

The most critical limitation to the study is time. Due to the short time available, the study will be limited to the geographical area set down in Section 1.1. The areas within the Namib-Naukluft Park (Sandwich Harbour and the desert dunes) will not be covered since they are already managed for conservation and are therefore not in as urgent need of management effort as

the areas outside the Park. The study will also not deal with any marine issues (like commercial fish stocks, line fishing, bait collecting) and management recommendations will only be made for the imperative and urgent priority classes.

Furthermore, archaeological sites are not included in the description of sensitive areas, whereas they should be included for a complete study. The reason for this is the little information that is available to the author. The curator of archaeology at the National Museum in Windhoek, Dr Kinahan, did not want to disclose the localities of archaeological finds in the study area due to fears of damage to artifacts once the localities are common knowledge (Dr Kinahan, pers.comm., 05/02/96).

The sections dealing with the evaluation of sites and management recommendations have been limited further by the lack of detailed information and public participation. Most of the suggestions need approval from and cooperation of the people living in the area. These people must be involved and must have the opportunity to alter priorities and suggestions to make them acceptable and workable. The public must also be educated to understand the reasons why some suggestions are made. Education will most probably change their opinions towards the intentions of authorities as well as create an appreciation of nature, which is important for the success of management efforts.

Another limitation is the short time spent in the study area by the author, and therefore the little information and understanding gained on the area. This may lead to a limited understanding and prioritising of problems.

2. SITES OF CONSERVATION IMPORTANCE

Conservation here refers to conservation of the natural environment, concentrating on preventing or limiting human damage to the natural environment, whilst allowing utilisation of the natural resources.

Why is there so much concern for the environment of the study area, if most of the coastline is already conserved? The reasons are:

1. There are habitats in the study area that are rare in the protected areas and are important for maintaining healthy populations of rare, threatened or endemic species or species that are of international or regional importance (like Palearctic migrant birds). Healthy populations ensure the continued existence of genes which allow for adaptation to environmental change. One example of a habitat supporting rare and internationally important species is a wetland.
2. The natural environment provides a scenic landscape that is an important tourist attraction in Namibia. Degradation of the environment can harm the tourism industry, one of the main money earners in the coastal region.
3. It is morally indefensible to damage the environment with unsustainable activities. Certain areas can be designated for activities like off-road driving, while other areas must be protected from the actions of people.

Identification of areas of conservation importance should be based on criteria that are compatible with the abovementioned motivations. The people who stay and work in the study area are the best judges of which sites are important. The sites that are discussed in this study are therefore mainly those identified by conservation managers, but also through literature review.

The location of the sites that are discussed is indicated in Figures 5a and 5b which are at the back of this section.

2.1 DESCRIPTION OF SITES OF CONSERVATION IMPORTANCE

2.1.1 WALVIS BAY WETLAND

a. Site description

The Namib coastline has a few sheltered bays that are protected from deep wave action. These bays trap fine silts and nutrients washed in by tides and provide the ideal habitat for plants and small organisms that cannot tolerate high energy surf, and which form the basis of the food chain. This factor increases the importance of the wetlands associated with these bays for species diversity in Namibia. Walvis Bay is such a bay, also having a lagoon and mudflats which attract numerous birds (Noli-Peard & Williams, 1991).

The lagoon, the eastern half of Pelican Point and its adjacent intertidal areas, the salt works and the naturally flooded areas to the south of the salt works are considered as the Walvis Bay wetland. The total area of this wetland covers an area of 35-40 km² (Noli-Peard & Williams, 1991).

Even though the Walvis Bay salt works destroyed extensive areas of natural tidal flooding during its development, it now provides large areas of permanently flooded, shallow water with extensive shorelines. Half the birds occurring within the Walvis Bay Lagoon are regularly recorded in the salt works area (Noli-Peard & Williams, 1991).

Walvis Bay Lagoon comprises different reaches, in response to different controlling environmental conditions. The lower reaches are characterised by stronger tidal velocities, non-turbid water, lower temperatures, constant salinities, coarser bottom sediments and low levels of organic matter. The middle reaches, however, experience lower tidal velocities, more variable temperatures and salinities, higher turbidity levels and finer-grained sediments with higher organic fractions (CSIR, 1989).

The different reaches of the lagoon are significant in terms of the benthic fauna that they support. The benthic communities found in the lagoon are characterised by mud prawns, tube worms and burrowing bivalves (CSIR, 1989). It was noted that the middle (deeper) reaches of the lagoon contain the highest species diversity and densities of individual species. This is a result of the biogenic sludge that collects in these sections. The mouth area of the lagoon appears to be dominated by the crown crab (*Hymenosoma orbiculare*), which is the main prey of the grey plover. The shallows and middle reaches of the lagoon support populations of the large tube-worm (*Diopatra sp.*), the colonial Paper Mussel (*Anomia sp.*), and sea-anemones (*Anthothoe sp.*). The intertidal fringes appear to be dominated by the small polychaete (*Prionospio sexoculata*), and the mud prawn (*Upogebia capensis*), and represents a northernmost distribution record for these species (CSIR, 1989).

The diversity and abundance of organisms within the lagoon is the primary reason why so many birds are attracted to the area. The Walvis Bay wetland is the most important wetland bird habitat along the Namibian coast. Table 1 indicates the bird numbers for the 5 most important localities in Namibia (Williams, 1993):

Table 1. Namib coast wetlands ranked according to wetland bird numbers

<u>Rank</u>	<u>Locality</u>	<u>Number of birds</u>
1	Walvis Bay Wetland	129 000
2	Sandwich Harbour	47 580
3	Orange River Mouth	10 605
4	Cape Cross Lagoons	9 307
5	Swakopmund salt works	9 088

In terms of the number and variety of coastal birds which it supports, the Walvis Bay wetland is also regarded as the most important coastal wetland in southern Africa between Angola and Mozambique and is most probably one

of the ten most important wetlands in Africa. Of the birds supported by the wetland, 5% are resident, 50% are intra-African migrants and 44% are Palaearctic migrants. The bird counts exclude the Cape cormorants (*Phalacrocorax capensis*) which roost at the lagoon but breed elsewhere. The reason for exclusion of these birds is that it is impossible to count their numbers without aerial photography. It is, however, estimated that their numbers can reach 60 000 (Williams, 1987).

The Walvis Bay wetland supports a fairly high percentage of the world populations of several birds. These birds and the relevant percentages are listed below (Noli-Peard & Williams, 1991).

- **Percentages of world populations supported:**

Chestnutbanded plover (*Charidrius pallidus*) 50%

Blacknecked grebe (*Podiceps nigricollis gurneyi*) 18%

Hartlaub's gull (*Larus hartlaubii*) 5%

- **Percentages of southern African subcontinental populations supported:**

Lesser flamingo (*Phoenicopterus ruber*) 60%

Greater flamingo (*Phoenicopterus minor*) 38%

Great white pelican (*Pelecanus onocrotalus*) 10%

There are also six species of birds found in the lagoon that are listed in the South West Africa/Namibia Red Data Book: Birds. These birds are the Caspian tern (*Hydroprogne caspia*), Damara tern (*Sterna balaenarum*), Swift tern (*Sterna bergii*), Hartlaub's gull (*Larus hartlaubii*), Greyheaded gull (*Larus cirrocephalus*) and Great white pelican (Williams, 1987). The wetland is considered of international importance because of these facts, and is registered as a Ramsar site under the Ramsar Convention (Braby, pers. comm., 14/02/96).

The number of birds breeding within this wetland is small, probably due to the accessibility of most places to Blackbacked jackal (*Canis mesomelas*), which is a predator of major importance (Noli-Peard & Williams, 1991).

Apart from the birds, the wetland is also important for Aquaculture. Walvis Bay is one of the few bays along the coast and is the best situated in terms of access and proximity to markets. Oysters (Pacific oysters, *Crassostrea gigas* and European flat oysters, *Ostrea edulis*) are grown in the ponds of the salt works and plans exist for developing a mussel farm near Pelican Point (M.Phil Environmental and Geographical Science, 1996).

b. Threats

The activities posing threats to the wetland will only be summarised here, since detailed discussion of the impacts is beyond the scope of this study.

The following existing impacts on the lagoon from harbour activities have been identified in M.Phil Environmental and Geographical Science, 1996 (Section 4.3.4):

- oil spills - these occur every year, still there is no equipment in the harbour for cleaning up oil spills;
- dumping of waste in or near the harbour by ships, despite a waste collection service in the harbour;
- disposing of sewage from ships into the harbour and bay area;
- oil, heavy metals and anti-fouling paints spilt from harbour activities;
- organic pollution from the effluent of fish factories;
- high silt levels due to dredging of the harbour.

It is predicted that the traffic in the harbour will increase with the completion of the Trans-Kalahari and Trans-Caprivi Highways. This will necessitate expansion of the harbour which will have a physical impact on the wetland. Pollution events will also increase, threatening the biotic components in the wetland.

Williams (1993) assessed the vulnerability to oil of the most important bird species along the Namib coastline. An Oil Vulnerability Index (OVI) was drawn up. Birds having OVI scores of 61 and above are considered species of "high concern" for which emergency contingency plans are necessary. According to this index, the birds frequenting Walvis Bay that have scores of 61 or above, are:

- Cape cormorant
- Hartlaub's gull
- Kelp gull
- Swift tern
- Great white pelican
- Damara tern
- Caspian tern
- Greater flamingo
- Lesser flamingo

Oil pollution will harm aquaculture in the lagoon and in the salt works' ponds (water is pumped from the lagoon to the ponds). Shellfish are highly susceptible to pollution through contamination of the flesh as well as reduced phytoplankton production: the food of shellfish (O'Toole, 1993).

Apart from the developments mentioned above, there is also the possibility that an Export Processing Zone (EPZ) will be established at Walvis Bay (M.Phil Environmental and Geographical Science 1996, Section 3.7). Heavy industry, which is zoned close to the lagoon in the Walvis Bay structure plan, could cause harmful leachates to reach the lagoon.

Another project that is planned, is the construction of a desalination plant at Paaltjies (M.Phil Environmental and Geographical Science 1996, Section 4.5). This will necessitate a power line going to, and a water pipe coming from Paaltjies across the wetland. A power line above the ground can kill birds, while a pipeline will cause damage to mudflats.

Siltation of the lagoon due to natural factors is making the lagoon shallower. It is predicted that the southern arm of the Kuiseb river can deposit a large quantity of sand in the lagoon when the river comes down in flood again. The wall that has been built to protect the town of Walvis Bay, will block the northern arm of the river, increasing the flow in the southern arm. It is, however, unlikely that the flow will be enough to wash the sand out of the lagoon into the open sea (CSIR, 1989).

Other activities that also impact on the birds in the wetland are small craft (motorised and non-motorised), low-flying tourist aircraft and domestic dogs which run loose amongst the birds. Potential impacts on the wetland are the proposed mussel farm, expansion of the harbour, increased residential and tourism development along the lagoon edge and expansion of the salt works (which is probably unlikely).

The birds in the lagoon are often flushed by low flying tourist aircraft (Lenssen, pers. comm., 30/11/95). This disturbance is acceptable at a low level, but not if it occurs often.

2.1.2 BIRDROCK GUANO PLATFORM

a. Site description

Platforms have been erected on the coast north of Walvis Bay, in the Swakopmund salt works and in the Cape Cross lagoons, to attract cormorants which, in turn, produce guano. This provides a source of guano that is easily accessible, compared to the islands which have to be reached by boat. These platforms are the only breeding sites of seabirds along the coast of the study area and are amongst the ten most important seabird localities in Namibia. The other breeding sites are on the islands off Luderitz. (Williams, 1993).

The platforms in the Swakopmund salt works and Cape Cross Lagoons are considered as part of those systems and will not be discussed separately. The Birdrock platform near Walvis Bay will therefore be considered as a separate site.

The main bird species breeding on the platform are:

Bank Cormorant	<i>Phalacrocorax neglectus</i>
Cape Cormorant	<i>Phalacrocorax capensis</i>
Crowned Cormorant	<i>Phalacrocorax coronatus</i>
White-breasted Cormorant	<i>Phalacrocorax carbo</i>
Great white pelican	<i>Pelecanus onocrotatus</i>

The Bird Rock platform supports the only breeding population of Great White Pelican in Namibia and up to 4% of the world population of Crowned Cormorants (Williams, 1993). Furthermore, this is the only platform in the world built in the open sea, making it a feature of interest for tourists. It is also the most visible platform to tourists (Williams pers. comm. 14/5/1996).

b. Threats

The greatest threats to the birds on this platform is diesoline and oil pollution from ships as well as pollution in Walvis Bay from the harbour activities. Chemicals and plastics can be harmful to pelagic sea birds.

An occurrence of fish oil pollution in June 1974 caused large scale mortality of Cape cormorants, particularly in the area of Walvis Bay and Swakopmund (Berry, 1976).

This platform is the closest of the three to shipping routes and activities and is therefore the most threatened of the three bird breeding localities. The birds breeding on the platform also have high OVI ratings, which mean that they are highly susceptible to oil pollution (Williams, 1993).

2.1.3 CAPE CROSS LAGOONS

a. Site description

The Cape Cross lagoons are a series of smallish lagoons and are situated on the coast of the study area, just south of Cape Cross itself. In total, the lagoons are about 10 km long, up to 1000 m wide and cover an area of about 5 km². The lagoons were formed by longshore sediment drift from south to north creating a sand barrier across a former embayment. Water seeps through the sand barrier or is washed over the barrier during extreme storms or high tides. The lagoons are therefore saline, non-tidal and permanent, offering a habitat that differs from the wetlands at Walvis Bay and Sandwich Harbour. Within the lagoons, several guano platforms with a total area of 68 000 m² have been erected for guano collection, and provide important resting and breeding areas for seabirds (Williams, 1991).

These lagoons support up to 11000 birds, excluding the cormorants. Cape Cross is the most important locality for the endemic southern African subspecies of the Blacknecked Grebe (*Podiceps nigricollis gurneyi*), of which between 6 and 16% utilise these lagoons. The lagoons also support between 1 and 3% of the subcontinental populations of Greater and Lesser Flamingo as well as between 5 and 22% of the coastal population of Cape teal (Williams, 1991).

The birds breeding on the guano platforms are Cape cormorant, Whitebreasted cormorant (*Phalacrocorax carbo*) and Kelp gull (*Larus dominicanus vetula*) (Williams, 1991).

The lagoons are within a private nature reserve and are recognised as internationally important wetlands, proposed as a Ramsar site (Williams, pers. comm., 14/02/96).

b. Threats

There are no real immediate threats to these lagoons. The birds have co-existed with the salt works and guano collecting activities and are therefore not threatened by it. The sea birds breeding on the platforms will, however, be threatened by mineral and fish oil spills. All three breeding species are considered as species of high concern according to the Oil Vulnerability Index (Williams, 1993).

2.1.4 CAPE CROSS SEAL COLONY

a. Site description

The Cape Cross seal colony is the only breeding colony of Cape fur seals (*Arctocephalus pusillus*) along the northern half of the Namibian coast. It is the largest land-based breeding colony of Cape fur seals in the world and produces 19% of the total pup production of the species (about 82% of the Namibian production). Protection of the breeding site is therefore vital for the health of the world's Cape fur seal population (Roux, 1993).

The Cape Cross colony has been increasing at a rate of 6,8% since 1972, and has now reached a population of more than 80 000 individuals. Culling of the seals takes place annually between August and November and is a controversial issue. The general policy of the Ministry of Fisheries and Marine Resources is that 30% of the annual pup production is allocated for harvesting. Seal harvest numbers at Cape Cross increased from 7395 in 1990 to 16 890 in 1993 (Roux, 1993).

Cape Cross is the only breeding colony accessible to the public, and is an important tourist attraction for Namibia, attracting over 20 000 tourists per year (Roux, 1993). The income generated from these tourists is the highest of all tourist activities in the study area and is important for the economy of the study area. The peak tourist season is from December to March. The breeding colony should be managed in a way that the attraction will not be diminished.

Seals are seen as a marine resource and are therefore managed and harvested by the Ministry of Fisheries and Marine Resources. The seal colony, however, is on land managed by the Ministry of Environment and Tourism which tries to encourage tourism. This situation creates a conflict of interest which is not easy to resolve.

b. Threats:

The threats to the seals are unsustainable culling, overfishing of their food source, oil spills and the building of a harbour at Cape Cross. Overfishing and unsustainable culling should not happen with proper management of the resources, therefore it will not be considered as an immediate threat with great probability. The building of a harbour at Cape Cross is uncertain for the immediate future and will not be considered for this study either.

Oil spills are therefore the only threats to the colony and can cause severe damage. Oil affects the insulation properties of the pelts of the seals, causing them to die of cold (O'Toole, 1993).

2.1.5 SWAKOPMUND SALT WORKS

a. Site description

The salt works, 6 km north of Swakopmund, consist of extensive artificial salt pans which were created by the excavation of a low-lying dry salt pan, and the constant pumping of sea water into the pans. These pans are also commercially utilised for oyster farming (Pacific and European flat oysters), and guano is annually harvested from a guano platform situated within an evaporation pan..

The wetland attracts upwards of 20 000 wetland birds, including over 1% of the subcontinental populations of Greater and Lesser flamingos and Chestnutbanded plovers. The salt works is an important foraging area for

Damara terns and Great crested grebe The salt works is the most northern breeding locality for Hartlaub's gull. Other birds breeding here are swift tern, kelp gull, chestnutbanded plover and avocet (*Recurvirostra avosetta*) (Noli-Peard & Williams, 1991).

The guano platform support up to 250 000 pairs of Cape cormorants (a quarter of the global population - Williams, pers. comm. 14/5/96) and is also a breeding locality for Whitebreasted cormorants (Noli-Peard & Williams, 1991). This platform is the most important of the three platforms in the study area (Williams, 1993).

The salt pans are registered as a private nature reserve and have been proposed as a Ramsar site (M.Phil Environmental and Geographical Science, 1996).

b. Threats:

The threats in the salt pans are the same as for the Cape Cross lagoons. Mineral and fish oil pollution can have a severe impact on the sea birds breeding on the guano platforms (see mention to OVI in previous sections). Oil pollution can also affect the oysters, because water is pumped from the sea into the ponds where the oysters grow.

2.1.6 BIRD PARADISE

a. Site description

The evaporation ponds in the Walvis Bay sewerage works (Bird Paradise) created a fresh water wetland surrounded by reeds. It is an important source of fresh water for flamingos and supports 53% of the ducks and geese in the study area (Whitelaw, *et al*, 1978). Bird Paradise is an attraction for bird watchers and must be managed to strengthen the attraction.

b. Threats

The only threat is that all the treated effluent is pumped away for use in the town with subsequent drying out of the evaporation ponds.

2.1.7 GRAVEL PLAINS

a. Site description

In the rocky desert north of the Kuiseb River extensive areas of gravel plains occur. These plains are characterised by sandy soils or soils often associated with crystalline gypsum or salt deposits. These soils have a surface capping and/or a surface scattered with many cobbles and pebbles (desert pavement). Soils with gypsum crusting or a pebble layer are often very old, take extremely long periods to develop and represent a very stable base for the growth of plants (Jacobson *et al*, 1995).

Even though the gravel plains generally look barren, various plant communities are found in the area. Sparsely scattered groups of *Zygophyllum stapfii* and *Arthroa leubnitziae* are the only shrubby inhabitants of this region. *Welwitschia bainesii* trees are mainly found on flats south of the Swakop River. Lichens flourish on the gravel plain areas close to the coast where they obtain moisture from fog. The gravel plains of the study area are mostly covered with lichens, therefore gravel plains will not be discussed any further

2.1.8 LICHEN FIELDS

a. Site description

Lichens are plants formed by a symbiotic relationship between fungi and algae. They grow very slowly and only where the substrate is stable, like gypsum and gypcrete soils, within the mistbelt in areas where they are sheltered from the south-east winds (Environmental Evaluation Associates of Namibia, 1991). The lichens provide food for various small organisms, as well as springbok during droughts (Jones, 1987). In other parts of the world

lichens have been used to extract dyes, medicines and other products (Environmental Evaluation Associates of Namibia, 1991).

Lichens occur throughout the study area where the habitat is suitable for them, but are usually overlooked due to their small size. The lichen fields north of the Ugab River are less diverse than those south of the Ugab (the study area) (Braby, pers. comm., 08/02/96). The lichens occur in communities of which there are four major ones in the study area, namely the *Combea mollusca* community, the rock lichen communities, the *Paramelia hypomeleana*/ *Teloschistes capensis* communities and the fine gravel communities (Directorate of Nature Conservation and Recreational Resorts, 1987). Figure 3 indicates the major lichen communities in the study area. The lichens growing in the Namib are endemic and occur nowhere else in the world. Some of the lichens species are restricted to an area of only a few square kilometers (Jones, 1987).

The lichen field near Wlotskasbaken is the largest single lichen field in the world, and is a popular tourist attraction. This lichen field has already been damaged to some extent, but is still worthy of conservation (Braby, pers. comm., 08/02/96). The Lagunenbergl lichen field (km 114 - 118 north of Swakopmund) is particularly diverse because of its elevation and position relative to the coast (Environmental Evaluation Associates of Namibia, 1991). Apart from these two lichen fields there are other lichen communities in the study area that need protection (see Figure 3). These areas are becoming increasingly degraded as a result of off-road vehicle activity. The lichen fields in the Cape Cross Seal Reserve are the only formally protected lichen fields in the study area.

Lichens are extremely fragile to disturbance due to their slow growth and dependency on a stable substrate. The soils on which the lichens grow are easily compacted when a heavy weight is applied, pebbles are pressed into the sandy soil and the surface capping is broken. These fragile soils do not easily recover from such damage, and vehicle tracks may remain visible for

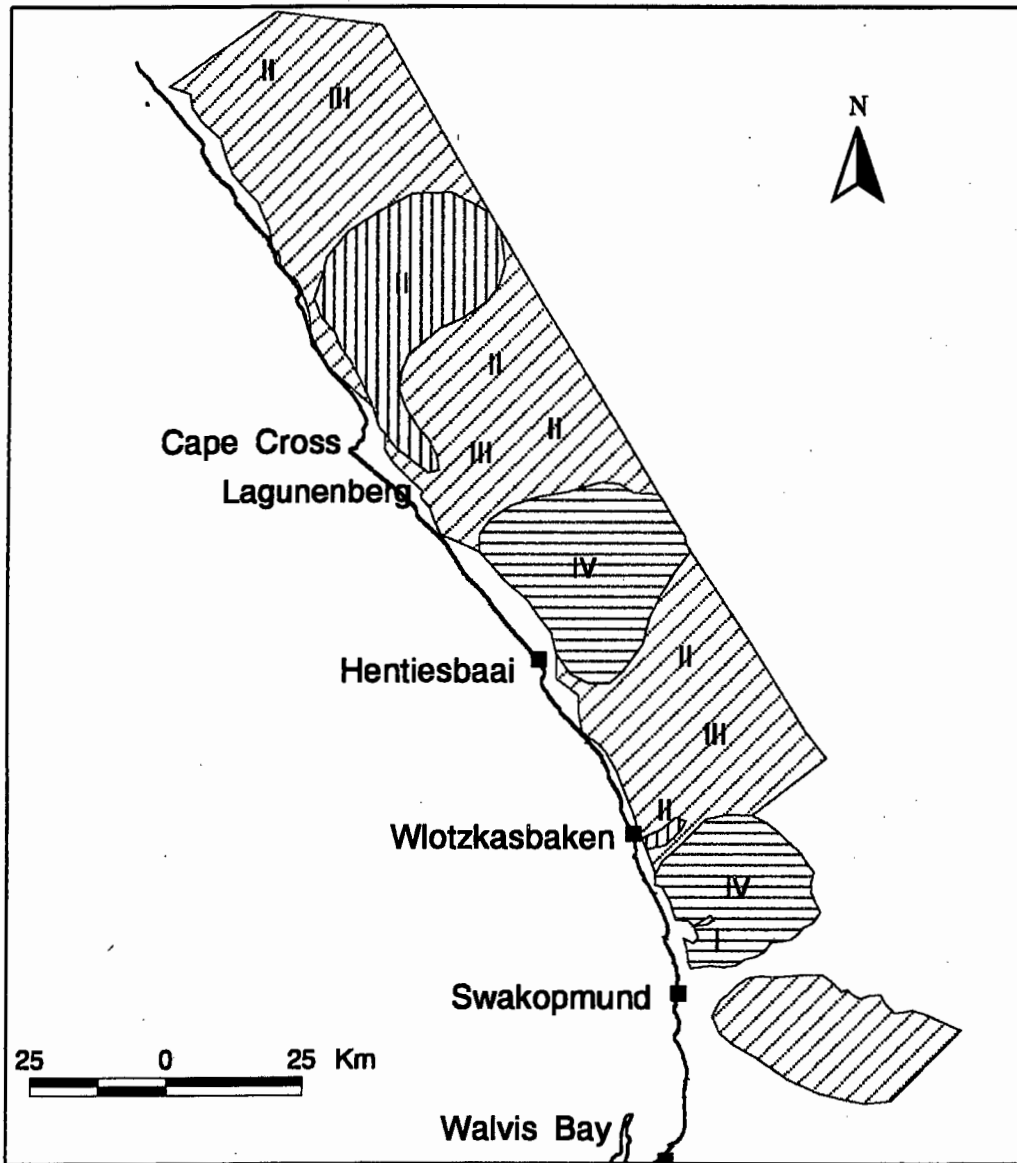
decades. These tracks reduce the scenic value of the desert, diminishing or eliminating the tourism value. Furthermore, lichens are killed and broken up by vehicles passing over them, leaving permanent scars (Jacobson *et al*, 1995). Besides the aesthetic impacts of vehicles on desert pavements and physical damage to lichens and other plants, susceptibility to wind and water erosion is increased (Braby, 1990).

The same impacts on desert soils have been identified and studied in the United States of America. It was found that 40 to 50 year old tracks on desert pavement soils have only partly recovered in that time, if at all, while substantial erosion has occurred (Wilshire, 1983).

Soil compaction was studied in the Mojave Desert in the United States of America. The effects of soil compaction generally are reduced rates of water infiltration and reduced plant growth. In the Mojave Desert study, it was found that the greatest compaction and reduction of water infiltration rates happened within the first few vehicle passes (Webb, 1983). Increased rates of erosion is not due to compaction, but to shear damage. Shear damage results in the destruction of the desert pavement and powdering of the soil crust: the two mechanisms that protect bare soil (Eckert, *et al*, 1979).

b. Threats

The main threat to lichen fields and gravel plains is off-road driving, especially around towns or other settlements and campsites. Informal mining and quarrying of gypsum and gypcrete gravel for road construction are impacts that are less wide scale, but more destructive than off-road vehicles. The cause of damage is twofold: the surface is disrupted where mining takes place and miners drive their vehicles wherever they want. See M.Phil Environmental and Geographical Science 1996, Section 7.5.3 for further detail on informal mining.



-  I: *Combea mollusca*
-  II: Rock lichen communities
-  III: *Paramelia hypomeleana*/*Teloschistes capensis*
-  IV: Fine gravel communities

Figure 3. Lichen Communities

Source: Directorate of Nature Conservation and Recreational Resorts, 1987

Caledonia Mining Corporation (Nam) has an exclusive prospecting licence for a strip of land along the entire coast from about Swakopmund to the Ugab river. Further prospecting licences have also been issued to other companies, comprising most of the land between the Swakop and Omaruru Rivers (M.Phil Environmental and Geographical Science, 1996). If all this land is mined, valuable lichen fields will be lost for ever.

Expansion of existing towns or the establishment of new development nodes will impact directly on lichen fields, but more severe impacts will be caused by the higher numbers of off-road vehicle users staying in the towns. The expansion of Wlotzkasbaken will impact on the most important lichen field in the Namib Desert. This town should never be allowed to expand in an eastern direction across the road to Henties Bay, to protect the lichen field.

Small developments or governmental projects such as road works and pipelines also damage lichen fields. Environmental impact studies are usually called for when big developments by private institutions are planned, but not for small developments and governmental projects. The Directorate of Resource Conservation also have no authority to object to projects or the way in which they are carried out. Areas that are of specific scientific interest can therefore be degraded through such developments (Braby, pers. comm., 14/02/96).

Apart from their off-road driving, tourists also enjoy picking up stones with lichens growing on them. Popular stopping places along tourist routes can become denuded of lichens. The practice of picking up these stones should be discouraged.

2.1.9 DAMARA TERN BREEDING SITES

a. Site description

Damara Terns are endemic to Namibia and the southwestern parts of South Africa, and are cited as Red Data Book (South Africa) species. The Namibian population has about 90% of the world population, estimated at 7 000 birds (O'Toole, 1993). These birds breed on the gravel plains and salt pans, mainly between Sandwich Harbour and Möwe Bay. Damara terns breed during the peak holiday season (December to March) and lay only one egg (Jones, 1987).

As a result of these facts, their coastal breeding sites are important areas for conservation of the Damara terns. Examples of such breeding colonies are found at the Jakkalsputz salt plans, 50 km north of Swakopmund, and at Patrysberg, 4 km north of Langstrand, between Swakopmund and Walvis Bay.

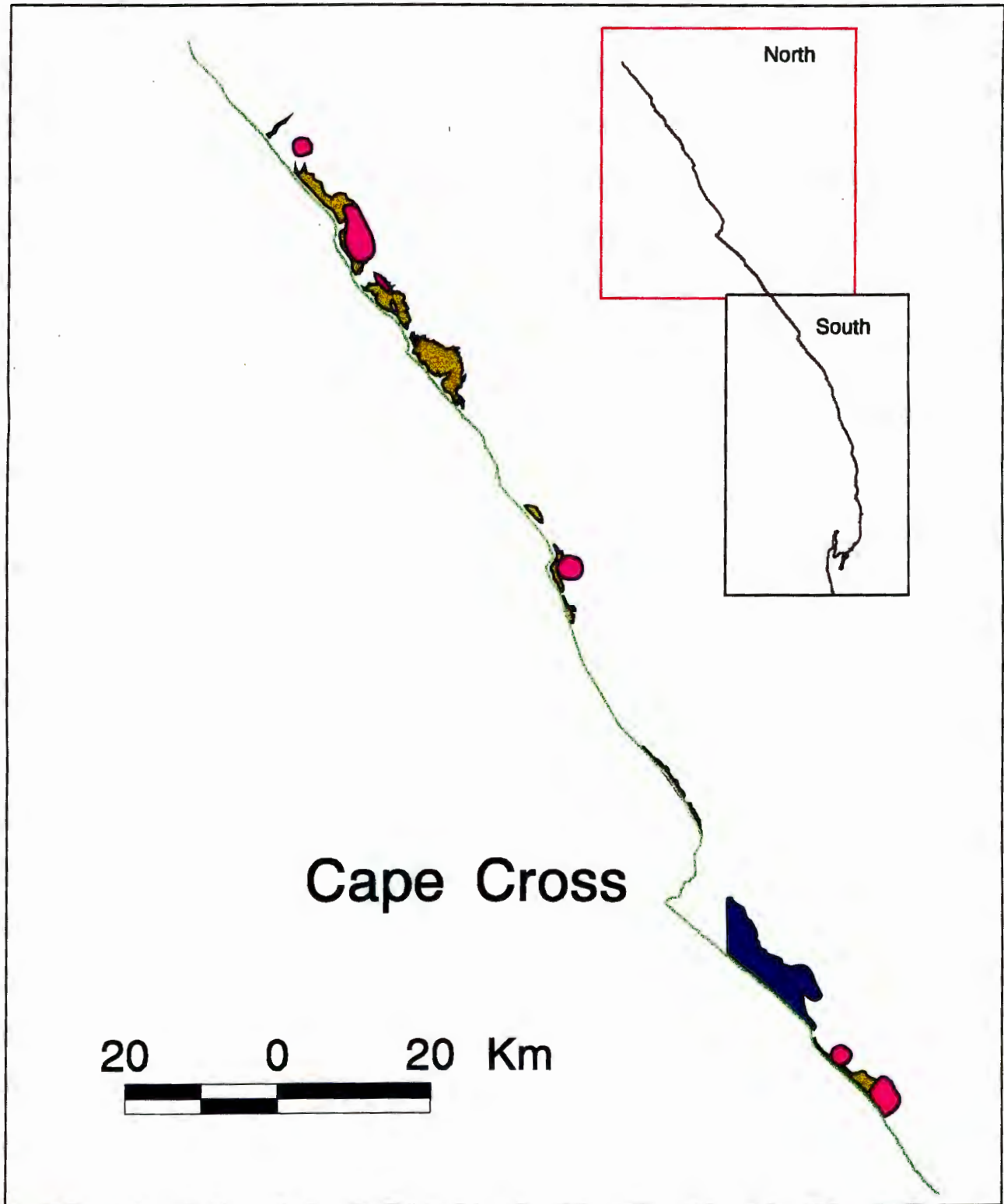
Figure 4 indicates the main breeding sites in the study area.

b. Threats

The most frequently occurring threats to the breeding birds are off-road vehicles, people walking through colonies and urban sprawl. Urban sprawl brings large numbers of people close to the breeding colonies, increasing the disturbance on them (for example the colony close to Langstrand).

Off-road vehicles can flush birds from their nests and destroy eggs and kill chicks. Disturbance can eventually cause the birds to abandon their nests. There is concern among conservationists that the Damara tern numbers are decreasing due to human disturbance (Jones, 1987).

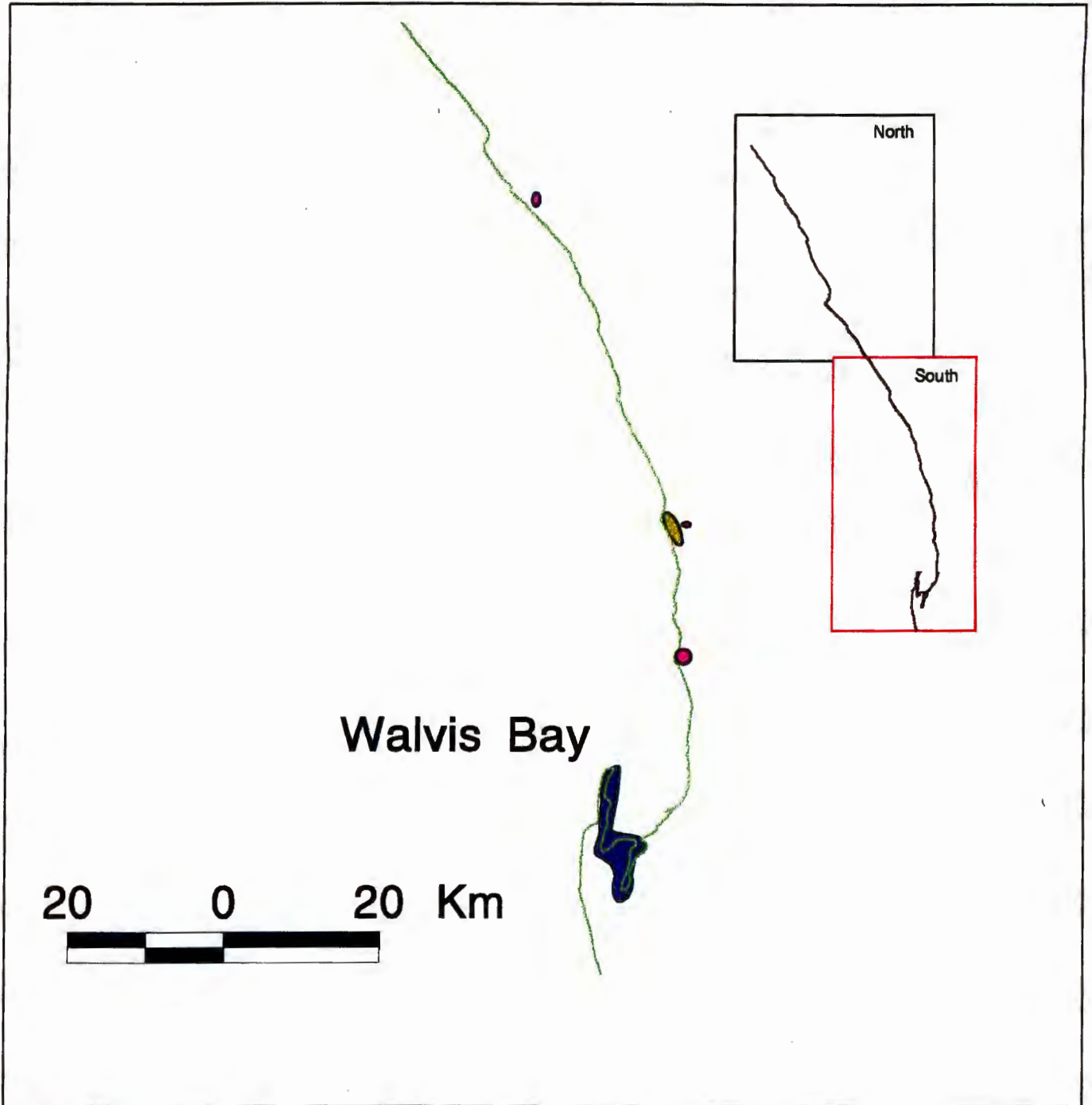
It has been noted in other studies that birds adapt to vehicles passing close to their nests, but flush when persons or dogs approach (Van der Merwe, 1988). Braby (pers. comm., 08/02/96) also found that people walking



-  Damara Tern Colonies
-  Saltpans
-  Wetlands



Figure 4a. Distribution of Damara Tern Colonies (Northern Section)



-  Damara Tern Colonies
-  Saltpans
-  Wetlands



Figure 4b. Distribution of Damara Tern Colonies (Southern Section)

through the breeding colony was a greater disturbance than vehicles. The Damara terns at Patryberg (see Section 2.1.10) were observed to "chase" vehicles for some time by flying behind them. It was found at Patryberg (north of Langstrand) that vehicle disturbance caused the incubation period to the Damara tern eggs to rise from approximately 19 to 22 days. Vehicle disturbance was found to cause a 10% failure rate in Damara tern nesting, while vehicles kill 5% of Damara tern chicks in the Patryberg colony yearly (Braby, pers. comm., 08/02/96). Chicks try to run away from vehicles and hide in vehicle tracks. Drivers of off-road vehicles usually follow existing tracks, running over the chicks hiding in these tracks (Van der Merwe, 1988).

Mining of the coastal strip north of Swakopmund will destroy all the Damara tern breeding sites, except the one at Patryberg and maybe the one near the Salt works. Even if the breeding sites themselves are not mined, the disturbance may cause the birds to abandon the sites.

Damara terns are vulnerable to oil spills, since they feed off the coast. Williams (1993) rated the Oil Vulnerability Index (OVI) points for Damara terns as 64, therefore they are of "high concern", needing emergency contingency plans. Vehicle traffic of clean-up operations can disturb breeding colonies (O'Toole, 1993).

2.1.10 PATRYBERG

a. Site description

The 30 km of mixed shoreline between the Swakop River and Walvis Bay is exceptionally rich in waders compared to the rest of the Namibian and South African coastline. It is due to the large off-shore kelp beds and a mixture of rocky and sandy shores. This piece of coast supports a total of 12195 waders in summer (98% are Palearctic migrants) and 3000 in winter. The summer density is therefore 407 birds per kilometer, compared to the average wader density on mixed shores on the west coast of the south-

western Cape (South Africa) of 78,5 birds per kilometer. The highest individual density elsewhere is about half the density of the 30 km coast between the Swakop River and Walvis Bay (Whitelaw, *et al.*, 1978). Patrysburg is also a breeding site of whitefronted plovers. Furthermore, there is also a Damara Tern breeding colony 4 km north of Langstrand which is the densest breeding colony along the Namibian coast (Braby, pers. comm., 08/02/96).

Township development and recreational activities make it impossible to manage the whole stretch of coast for bird conservation. Management effort should therefore be concentrated on Patrysburg, the stretch of coast west of the Swakopmund to Walvis Bay road, between Langstrand and the old railway bridge north of Langstrand. This area will be sufficient to protect both the waders and the Damara Terns.

b. Threats

Patrysburg is heavily utilised by people for angling, crayfish and bait collecting, off-road driving and recreational walking (often with dogs). Dogs have been observed killing Damara tern chicks (Braby, pers. comm., 14/02/96). Labourers working in Langstrand also commute daily between Swakopmund and Langstrand by walking through the area.

This stretch of beach is heavily utilised by ORV's, which is a great disturbance to the birds. See Section 2.1.8 for more detail on the effects of ORV's on breeding Damara terns. The impacts will be the same on the Whitefronted plovers (*Charadrius marginatus*) that also breed at this site. Whitefronted plovers breed on the driftline above the high water mark, an area frequently used by off-road vehicles (Van der Merwe, 1988)

The impact is not as severe on the non-breeding waders as it is on the resident breeding Damara terns and Whitefronted plovers. Both these birds breed in a season when human activity on the beach is very high.

The development of Langstrand, apart from direct habitat destruction, increased this recreational pressure greatly by putting many people close to the birds. The northern expansion of Langstrand and southern expansion of Swakopmund (see M.Phil Environmental and Geographical Science 1996, Section 5.6.2) will put further pressure on the birds and can lead to the Damara terns abandoning the breeding site.

Oil spills are a big concern for the birds feeding off this site. The birds found at this site that are most sensitive to oil (OVI scores of more than 61) are African black oystercatcher and Damara tern, while Chestnutbanded plover have an OVI score of 60 (Williams, 1993).

Another threat to the Damara tern breeding colony, is the lack of authority of the Directorate of Resource Conservation over development projects. Road construction through the breeding colony was started in the breeding season, and not afterwards as was requested by the Directorate of Resource Conservation (Braby, pers. comm., 14/02/96).

2.1.11 DOLERITE DYKES

a. Site description

Dolerite dykes occur throughout the study area, particularly inland north of Swakopmund. These dykes are colonised by unique assemblages of succulent plants, i.e. *Lithops*. Several species of these plants are endemic, and because they occur in isolated pockets, are sensitive to disturbance and habitat loss. Off-road vehicle drivers frequently use these areas to test the performance of their vehicles, and resulting in the destruction of these plant communities (Braby, pers. comm., 08/02/96).

b. Threats

The dykes themselves consist of hard rock which is not sensitive, but the plants growing on these dykes are threatened by off-road driving. Fortunately this occurs mainly close to settlements, while the dykes are wide spread. This reduces the impact on the plants.

2.1.12 COASTAL HUMMOCK DUNES

a. Site description

Coastal hummock dunes are found all along the Namib coastline above the high water mark. The area of greatest concern in the study area is the dune field south of Henties Bay in the municipal area of Henties Bay. It is an area that is exposed to high vehicle numbers and is therefore threatened by these vehicles (Braby, pers. comm., 08/02/96).

The vegetated hummock dunes along the coast are important for stabilising beach sands, and provide an important habitat for birds, small mammals, reptiles and insects. In the rocky desert north of Swakopmund, this sand stabilising is important to protect gravel plains and salt pans.

It is well known that the vegetation stabilising coastal dunes is easily damaged by vehicles. In coastal studies in areas with more favourable climates than the Namib Desert, it was found that off-road vehicle trampling changes the number of species present as well as the height and percentage cover of dune vegetation. Once dune vegetation is destroyed and the sand is bare, the micro-environmental factors change, making the environment harsher for plants to establish. Bare sand is also exposed to wind, causing dune erosion (Van der Merwe 1988).

The diversity of plant species growing on coastal hummock dunes in the study area is not very high, with *Salsola nollothensis* being dominant. The environmental factors are very harsh for plant stabilising. Where these plants are used for driftsand stabilising near Walvis Bay, they are watered with sea

water until they are established. Without the water, the seedling mortality is very high (Esterhuysen, pers. comm., 13/02/96). Plants killed by off-road vehicles are therefore not easily replaced by new recruits.

b. Threats

The greatest threat to these dunes are off-road vehicles. There is no need for fisherman to drive over these dunes to their fishing spots, therefore it must be recreational drivers who cause most of the damage.

Mining of the coastal strip north of Swakopmund will destroy large areas of coastal hummock dunes.

2.1.13 SAND DUNES BETWEEN WALVIS BAY AND SWAKOPMUND

a. Site description

The dune field between Walvis Bay and Swakopmund are approximately 30 km long and 10 km wide. It hosts a wide variety of organisms specifically adapted to the dune environment. These organisms are, however, also found in the dunes south of the Kuiseb river where they are conserved. The dunes in the study area are therefore not important for the conservation of certain species (Lenssen, pers. comm., 30/11/95).

This dune field is a popular tourist attraction, and is regularly used for recreational purposes. The dunes are relatively resistant to recreational activities, since they are naturally devoid of vegetation and therefore prone to sand movement by wind. Caledonia Mining has recently been given an Exclusive Prospecting Licence to explore heavy mineral deposits within the dunes (Walden, pers. comm., 06/02/96). The feeling is that mining will not harm the ecology, but can harm the dunes as a scenic and recreational attraction. A popular activity for tourists is to walk to the crest of the dunes next to the road. From there it is possible to see almost the whole width of the dunes on a clear day (personal observation). The mining activities will

most probably be visible from these dune crests. These visual and recreational attractions are important for both local and foreign tourists.

b. Threats

Dune mining will distract from the visual quality of the dune field and affect the ecology of the dunes, although it will recover, being a naturally unstable system.

2.1.14 RIVERS

a. Site description

The large rivers flowing through the study area are the Kuiseb, the Swakop and the Omaruru rivers. These rivers are classified as ephemeral or episodic, because surface flows only reach the river mouths after exceptionally heavy rainfall events in the interior. Sub-surface water usually occurs in the beds of the rivers, often at shallow depths (CSIR, 1991). The water supports trees and shrubs, and at times surfaces in springs or oases. These rivers are regarded as linear oases which support desert and non-desert fauna, as well as human settlements (Smuts, 1989).

The dominant trees of the river beds are *Acacia giraffae*, *Acacia albiba* and *Tamarix austro-africana*. These woody plants along the river beds are of great importance to the survival of animals, by providing shelter and food during critical periods (M.Phil Environmental and Geographical Science, 1996).

The aquifers of the Kuiseb and Omaruru Rivers hold water of high quality, and presently are the only suppliers of water for towns in the study area (Heyns, 1992). The over-abstraction of water from these sources has had numerous environmental implications. These include destruction of riverine vegetation, and a decrease in the water quality of the aquifers (Brummer pers. comm., 04/12/95).

After periods of flooding, the mouths of the Swakop and Omaruru rivers form temporary lagoons which are utilised by a wide variety of wetland birds. In terms of bird numbers, these sites are not of major national conservation importance (Noli-Peard & Williams, 1991).

An important geomorphological feature is that the Kuiseb and Swakop rivers act as breaks barring the northward movement of the dunes onto the gravel plains and into urban areas (Jacobson *et al.*, 1995).

b. Threats

The Omaruru and Kuiseb rivers are at present the only sources of water available to supply the households and industry in the study area. Rössing Uranium mine extracts water from the Khan River for its use (M.Phil Environmental and Geographical Science, 1996). The priorities on demands for water are firstly domestic use, including livestock watering and secondly economic activities. The environment is not recognised as a consumer of water, and is therefore ignored. This is clear through the die-back of ana trees (*Acacia albida*), Inara (*Acanthosicyos horrida*) plants and palms in the lower Kuiseb River, due to over abstraction of groundwater. The water is abstracted to a point below the roots of the plants, denuding them of water (Jacobson, *et al.*, 1995), while the salinity of the water also is rising (Holtzhausen and Brummer, pers. comm., 04/12/1995). It has been found at coastal towns along the South African coast that over abstraction of groundwater in sandy substrates reduces the pressure of the fresh groundwater against the incoming saltwater (the so called salt wedge) from the sea. This cause the saltwater to move further inland with subsequent rising in the salinity of ground water and soils.

The die-back of vegetation in the rivers has an ecological as well as economic effect. Ecologically, the insects, birds and game living off the plants are affected. Economically, the trees provide forage for livestock of

informal farmers, as well as wood for fuel and building material. The main income of the Topnaars living in the lower Kuiseb River is derived from the Inara plants. In the Ugab River, it is estimated that the value of the seed pods of ana trees growing in a certain area is between N\$ 1-5 million a year. The economic impacts are therefore substantial when the cost of alternative livelihoods for the people living off the rivers is calculated (Jacobson, *et al.* 1995).

The vegetation of the lower Kuiseb River was monitored by the South African Government for die-back (Ward, 1992). This monitoring was, however, discontinued by the Namibian Government after the Walvis Bay Enclave was handed over to Namibia (Brummer, pers. comm., 04/12/1995)

Farm dams in the catchment areas of the rivers aggravate the effect of abstraction of groundwater. These dams trap all surface runoff, preventing the aquifers in the lower parts of the rivers to be supplemented. Permission is required from the Department of Water Affairs to build or renovate dams larger than 20 000 cubic meters. Such large dams are, however, often constructed or renovated illegally. Visits to farms or flights over them often reveal large dams that have not been registered. A few of these dams in a catchment area can cause miscalculation of the available groundwater, causing over abstraction (Jacobson, *et al.* 1995).

The Rössing Uranium mine monitors the vegetation around the Khan River where water is abstracted for over abstraction. To date, no effect has been detected. The waste water of the mining activities is pumped to a tailings dam which is not lined. The water therefore continually seeps into the ground. The groundwater around the dam is monitored through a few boreholes, and the water quality complies with the standards set by the Department of Water Affairs in the mining permit requirements. The water quality standards used by the Namibian Water Act 54 of 1956 are based on the South African Standards that existed at 1978. Furthermore, these standards are guidelines and do not carry the force of law (M.Phil

Environmental and Geographical Science, 1996). Rössing is the mine with the best environmental and safety standards in the coastal zone of the Erongo Region. The possibility is therefore great that the groundwater of the Khan and other rivers is polluted by mining activities.

Another mining activity that threatens river beds, is the mining of sand for building purposes. Both Swakopmund and Walvis Bay mine sand from the Swakop River. Swakopmund's sand mine is 12-15 kilometers inland and out of sight, while Walvis Bay mines sand next to the road bridge entering Swakopmund from Walvis Bay (Holtzhausen and Brummer, pers. comm., 04/12/1995).

Sand mining entails the digging of numerous pits, affecting the vegetation and stream flow and causing erosion. Sand is mined up to the water level, exposing the water for evaporation. This causes a lowering of the ground water table, which in turn, is disastrous for the vegetation. The Walvis Bay sand mine is also unsightly, causing conflict with the Swakopmund Municipality who wants to encourage tourism. For Walvis Bay it is, however, the only source of suitable building sand and they are not so concerned about the adverse affects of the mining (Holtzhausen and Brummer, pers. comm., 04/12/1995).

2.1.15 MESSUM CRATER

a. Site description

The Messum crater itself is not floristically particularly rich, but has lichens and particularly large *Welwitschia* trees on its elevated outer rim. From outside it does not look like anything in particular, but is totally secluded, making it an interesting experience for a single group to camp in there. There are bushman paintings in the crater and game like springbok (*Antidorcas marsupialis*) and Hartmann's mountain zebra (*Equus zebra hartmannae*) are often found in there (Williams, pers. comm., 14/05/1996).

b. Threats

The crater is mainly threatened by indiscriminate off-road driving, particularly on the outsides. The distance that people have to travel to reach it, however, reduces the number of vehicles and therefore the impact. People littering and camping indiscriminately in the crater can distract from the beauty of the area (Williams, pers. comm., 14/05/1996).

2.2 SUMMARY OF THREATS AND SITES

Table 1 represents a framework summarizing all the sites described and the threats that are posed to those sites.

Table 2a. Framework summary of threats to sites of conservation importance - terrestrial habitats.

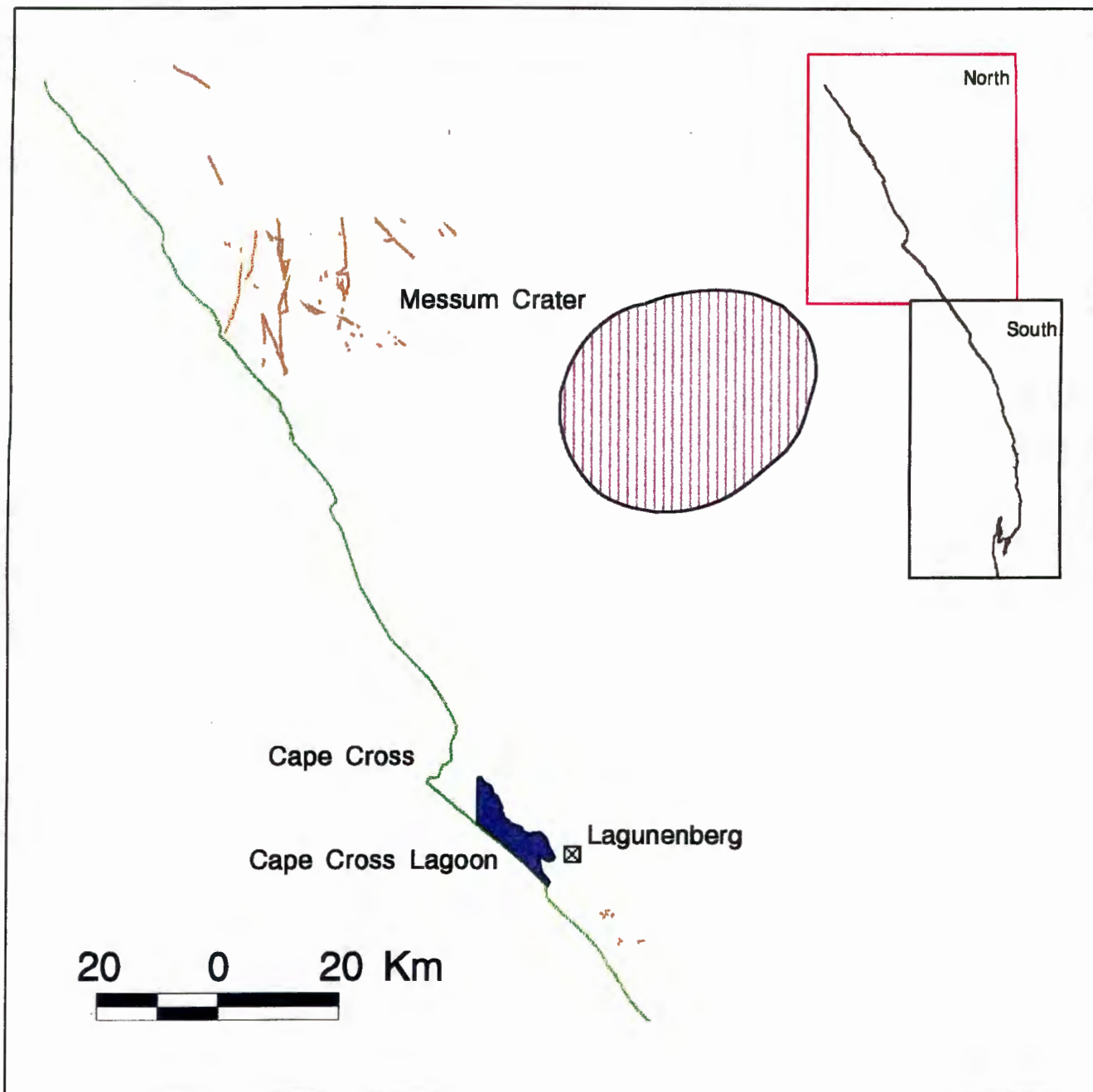
	Lichen Fields	Wlotzkasbaken Lichen Field	Lagunenbergr	Dolerite Dykes	Coastal Hummock dunes
Non-residential Development	<ul style="list-style-type: none"> • Roads, pipelines, powerlines, waste disposal sites, etc. • Occurs irregular • Impact severe, localised (small portion of total lichen fields affected) • Environment fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • Roads, pipelines, powerlines, waste disposal sites, etc. • Occurs irregular • Impact is severe, localised (small portion of lichen field affected) • Environment fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • Not really affected - too far from services 	<ul style="list-style-type: none"> • Only few dykes near roads affected 	<ul style="list-style-type: none"> • Not really affected - very little services, if any on beach
Residential Development	<ul style="list-style-type: none"> • Expansion of towns have direct physical impact as well secondary impact of increased numbers of people • Occurs constant • Severe impact • Direct impact on small proportion, but indirect impact on large proportion of lichen fields • Environment fragile; takes extremely long to recover. Direct impact permanent 	<ul style="list-style-type: none"> • Potential expansion (north and east) of Wlotzkasbaken - direct physical impact Other expansion secondary impact of increased numbers of people • Severe impact, especially N&E expansion • Direct impact on small proportion, but indirect impact on large proportion of lichen fields - both significant • Environment fragile; takes extremely long to recover. Direct impact permanent 	<ul style="list-style-type: none"> • Not affected - too far from towns 	<ul style="list-style-type: none"> • Very little affected - too scattered 	<ul style="list-style-type: none"> • Expansion of towns have secondary impact of increased numbers of people on coast. Direct impact is off-road driving
Tourism & Recreation	<ul style="list-style-type: none"> • Tourists picking up stones with lichens • Mostly at favourite stop points, denuding areas - localised, small area affected • Occurs constant • Environment fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • Tourists picking up stones with lichens • Mostly at favourite stop points, denuding areas - localised, small area affected • Occurs constant • Environment fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • Tourists picking up stones with lichens • Mostly at favourite stop points, denuding areas - localised, small area affected • Occurs constant • Environment fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • <i>Lithops</i> collectors may potentially be problem; not so at this stage 	<ul style="list-style-type: none"> • People walking on dunes localised low occurrence - little affect
Off-Road Driving	<ul style="list-style-type: none"> • Recreational driving off main tracks • Large areas affected, mostly near roads & towns • Occurs constant • Severe visual, physical and ecological impacts • Environment fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • Recreational driving off main tracks. • Whole area affected, mostly near roads & town. • Occurs constant • Severe visual, physical and ecological impacts • Environment fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • Recreational driving off main tracks. • Large area affected • Occurs constant • Severe visual, physical and ecological impacts • Environment fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • Recreational driving on dykes. • Dykes close to towns mostly affected; not all affected • Occurs constant • Bad impact on plants • Plants fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • Recreational driving over dunes, mostly near towns. • Occurs constant • Bad impact • Impact on large proportion of coastal dunes; visual and ecological • Vegetation fragile; takes extremely long to recover
Mining	<ul style="list-style-type: none"> • Formal and informal mining and prospecting; potential mining; off-road driving by mine workers; collecting of gravel for road & other works • Constant & potential impact. • Severe visual, physical and ecological impacts • Environment fragile; takes extremely long to recover. Will never recover from mining 	<ul style="list-style-type: none"> • Potential mining; off-road driving by mine workers; collecting of gravel for road & other works • Constant & potential impact • Severe visual, physical and ecological impacts • Environment fragile; takes extremely long to recover. Will never recover from mining 	<ul style="list-style-type: none"> • Potential mining; off-road driving by mine workers; collecting of gravel for road & other works • Constant & potential impact • Severe visual, physical and ecological impacts • Environment fragile; takes extremely long to recover. Will never recover from mining 	<ul style="list-style-type: none"> • Potential mining; off-road driving by mine workers • Constant & potential impact • Bad impact on plants, depending on extent of mining • Environment fragile; takes extremely long to recover. Will never recover from mining 	<ul style="list-style-type: none"> • Potential mining along coast • Impact depends on extent of mining • Sand dunes will take extremely long, if ever, to recover

Table 2b. Framework summary of threats to sites of conservation importance - bird habitats.

	Walvis Bay Wetland	Birdrock Platform	Damara Tern Breeding Sites	Patrysburg	Swakopmund Salt works	Cape Cross Lagoons
Oil spills	<ul style="list-style-type: none"> • High shipping activity in bay - high potential for accidents • Spills from shipping and washing out of tanks in harbour - regular • Inferior bunker oil storage - regular dumping in bay. • Pumping effluent of fish oil factories into bay - potential for oil spillage. • Harbour lacks spill treatment equipment. • Impact depends on extent & treatment of spill & birds (severe on some birds & oysters; bad on other organisms) • Speed of recovery of environment depends on impact 	<ul style="list-style-type: none"> • High shipping activity in bay - high potential for accidents • Spills from shipping and washing out of tanks in harbour -regular • Inferior bunker oil storage - regular dumping in bay • Pumping effluent of fish oil factories into bay - potential for oil spillage • Harbour lacks spill treatment equipment. • Impact depends on extent & treatment of spill & birds (severe on birds; especially in breeding season) • Speed of recovery depends on impact 	<ul style="list-style-type: none"> • Potential shipping accidents and dumping of oil • Impact depends on extent & treatment of spillage & birds 	<ul style="list-style-type: none"> • High shipping activity in bay - high potential for accidents • Inferior bunker oil storage - regular dumping in bay • Pumping effluent of fish oil factories into bay - potential for oil spillage • Impact depends on extent & treatment of spill & birds: - Damara terns most impacted, can be severe; especially in breeding season - oil washing up on beach affects waders & intertidal organisms • Speed of recovery depends on impact 	<ul style="list-style-type: none"> • Potential shipping accidents and regular dumping of oil • Impact depends on extent & treatment of spillage & birds: - spills in vicinity - severe impact on birds on platform & some others, as well as oysters - spills in bay and further away - bad impact on birds on platform - impacts on birds worse in breeding season 	<ul style="list-style-type: none"> • Potential shipping accidents and dumping of oil • Impact depends on extent & treatment of spillage & birds: - spills in vicinity - severe impact on birds on platform & some others - spills further away - bad impact on birds on platform. - impacts on birds worse in breeding season
Pollution from Harbour	<ul style="list-style-type: none"> • Chemicals, sewage & factory effluent • Occurs regular • Affect ecology, water for fish processing & mussel farming • Ecosystem will recover if practices stopped 	<ul style="list-style-type: none"> • Chemicals, sewage & factory effluent • Occurs regular • Affect bird & prey health 	<ul style="list-style-type: none"> • Terns feeding in Walvis Bay lagoon affected, other not - generally low effect 	<ul style="list-style-type: none"> • Terns feeding in Walvis Bay lagoon affected, other not - generally low effect 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable
Non-residential Development	<ul style="list-style-type: none"> • Potential & regular roads, harbour wall & desalination plant, restaurants, hotels, etc. • Effects depend on development • Impact permanent 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Potential roads & other services through colonies • Affect one site at time • Destroy habitat - bad impact • In breeding season very bad impact 	<ul style="list-style-type: none"> • Presently roadworks & potentially other services through Damara tern colony • Working during breeding season very bad impact 	<ul style="list-style-type: none"> • Potential, none at present 	<ul style="list-style-type: none"> • Potential, none at present
Residential Development	<ul style="list-style-type: none"> • Potential development on lagoon. • Permanent disturbance on birds 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Potential expansion of towns towards colonies • Permanent disturbance 	<ul style="list-style-type: none"> • Potential expansion of Langstrand towards site • Permanent disturbance • Can cause birds to leave site 	<ul style="list-style-type: none"> • Potential - expansion of Swakopmund 	<ul style="list-style-type: none"> • Not applicable
Tourism & Recreation	<ul style="list-style-type: none"> • Tourist flights low over wetland • Dogs running loose among birds • Disturb & kill birds 	<ul style="list-style-type: none"> • No access for tourists - only view from beach 	<ul style="list-style-type: none"> • Very little at present 	<ul style="list-style-type: none"> • People & dogs walking through site • Disturb & kill birds • Severe impact when breeding 	<ul style="list-style-type: none"> • Very low at present 	<ul style="list-style-type: none"> • None at present
Off-road Driving	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Driving through colonies to coast • All colonies affected regular 	<ul style="list-style-type: none"> • Recreational driving & access to coast • Very bad impact, specially breeding birds 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable
Mining	<ul style="list-style-type: none"> • Potential expansion of salt works to north & east (unlikely) 	<ul style="list-style-type: none"> • Does not affect birds negatively 	<ul style="list-style-type: none"> • Potential coastal mining; devastating 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Does not affect birds negatively 	<ul style="list-style-type: none"> • Does not affect birds negatively
Siltation	<ul style="list-style-type: none"> • Natural siltation unstoppable • Dredging in harbour - regular, bad impact; can be mitigated • Potential siltation due to flooding - severe impact 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Natural process

Table 2c. Framework summary of threats to sites of conservation importance - remaining features.

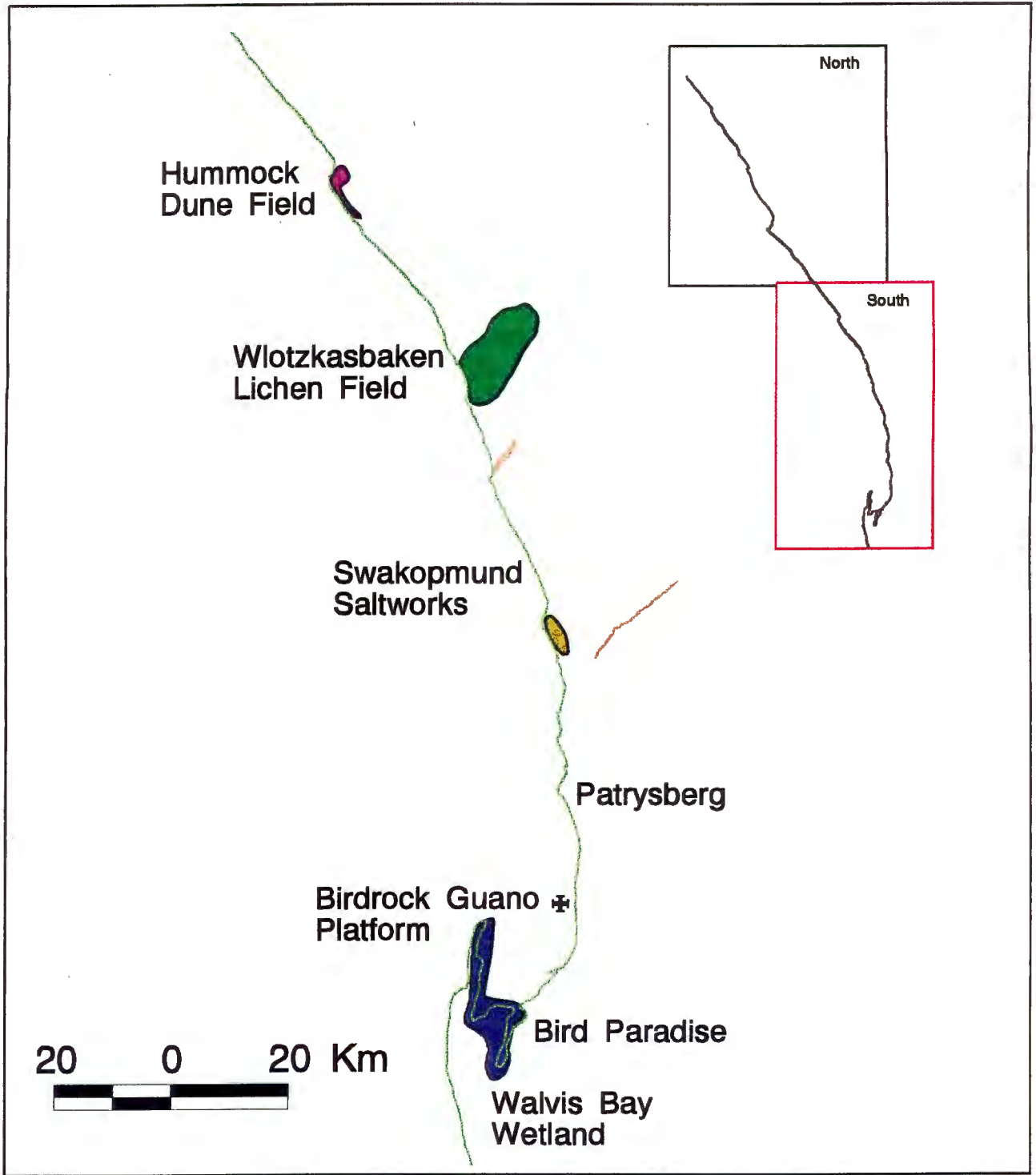
	Cape Cross Seal Colony	WBay/Swakopmund dunes	Messum Crater	Rivers	Bird Paradise
Oil spills	<ul style="list-style-type: none"> • Potential shipping accidents and dumping of oil • Impact depends on extent & treatment of spillage - spills in vicinity bad impact on seals, especially when young are born 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not affected due to dry mouths 	<ul style="list-style-type: none"> • Not applicable
Non-residential Development	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not permanently affected; very localised along road 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Water works - most already completed 	<ul style="list-style-type: none"> • Further development of sewage works can benefit birds
Residential Development	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • None in main dune field 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Development along Swakop River will impact on river. • Impact depends on type & extent of development - more people mean more water needed - severe impact 	<ul style="list-style-type: none"> • Expansion of sewage works can benefit birds
Tourism & Recreation	<ul style="list-style-type: none"> • No negative effect 	<ul style="list-style-type: none"> • Mainly sand skiing - small impact • Littering more serious - visual impact 	<ul style="list-style-type: none"> • Littering - visual impact 	<ul style="list-style-type: none"> • Very little affected 	<ul style="list-style-type: none"> • Bird watching; • Low disturbance.
Off-road Driving	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Driving has no lasting effect 	<ul style="list-style-type: none"> • Recreational driving off main tracks • Large area affected • Occurs constant • Severe visual, physical and ecological impacts • Environment fragile; takes extremely long to recover 	<ul style="list-style-type: none"> • Recreational driving in beds of large rivers have low to moderate impact; will recover with floods. 	<ul style="list-style-type: none"> • Not applicable
Mining	<ul style="list-style-type: none"> • Not applicable at present; off-shore drilling is potential threat 	<ul style="list-style-type: none"> • Potential heavy minerals mining • Very Bad visual impact • bad local ecological impact • Environment not fragile, will recover, but may take some time - can be mitigated by rehabilitation 	<ul style="list-style-type: none"> • Potential mining; off-road driving by mine workers • Constant & potential impact • Severe visual, physical and ecological impacts • Environment fragile; takes extremely long to recover. Will never recover from mining 	<ul style="list-style-type: none"> • Sand mining is Swakop River • Mainly two sites affected. • Mining close to Swakopmund has very bad impact, mainly visual. Both mines impact Bad on water table and possibly river flow. • Impacts may recover totally with floods. 	<ul style="list-style-type: none"> • Not applicable
Water abstraction	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Mainly from Omaruru and Swakop Rivers. Over-abstraction of groundwater • Bad impact on ecosystem • Impacts can recover when abstraction is reduced (take long time) and after floods (temporary) 	<ul style="list-style-type: none"> • Not applicable
Water used	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Not applicable 	<ul style="list-style-type: none"> • Potential increased recycling - destroy artificial habitat, but save natural rivers.



 Dolerite Dykes



Figure 5a. Distribution of study sites
(Northern Section)



Dolerite Dykes



Figure 5b. Distribution of Study Sites (Southern Section)

3. CONSERVATION PRIORITIES

Nature Conservation authorities never have enough resources (money and people) to reach the ideal position where all conservation worthy sites are formally protected and optimally managed. For this reason it is necessary to determine conservation priorities. Various attempts have been made by conservation scientists or ecologists world wide to rank sites numerically. The most popular evaluations are those using indices to express the value of a biotic community. Areas consisting of similar vegetation types or habitats are ranked according to the values obtained from the indices. The indices that are used to evaluate biotic communities consist of different criteria (Spellerberg, 1992). In most cases these indices and rankings are used for choosing the best areas for the establishment of nature reserves.

This study, however, differs from the biological evaluations used in the literature, in the following ways:

- the sites that are dealt with are of different habitat types;
- a single site will not be selected for protection as a nature reserve;
- tourism, recreation and mining must be allowed to continue in the study area, and at least in some of the sites.

Due to these differences the popular biotic evaluation methods are not suitable for use in this study. A different approach will therefore be used, but different criteria still need to be identified for comparing sites.

3.1 EVALUATION CRITERIA

Jarman (1986) used the criteria of vegetation type rarity factor, habitat diversity, species richness, threatened species, size, shape, invasion, abuse and special attributes to determine conservation priorities in the lowland fynbos. In a coastal zone management plan that the IUCN drew up for the Dhofar region of Oman, conservation sites were ranked using the criteria of habitat, bird species and individuals counts (diversity), Nature Conservation

Area type and perceived threat (IUCN, 1989). Usher (1986, p13) lists criteria most often used in site evaluation studies around the world. The criteria, in order of frequency of use, are:

- diversity
- naturalness, rarity
- area
- threat of human interference
- amenity value, educational value, representativeness
- scientific value
- recorded history
- population size, typicalness
- ecological fragility, position in ecological/geographical unit, potential value, uniqueness
- archaeological interest, availability, importance for migratory wildfowl, management factors, replaceability, silvicultural gene bank, successional stage, wildlife reservoir potential.

The criteria that will be used in this study are discussed below.

1. Nature conservation value

This criterion is made up of the criteria of diversity of a site (the number of species and the individual numbers), the numbers of rare, endangered and endemic species occurring at a site and the local or international importance of a site. The species considered must be all species occurring at a site, not only plants or birds. The evaluation of this criterion should ideally be done by specialists working in the study area with all the necessary data available. The numbers of lichen species and especially individuals are, however, unknown and it will be prohibitively expensive and time consuming to collect all this data. The author compared the sites using the information that is available. Table 3 summarises the conservation value of the sites.

Table 3. Framework summary of conservation and tourism value.

	Conservation value	Tourism value
Lichen Fields	<ul style="list-style-type: none"> • Endemic lichen species • Fragile plants and soils • Recovery very slow 	<ul style="list-style-type: none"> • Interesting landscape
Wlotzkasbaken Lichen Field	<ul style="list-style-type: none"> • Endemic lichen species • Largest single lichen field in world • Fragile plants and soils • Recovery very slow 	<ul style="list-style-type: none"> • Interesting landscape • Interesting lichen plants • Attracts international tourists
Lagunenbergr	<ul style="list-style-type: none"> • Particularly diverse lichen field • Endemic lichen species • Fragile plants and soils • Recovery very slow 	<ul style="list-style-type: none"> • Scenic feature in landscape • Interesting lichen plants
Dolerite Dykes	<ul style="list-style-type: none"> • <i>Lithops</i> and other succulents • Restricted habitat 	<ul style="list-style-type: none"> • Scenic features in landscape
Coastal Hummock dunes	<ul style="list-style-type: none"> • Stabilise beach sand • Habitat for specific plants & fauna 	<ul style="list-style-type: none"> • Lend diversity to landscape
Walvis Bay Wetland	<ul style="list-style-type: none"> • Rich estuarine fauna • Supports about 129 000 birds • Hosts Palaearctic & intra-African migrant birds • Hosts six rare bird species Ramsar site - wetland of international importance • Most important wetland bird habitat on Namib coast • One of ten most important wetlands in Africa 	<ul style="list-style-type: none"> • Hosts interesting & attractive birds • Scenic alternative to desert landscape • Close to tourism centres
Birdrock Platform	<ul style="list-style-type: none"> • Only breeding site for great white pelican in Namibia • One of most important breeding sites for cormorants in Namibia; one of three in study area 	<ul style="list-style-type: none"> • Only platform in world built in open sea • Accessible for tourists to see - attracts attention • Close to tourism centres
Damara Tern Breeding Sites	<ul style="list-style-type: none"> • Damara Terns endemic to southern Africa • 90% of world population in Namibia • Breed during peak holiday season 	<ul style="list-style-type: none"> • Can attract bird watchers (ecotourism)
Patrysberrg	<ul style="list-style-type: none"> • Hosts exceptionally large numbers of waders • Breeding site for whitefronted plovers and Damara terns 	<ul style="list-style-type: none"> • Popular place for fishing, bait & crayfish collecting • Popular for walking • Potential to attract bird watchers (ecotourism) • Close to tourism centres
Cape Cross Seal Colony	<ul style="list-style-type: none"> • Only Cape fur seal breeding site in study area • Largest land-based breeding colony in world • 19% of annual pup production of species • Nature reserve 	<ul style="list-style-type: none"> • Most accessible seal colony • Attracts over 20 000 tourists per year. • Far to travel, but close to good road
Cape Cross Lagoons	<ul style="list-style-type: none"> • Only natural saline lagoon without connection to sea in Namibia • Support up to 11 000 wetland birds • Support more than 1% of world populations of three bird species • 4th most important wetland in Namibia • International importance - potential Ramsar site. • Guano platform one of most important breeding sites for cormorants in Namibia; one of three in study area • Private nature reserve 	<ul style="list-style-type: none"> • Private property not open for tourism • Have potential for ecotourism • Far to travel, but close to good road
Swakopmund Salt works	<ul style="list-style-type: none"> • Artificial habitat • Supports up to 20 000 wetland birds • Supports more than 1% of subcontinental populations of two bird species • Northernmost breeding site for Hartlaub's gull. • Guano platform supports 1/4 of world population of Cape cormorant; is most important of 3 platforms • 5th most important wetland in Namibia • Private nature reserve 	<ul style="list-style-type: none"> • Popular with bird watchers • Has potential for ecotourism - good example of man & environment working together. • Close to tourism centres
WBay/Swakopmund dunes	<ul style="list-style-type: none"> • Host specially adapted desert organisms • Not important habitat for conservation - large areas conserved in Namib-Naukluft Park. 	<ul style="list-style-type: none"> • Popular for off-road driving, sand skiing and walking on dunes • Prominent scenic feature between two tourism centres
Messum Crater	<ul style="list-style-type: none"> • Lichens & <i>Welwitschia</i> on outer rim • Bushman paintings • Hosts springbok and zebra 	<ul style="list-style-type: none"> • Secluded - great experience visiting & camping in crater • High numbers of people will destroy attraction • Far to travel off-road
Rivers	<ul style="list-style-type: none"> • Linear oases • Support desert & non-desert organisms • Provide water to towns • Support rural communities 	<ul style="list-style-type: none"> • Green areas in dry landscape providing visual diversity.
Bird Paradise	<ul style="list-style-type: none"> • Artificial habitat • Source of fresh water for flamingos, ducks & geese • Increases bird diversity in study area 	<ul style="list-style-type: none"> • Good birdwatching site

2. Tourism and recreation value

Sites are valued by their scenic value, popularity or potential to attract Namibian and foreign tourists and popularity as a recreation area (see Table 3). The value will only be rated as positive if the tourism or recreational activities are not destructive. The evaluation of sites using this criterion should ideally be done by tourist operators in the study area using tourist numbers and other statistics. The author of this study again compared sites based on the information that is available.

2. Threats

The criterion of threats refers to the chances or likelihood that a disturbance will occur, combined with the fragility of a site to such an interference. The threats dealt with in this criterion are threats of human interference. Natural threats, such as coastal processes and cycles are not incorporated, since it is impossible to manage them. Furthermore, man-induced threats that are difficult to determine or predict, such as climate change, will not be considered either, since it is so difficult to predict the effects as well as suggesting preventative management.

Threats can be potential (it can happen at any time, but has not happened, at least within a decade), existing irregularly (happens every now and again) and existing continually. Continually happening threats are the most important ones, because they need the most urgent management.

Fragility (or sensitivity) is an indicator to how easily a site can be changed ecologically or physically due to human disturbance, as well as how long it will take for the site to recover. This means that species or habitats can be lost.

Single sites are more fragile than multiple sites (e.g. Damara tern colonies) or extensive sites (e.g. lichen fields in general). This is because an activity can damage a main part of that site, opposed to one example

(multiple sites) or part of a site (extensive sites). This factor is, therefore, also important in evaluating threats.

The information in table 2 was used for comparing sites.

3.2 EVALUATION METHOD

For each criterion, pair-wise comparison is done, comparing each site with each other site¹. After all sites have been compared, a weight was calculated for each site according to the preferences. The results of this evaluation is presented in Table 4.

Table 4. Weighted values of sites

Site/Criterion	Conservation Value	Tour/Recreation value	Threat
Wlotzkasbaken lichen field	11.7	9.2	10.8
Walvis Bay Wetland	11.3	11.7	12.5
Lagunenberg lichen field	10.8	7.5	9.2
Damara tern breeding sites	9.2	5	9.2
Lichen Fields	8.3	3.3	9.2
Birdrock Platform	8.3	7.9	4.2
Swakopmund salt works	7.5	9.6	2.9
Patrysberg	7.1	7.1	11.3
Cape Cross Seals	7.1	12.5	3.8
Cape Cross Lagoons	5.8	5.8	2.1
Messum Crater	4.6	4.6	6.3
Riverbeds	2.9	2.9	6.7
Hummock dunes	2.1	1.7	7.5
Dolerite dykes	2.1	0.4	3.3
W Bay/Swakopmund Dunes	0.8	10.4	1.3
Bird paradise	0.4	0.4	0

¹ The pair-wise comparison was done using a computer program written by a lecturer at the Faculty of Forestry of the University of Stellenbosch. The program was provided as part of the course material for forest management. A site can either be better (1) equal (0) or worse (-1) than another site, with the values in brackets indicating the preference. The program calculated the weights after comparisons were done.

3.3 PRIORITIES

The evaluation done in section 3.2 is still insufficient for determining management priorities. It is necessary to group sites according to three levels of management priorities. This way choices between different habitat types are made easier. The levels that will be used are: **imperative** sites that must get immediate attention and most of the effort, **important** sites that are of lower priority, but also need attention in the near future, and **desirable** sites that can wait until time and money are available, but must not be forgotten.

In order to obtain groupings according to which the sites will be subdivided, a cluster analysis using the three criteria was done with the aid of the program "Statistica" and a tree diagram produced (Figure 6). This diagram shows definite groupings, with three groups forming when the linkage distance of 4,5 is taken as a cut-off point. These three groups will be used as the priority groups, with the highest priority given to the group of sites with the highest conservation value. The priorities are therefore:

Imperative

Walvis Bay wetland
Wlotzkasbaken lichen field
Lagunenberg lichen field
Damara tern breeding sites
Patrysberg

Important

Lichen fields (general)
Cape Cross seal colony
Birdrock platform
Swakopmund salt works
Cape Cross Lagoons

Desirable

Messum Crater

River beds

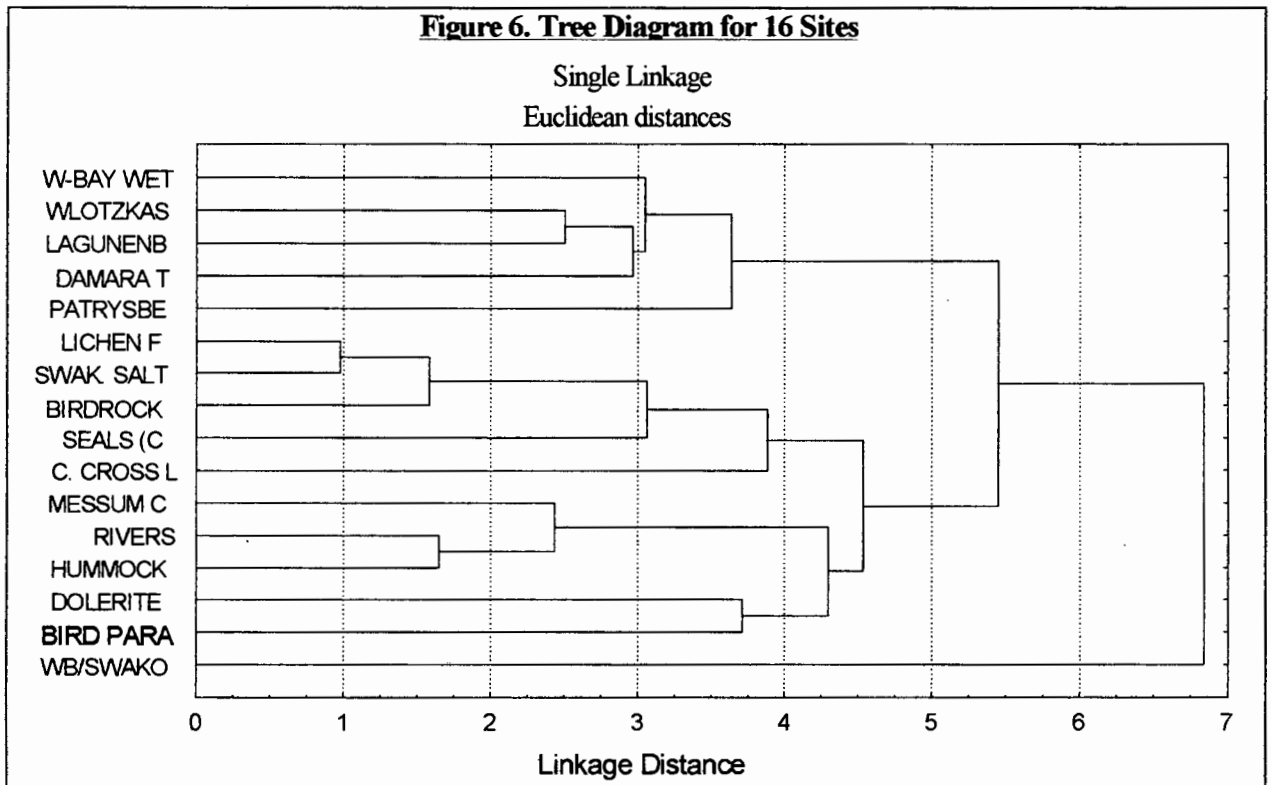
Hummock dunes

Dolerite dykes

Bird Paradise

The dunes between Walvis Bay and Swakopmund is an anomaly, since its conservation value is low, but its tourism value is high. It will not be considered as one of the three priorities, since it does not fall into one of the groupings.

Figure 6. Tree Diagram for 16 Sites



4. ADMINISTRATION OF THE STUDY AREA

The study area is divided into various areas of authority. This creates problems with the management of the environment, since the authorities all have different goals. In some cases areas of authority overlap, causing conflict between authorities.

The West Coast Tourist Recreational Area (from here referred to as Recreational Area), the largest part of the study area, is State land managed by the Department of Resource Conservation. This Recreational Area is, however, not managed as strictly for conservation as the other parks, with a variety of activities being allowed. Inside the Park the Ministry of Mines and Energy has jurisdiction over the minerals and regulate mining and prospecting. The only real conflict between the two Ministries is caused by the lack of environmental consideration by the Ministry of Minerals and Energy, and resultingly also by miners. The private companies owning mining rights control the areas where their mines are located, but must adhere to regulations under the Minerals Act 33 of 1992 and conditions set out in the mining licences. Swakopmund and Walvis Bay salt works and the Cape Cross lagoons all belong to private companies mining salt and guano (M.Phil Environmental and Geographical Science, 1996).

Cape Cross and the seal colony are inside a seal reserve managed by the Department of Resource Conservation. The seals are, however, managed by the Ministry of Fisheries and Marine Resources. This is a source of conflict between the Ministries.

The municipal area of Henties Bay and the Wlotzkasbaken Peri-Urban Area are within the Recreation Park, but are under the jurisdiction of the Henties Bay Municipality and the Peri-Urban Board. Some of the identified sensitive areas lie within these urban areas and are in danger of being destroyed by urban sprawl or recreation. A part of the Wlotzkasbaken lichen field and

some hummock dunes are good examples of this (M.Phil Environmental and Geographical Science, 1996).

The municipality of Swakopmund has jurisdiction over the area from the northern bank of the Swakop River to the northern extent of the salt works and approximately 20 km inland. The rest of the study area to the south falls within the Walvis Bay municipal area. The municipal boundary on the seaward side is the high water mark.

The Walvis Bay lagoon and bay area and its surrounds fall within the jurisdiction of various authorities. The Ministry of Fisheries and Marine Resources manages the sea up to the high water mark, the Walvis Bay Municipality has jurisdiction of the land area up to the high water mark of the sea, and the Namibian Port Authority (Namport) manages the harbour area and shipping in the bay.

The Ministry of Environment and Tourism is responsible for the conservation of all wildlife of Namibia and has jurisdiction up to the low water mark. This causes conflict between them and other authorities who are not primarily concerned about nature conservation. There is, however, no legislation empowering the Department to address habitat destruction. The problems found in the different areas will be addressed in the following section on management recommendations.

5. MANAGEMENT RECOMMENDATIONS

Various efforts have already been made at drawing up management plans, such as the Master plan for the West Coast Recreational Area (1987) and the Guidelines for the Development of the Central Namib (Department of Governmental Affairs, 1988). The management suggestions made here are an attempt to strengthen these policy plans or suggest methods for to strengthen the powers of conservation authorities, rather than to redo the plans. The goals and objectives set out in the First Draft of the Masterplan for the West Coast Recreational Area will be adhered to, since they were decided on by managers working in the area.

General recommendations for the management of imperative and important sites only will be made, with more detailed recommendations for some widespread threats. The actions that are recommended are not only for the Department of Resource Conservation to implement, but also for other authorities. These authorities are identified in some cases.

5.1. WALVIS BAY WETLAND

The recommendations for the management of the wetland will not be discussed in great depth, since the threats were not discussed in detail. An attempt is, however, made to suggest a management option for each of the threats posed to the wetland.

5.1.1 AUTHORITY

The authorities responsible for different parts of the wetland have different interests, which can cause conflict between them. A good example of this conflict is between the Ministry of Fisheries and Marine Resources and the Ministry of Environment and Tourism (Department of Resource Conservation). The former Ministry is interested in the management of a commercial resource - mainly the fish and sea birds (mainly cormorants) in

the lagoon - while the latter Ministry is interested in the conservation of the natural environment, especially the waders using the wetland. Furthermore, the Walvis Bay Municipality wants to develop the coast for tourism and industry, while the Department of Resource Conservation is concerned about habitat loss and secondary impacts. There is, however, no legislation empowering the Department to address habitat destruction.

Due to the conflict between the two Ministries, a coordinating committee between the Ministry of Fisheries and Marine Resources and the Department of Resource Conservation was established to manage the wetland. This committee, however, does not function any more, because it does not benefit the Ministry of Fisheries and Marine Resources and there is no other authority overseeing the functioning of the committee.

The wetland clearly needs a single authority whose responsibility is the management of the wetland as a Ramsar site. This authority should address pollution, siltation, aquaculture, recreation, mining and development in and around the lagoon.

5.1.2 POLLUTION

Most of the threats to the wetland that were identified are caused by pollution coming from the harbour and related activities. Three kinds of pollution occur, namely oil and fuel pollution, chemical, sewage and other organic pollution and solid waste pollution.

a. Oil and fuel pollution

The Namibian coastline is presently not at high risk from oil tanker disasters, since the tanker traffic close to the coast is low. The shipping close to shore originates mainly from the fishing industry. Fishing vessels carry substantial quantities of fuel oil and those operating off the study area are mostly based in Walvis Bay (O'Toole, 1993).

The harbour is important for the economy of the whole of Namibia, therefore it cannot be closed down or scaled down, but needs to expand for economic growth to take place. It is, however, still important that the management of the harbour is done in such a way that the ecology of the wetland is not harmed. To achieve this, Namport, should provide adequate storage facilities for bunker oil in the harbour and acquire equipment that will restrict oil and diesoline spills to the harbour and bay area and prevent it from entering the lagoon. Equipment to clean up and disperse oil spills must also be acquired. Furthermore, action must be taken against vessels dumping oil in the bay area. This can be done under the Seashore Ordinance 37 of 1958 which allows for regulations to prevent or control the dumping of substances that can harm the health of the public within a three mile zone from the beach (M.Phil Environmental and Geographical Science, 1996). The Walvis Bay wetland is seen as a high priority area in the draft Oil spill contingency plan for Namibia and action must be taken fast to prevent damage to the ecosystem and aquaculture (O'Toole, 1993).

In the event of birds being contaminated by oil, these birds must be captured and rehabilitated. The draft Oil spill contingency plan for Namibia (O'Toole, 1993) also identifies this need, but the responsible authorities have changed since then. The Sea Birds and Seal Protection Act 46 of 1973 is administered by the Ministry of Fisheries and Marine Resources, therefore staff of this Ministry and some veterinary surgeons in the study area should be trained in the methods to treat contaminated birds. Training can be done through Saccob, the sea bird "rescue" centre in Cape Town, South Africa, which has ample information and experience. Equipment for treating and rehabilitating birds should be acquired and stored for oil spill events.

b. Chemical, sewage and other organic pollution.

Great amounts of paints and other chemicals are used and spilled in the dry docks and other areas in the harbour. These chemicals are harmful to the

environment. Efforts should therefore be made to contain spillages and fouled water and to treat the water before it is returned to the sea.

Sewage is disposed from ships into the harbour and bay. The environment can assimilate it, but large quantities will cause environmental changes, such as algal blooms. Apart from this environmental affect, sewage will also affect aquaculture in the wetland and bay as well as fish processing. This is due to the mussels and oysters absorbing substances that are detrimental to human health and fish being processed in sea water from the bay. Special efforts should therefore be made to prevent sewage disposal close to shore by enforcing the Seashore Ordinance 37 of 1958 in the harbour and bay area. It is acknowledged that this will be difficult, since it is not easy to catch the culprits.

A greater source of organic pollution is the fish factories' waste water containing large quantities of fish offal, which is let out directly into Walvis Bay in the vicinity of the harbour. The effluent is not monitored and there are no standards in place to reduce pollution. This, together with the pollution from the harbour, poses a problem to the factories, since they need to abstract water from the bay for fish processing. The fishing industry is dependent on export, among others to Europe. The European Community has, however, passed a directive which defines health conditions for the production of fishery products. This forced fish factories in Walvis Bay to install water treatment plants in order to be able to export to Europe. The fish that is processed by factories exporting to other markets including South Africa is, however, still processed in the foul water of the Bay.

In order to reduce the impact of pollution on the wetland and the fishing industry itself, it is necessary that strict pollution standards and stiff penalties are set by legislation. This must be enforced through regular monitoring of effluent and penalising trespassers in order to be effective. Namport is responsible for environmental monitoring in the harbour and has a port health officer on duty. There is, however, only one such officer who has many

tasks and therefore does not do any water quality monitoring. It is suggested that an officer is appointed to do water quality monitoring regularly. Furthermore, the Department of Water Affairs is responsible for setting effluent standards and monitoring effluent. This is not done properly either and must be addressed (M.Phil Environmental and Geographical Science, 1996).

The bay area and lagoon is one of the few suitable places along the Namibian coast for mussel farming, being the most accessible and strategically situated for export. With mussels being filter feeders, they need clean water in order to be fit for human consumption. The pollution from the harbour and fish factories can therefore be damaging the potential of the lagoon for aquaculture. Furthermore, the structure plan for Walvis Bay incorporates plans for heavy industrial development next to the harbour (M.Phil Environmental and Geographical Science, 1996). Together with the encouragement of heavy industry by an EPZ policy, this can lead to further pollution of the water in the harbour and bay. From an environmental point of view the placing of the heavy industry zone is bad and should be changed, but not from a strategic point of view. It is doubtful whether the structure planning process involved environmentalists, therefore it can be useful to hold a workshop to discuss this point and reach the best situation. Strict pollution standards can be used to mitigate the effect of industrial development next to the bay.

c. Solid waste pollution

Solid waste is regularly dumped from ships in the bay area, even though they pay for a collection service from the harbour. The waste washes up on the beaches where it is unsightly and also entangles birds and seals which then subsequently die. The Seashore Ordinance 37 of 1958 is again applicable and should be enforced in the harbour and bay. It is, however, difficult to find culprits, making it very difficult to enforce the Ordinance.

Namibia is not party to a host of conventions pertaining to the prevention of pollution and dumping from ships and sea-bed activities (offshore drilling) (M.Phil Environmental and Geographical Science, 1996). Becoming party to and ratifying (making legislation to enforce it) these conventions will help to keep the marine environment healthy.

5.1.3 DEVELOPMENT

Developments inside and in the vicinity of the wetland and bay can severely impact on the wetland which is a Ramsar site and of international importance. In order to prevent or at least reduce impacts, all developments (including Government projects) in and around the lagoon must be accompanied by environmental assessments. The assessments can be legislated by including the Walvis Bay lagoon and bay area, mudflats and Pelican Point in the list of sensitive areas in the Environmental Assessment Act which is presently drafted (See M.Phil Environmental and Geographical Science (1996), Section 11.2 for more detail). The Townships Board and the Namibia Planning Advisory Board must also be given the responsibility of taking the environment into consideration when assessing a development application.

Comments on the ecological impact of development plans in the study area should be gained from the officials of the Directorate of Resource Conservation, which is an interested party in developments. This requirement must be written into the planning legislation so that it cannot be ignored. This will ensure that sensitive environments are not harmed by developments. These officials are presently commenting on plans, but only in some cases and their comments are most often ignored (Braby, pers. comm., 08/02/96).

There are already several developments proposed that may impact badly on the lagoon. One is the marina development that is indicated in the structure plan for Walvis Bay, the other the desalination plant at Paaltjies. An above-

ground powerline crossing the lagoon to supply power to the desalination plant must never be allowed. It will be a severe visual scar that will reduce the value of the lagoon for tourism and it will cause the death of numerous birds flying into the cables. Furthermore, trenches for pipes and cables should follow the road to Paaltjies and not cut across the lagoon. Apart from the reduced disturbance of the mudflats, it will also make maintenance easier and cheaper.

5.1.4 SILTATION

Siltation occurs naturally in all wetlands. In the Walvis Bay wetland it is aggravated by the longshore drift of sediments along the coast causing the sandspit (Pelican Point) to move in a northern direction. This will gradually change the wetland as it is at present, but will also make the harbour and bay shallower (CSIR, 1989). This process cannot be stopped by human actions and can only be remedied by dredging.

There are, however, also human causes of siltation which can be addressed. High silt levels due to dredging in the harbour can most probably not be prevented. This problem will even increase as the harbour, and therefore the dredging area and depth, expands. Ways should, however, be sought to reduce the impact. One way might be to dredge during tides when the silt is washed out to sea or to prevent dredging at times of the year when the system is at its most productive and supports the highest bird numbers.

Another cause of concern is sand deposition in the lagoon by the Kuiseb River. It is predicted that the wall that was built in the northern arm of the Kuiseb to protect Walvis Bay from flooding, will cause flood water to divert to the southern arm. This will increase the flooding effect of that part of the river, causing large quantities of sand to be deposited in the lagoon (CSIR, 1989). The only feasible solution to this problem is to break the flood protection wall, but this will not be acceptable to the people of Walvis Bay.

5.1.5 OTHER THREATS

Another impact on the birds in the wetland is aircraft passing low over the lagoon. Such air craft flush the birds during which events flamingos often break legs. These flights should be banned or at least restricted to the minimum. Furthermore, the salt works must not be allowed to expand into the lagoon, since it will destroy prime mudflats frequented by waders.

Aquaculture can impact on the ecosystem and recreation potential of the lagoon and bay if it expands too much. The Ministry of Fisheries and Marine Resources must therefore determine the maximum lagoon area that can be set aside for aquaculture.

5.2 LICHEN FIELDS

This section will deal with the Wlotzkasbaken lichen field, the Lagunenberg lichen field as well as lichen fields in general. This is done because the threats to the lichen fields are very similar. Specific recommendations for specific sites will be given when applicable.

5.2.1 OFF-ROAD DRIVING

The most severe immediate threat to the lichen fields is off-road driving. It is impossible to fence off all important areas with proper fencing, since the areas are so vast and metal fences will rust away in a very short time. Furthermore, fencing is not desirable due to the visual effect that it will have. In the draft Masterplan for the West Coast Recreational Area it is set as policy that fences must not be erected in the area. Other methods must therefore be found to solve the problem.

Off-road driving is a popular tourist and recreational activity in the study area, due to the popularity of the area for recreational fishing (angling) and the desert landscape. Angling is one of the major attractions for tourists to the study area. Approximately 40% of the tourists in the study area in 1994 were Namibian citizens, and 53% of all foreign tourists in 1993 were South

Africans (M.Phil Environmental and Geographical Science, 1996). These tourists mostly travel in their own vehicles, increasing the number of off-road vehicles present in the study area substantially, especially during the peak holiday seasons. Apart from this, there are also several four wheel drive hire and safari companies, mainly in Swakopmund.

Since the most popular tourist and recreation activity is angling, the most off-road traffic is on the beaches as well as the gravel plains and salt pans adjoining the beaches, mostly close to towns. There are, however, good fishing spots all along the coast, causing the pressure to be spread to the remote areas as well. Other recreational activities requiring off-road vehicles are scenic drives and sport driving which can either be competitive or non-competitive. The areas that are mostly impacted by recreational driving are areas adjoining towns, main roads, camp sites and mines (Braby, pers. comm., 08/02/96). Rallies are regularly held in the area (Braby, pers. comm., 08/02/96) and international rallies have crossed the study area in the past (Jones, 1987). The competitors in these rallies generally stick to certain, preset routes and cause little damage. It is rather the spectators driving and parking off these routes that cause damage (Braby, pers. comm., 08/02/96).

Studies in the United States of America revealed that there are three types of off-road vehicle (ORV) users: those using ORVs for their work, law abiding recreational users and users who do not care about others or the environment. In the recreational user group there are those who use their vehicles to reach a destination or to experience the outdoors and those who do off-road driving as a sport and want challenges. The first group would be happy with easy trails and access routes, while the latter group want areas designated where they can drive where they want to (Kockelman, 1986). It can be assumed that the same types of users exist amongst ORV users in the study area, with the majority falling in the recreational user group.

Most people think they do no harm by driving through the desert, because they do not damage any vegetation. During discussions with anglers, Els &

McLachlan (1990) came to the conclusion that most of the problems caused by off-road driving were due to ignorance. They found that the anglers did not think that their driving was harmful, because they were not aware of the diversity of beach fauna. This is most probably also true for the anglers in the study area, (especially for the tourists) and can be extrapolated to inland off-road users as well.

The West Coast Recreational Area is the only place where people can drive and fish where they want to. It will therefore not be desirable to close the area off for ORVs, but rather to plan for them and reduce their impacts.

The only way to plan for these vehicles, is to demarcate popular access routes and trails as acceptable routes and close off other tracks. Sacrifice areas must be set aside where people can play with their vehicles. This need was also identified in the draft Masterplan for the West Coast Recreational Area (Directorate of Nature Conservation and Recreational Resorts, 1987) and the Guidelines for the Development of the Central Namib (Department of Governmental Affairs 1988). It is important to mark enough routes providing access to fishing spots and other interesting places to accommodate people's needs, otherwise people will still drive through closed areas. The popular areas already have unofficial access routes which can be marked by signposts and painted rocks or dropper poles. At least some of the most popular fishing spots on the beach should be made accessible to normal two wheel drive cars.

The area between the tarred road from Swakopmund to Windhoek and the Swakop River was identified in the draft Masterplan for the West Coast Recreational Area as an area that can be sacrificed. This area has subsequently been changed to an area north of the tarred road (Braby, pers. comm. 08/02/96). More areas can be sacrificed if the need exists.

The best long-term solution for keeping ORVs out of sensitive areas, is to start a campaign to educate the people of Namibia on the sensitivity of the

Namib Desert and the organisms living in it. A television programme or series will be the most effective way to reach the whole population of Namibia. In this way the Namibian tourists will also understand why the desert is sensitive and what they should look out for. Such a programme can be supported by erecting information boards next to the main roads at the sensitive sites. These boards should be legible from a vehicle in order to reach people who will not stop and get out of their cars.

Furthermore, conservation authorities can be empowered to reduce the incidence of destructive off-road driving through adequate regulations. The Nature Conservation Ordinance 4 of 1975 has no regulations addressing off-road driving outside nature reserves or Areas. Compared to this, the Nature Conservation Ordinance 4 of 1975 of the Cape Province (South Africa), has a regulation (61) that prohibits the driving or operation of any vehicle in any other place than a public road. This excludes landowners driving on their own land (Proclamation 740 of 1990). A similar regulation can be proclaimed under the Namibian Nature Conservation Ordinance (4 of 1975). It can be made applicable to the coastal zone alone if it is not appropriate for other areas of Namibia. Furthermore, it can exclude certain beaches to allow anglers some freedom, as well as areas that have been designated for off-road vehicle use. The officials working in the study area will know best which areas to include and which not.

It might not be very practical to enforce such a regulation with the existing staff over the vast coastal area. A concentrated law enforcement media coverage and education effort going along with the proclamation of the regulation will make drivers aware of the regulation. A notice must be handed out with every off-road vehicle that is hired. This will stop the majority of the law abiding citizens and tourists from doing damage off recognized routes, reducing the impacts on the environment significantly.

5.2.2 MINING

According to the Guidelines for Development of the Central Namib, virtually the whole study area contains some minerals or other commodities that are worth mining. The Wlotzkasbaken area contains uranium, limestone, tungsten, gold, pegmalite minerals (e.g. feldspar, rose quartz), copper, lead and zinc, while Lagunenbergr contains tin and rare earth elements. For most of the area up to the Omaruru river prospecting licenses have been issued (M.Phil Environmental and Geographical Science, 1996). If all of these areas are to be prospected and mined, the lichen fields will be in great danger and several species of lichens will go extinct. The area will also lose its attraction to tourists, which is presently an important source of income to the region that is more sustainable than mining.

It is therefore important that the Government, specifically the Ministry of Mines and Energy, draft policy for mining in the Recreational Area. This policy must address the protection of the natural environment, specifically sensitive areas, and try to balance conservation and economic gain through mining. Prospecting and mining must never be allowed in areas identified by this study and the Department of Resource Conservation as important, i.e. the Wlotzkasbaken lichen field and Lagunenbergr.

The Minerals Act 33 of 1992 makes provision for land to be reserved from prospecting and mining, if it is in national interest. The areas identified by this study and the Department of Resource Conservation are in national interest, and must therefore be reserved in the Minerals Act. The remaining lichen fields, which is the rest of the Recreational Area, must be included in the list of sensitive areas in the Environmental Assessment Act which is being drafted, while mining in this area must be listed as an activity for which an assessment is required.

Strict guidelines for protecting the environment during mining in the Recreational Area as well as rehabilitation afterwards must be included in the licence conditions of all new prospecting and mining licenses. The Minerals

Act 33 of 1992 addresses pollution and waste management, but not other environmental concerns or site rehabilitation. A prerequisite for the issuing of prospecting and mining licenses must be that the Ministry of Environment and Tourism is allowed to comment on the mining or prospecting proposal and proposed license conditions. This should be written into the Act. If the comments of the latter Ministry are ignored, written reasons must be provided. Compliance to the license conditions must be monitored and enforced by the Ministry of Mines and Energy. Officials of the Ministry of Resource Conservation should, however, be provided with a copy of the conditions to enable them to act as a watchdog.

Mining also has a secondary affect caused by mine workers driving all over the sensitive desert environment, causing large scale damage. The Ministry of Environment and Tourism must communicate with the Ministry of Mines and Energy to try and find a solution. A possible solution can be to force mine owners or managers to fence off work areas or properties where their employees can do what they want. These people must then be prohibited to drive off public routes outside these fenced-off areas. This restriction, along with penalty clauses, should ideally be included in the mining permit. An attempt can also be made to reduce the effect of prospectors driving through the desert, although it will be more difficult to restrict the movements of these people.

All these suggestions are made for new licenses. Addressing existing licences will be more difficult. Setting aside the Wlotzkasbaken and Lagunenbergl lichen fields in the Minerals Act 33 of 1992 will prevent new mining and prospecting in those areas. Unfortunately no new conditions can be made for allowing existing mining or prospecting.

5.2.3 DEVELOPMENT AND TOWN PLANNING

When developments are planned and structure plans are drawn up the sensitivity of the lichen fields must be taken into account, especially the

Wlotzkasbaken and Lagunenberg lichen fields. Officials from the Directorate of Resource Conservation must be allowed to comment on any development plans or structure plans. Furthermore, the Wlotzkasbaken and Lagunenberg lichen fields must be listed as sensitive sites in the proposed Environmental Assessment Act. Expansion of the town of Wlotzkasbaken must not be allowed in a northern direction or in an eastern direction across the road leading to Henties Bay, to protect the lichen field.

5.3 DAMARA TERN BREEDING SITES

The Damara tern breeding sites are found all along the coast of the study area, therefore only general management suggestions can be made. Specific suggestions will be made for the Patryberg colony in that section.

5.3.1 OFF-ROAD DRIVING

The breeding sites are located high up on the beaches and are fairly large, since the birds breed far apart. This results in the “need” for anglers to drive through the colonies to reach the fishing spots.

A questionnaire survey was done amongst anglers in the Eastern Cape, South Africa. The reasons given by the anglers for driving on the beach were that the good fishing spots are too far from access points for walking, their equipment is too heavy to carry over long distances and they want to reach isolated beaches to “get away from it all”. A number of anglers indicated that they would appreciate access roads to favourite angling spots. It would reduce the distance travelled along the beach with resulting savings in maintenance and fuel costs (Els & McLachlan, 1990). The same will be true for anglers in the study area, therefore the impact of vehicles on the birds can be reduced by providing good quality access roads or demarcated access routes that avoid the birds, to fishing spots. These routes should only go through colonies where these cover large areas and detours will be unacceptably long. Signboards disclosing information about the birds should be posted where popular tracks are closed off, explaining why it was done.

Apart from access routes, the same solutions to the problem of off-road driving can be recommended as for lichen fields.

5.3.2 OIL SPILLS

Damara terns feed in the sea and are therefore susceptible to oil slicks in forage areas. Due to the widespread occurrence of the colonies, it is impossible to address the colonies in an oil spill contingency plan. The draft Oil spill contingency plan for Namibia (O'Toole, 1993) addresses strategies for dealing with spills along the whole Namibian coastline. The coastal areas where the terns breed are given a high priority rating for oil spill reaction and measures are suggested for protecting and cleaning up those areas. This should be adequate for protecting the birds. Action must be taken against vessels dumping oil at sea to prevent these disasters from happening.

If birds do get contaminated by oil, attempts must be made to capture and rehabilitate them. Plans can include the hand rearing of chicks if oil spills occur during the breeding season. Research on the birds must cover these aspects to provide the necessary information and techniques.

If oil spills along the coast need to be cleared up during the breeding season of the terns, attempts must be made to mark the boundaries of the relevant breeding sites. Drivers of clean-up vehicles must attempt to avoid driving through the sites. If access routes are made to the coast, these must be followed up to the beach where drivers can drive on the beach to the necessary areas.

5.3.3 MINING

A 15 km wide strip along the coast, especially from Walvis Bay to Henties Bay has a high gypsum content. An exclusive prospecting licence for the whole coastline has been granted to Caledonia Mining Corp. (M.Phil Environmental and Geographical Science, 1996). All the Damara tern

breeding sites fall inside this prospecting area. Prospecting and mining must not be allowed in Damara tern breeding areas.

In order to protect the breeding sites from prospecting and mining, the sites must be mapped out in the finest detail possible. This information must be available to mining and other officials. These areas must be reserved in the Minerals Act 33 of 1992 to protect them from mining. All breeding sites will probably not be reserved, therefore the remaining areas must be included in the list of sensitive areas in the Environmental Assessment Act.

Whenever mining, prospecting or other projects are planned, the breeding sites must be avoided. If work is to be done during the breeding season in the vicinity of breeding sites, the sites must be temporarily fenced off to avoid traffic through the sites, as well as other disturbances.

5.3.4 URBAN DEVELOPMENT

The Damara tern breeding sites must be taken into consideration when urban expansion is planned. Coastal towns and resorts should preferably not expand in the direction of breeding sites and a buffer zone must be kept open between the breeding site and the town. This will avoid or reduce the impact of people and dogs on the birds.

5.4 PATRYSBERG

Patrysborg is rich in waders and is a breeding habitat for Damara terns and whitefronted plovers. The waders do not use this area for breeding, therefore they can move around more than the breeding birds and are less susceptible to disturbances. Management effort should therefore be concentrated on both protecting the whole area as bird habitat as well as the breeding birds.

5.4.1 AUTHORITY

This beach area up to the high water mark falls within the jurisdiction of the Walvis Bay Municipality. The Municipality, however, does not seem to be interested in the conservation of the birds. This fact is clearly indicated by the lack of mention or consideration in the Langstrand- Dolphin Beach final draft structure plan (Stubenrauch, 1994) of the importance of this stretch of beach for birds. It can also be assumed that this lack of mention indicates a general lack of consideration towards the natural environment (apart from restraining factors) in the planning process, therefore in planning legislation, in Namibia.

It is the responsibility of the Directorate of Resource Conservation (from now referred to as the Directorate) to protect wildlife, which includes the birds at Patryberg. Nature conservation officials from the Directorate have marked the Damara tern nests and monitor the breeding success of the birds. There is, however, no legislation concerning the protection of wildlife habitats so that the Directorate has very little power in the management of Patryberg. Management can only be done through talking other authorities into it, which is seldom successful (Braby, pers. comm., 08/02/96). The continued existence of the breeding site and the good wader habitat therefore depends on the Walvis Bay Municipality and their acceptance of responsibility for it. A campaign should be launched to make the public aware of the value of the site to birds. This might pressurise the municipality into caring about the birds.

5.4.2 OFF-ROAD DRIVING

With angling being the most popular tourist attraction in the study area, great pressure is exerted on the popular fishing spots close to Walvis Bay and Swakopmund. The area between Paaltjies and the Namib Naukluft Area boundary south of Walvis Bay as well as the rocky coastline from Dolphin Beach to the Swakop River (including Patryberg) are the most popular (personal observation). The latter area is the only rocky coastline close to

Walvis Bay and Swakopmund and is habitat for crayfish (*Jasus lalandii*) of which the numbers and sizes are very small further north. This is a natural phenomenon, since it is the northern most part of the distribution range of the crayfish (M.Phil Environmental and Geographical Science, 1996). Of this beach area, Patryberg is the most popular for crayfish and bait collecting, increasing the traffic on the beach.

A 90 day survey done on anglers visiting the Sandwich shoreline, which is in the Namib Naukluft Area, gives an indication of the numbers of vehicles using the beaches. During the survey, which was done from 12 December 1989 to 28 March 1990, 3 131 off-road vehicles (ORVs) entered the Area (approximately 35 vehicles per day). Most of these vehicles were either from Walvis Bay or South Africa (Lenssen, *et al*, 1991). It must be noted that permits are required to visit this shoreline and it is only open between 06:00 and 20:00. Furthermore, the survey was done when Walvis Bay still was part of South Africa. Namibians therefore needed passports to visit this beach. The passports and permits most probably excluded a number of fisherman, therefore lowering the numbers of visitors to the Sandwich shoreline. The limitation of passports is now removed and tourism to the study area is continually increasing (M.Phil Environmental and Geographical Science, 1996). The numbers of vehicles on beaches in the study area can therefore be substantially higher than the figure given for the Sandwich shoreline.

Langstrand is no exception and apart from the off-road vehicle users visiting the beach area north of Langstrand for angling or crayfish collecting, there are also the people with all types of vehicles (like motorcycles) that use the beach for recreational driving. Most of the driving is done along the raised site of the old railway line, but access to this "route" is gained from anywhere along the tar road.

It is therefore recommended that the Municipality proclaim by-laws that disallow vehicles from this stretch of beach to protect both the Damara terns

and the whitefronted plovers. The old railway line can be demarcated as an accepted route if necessary. This route must be wide enough for vehicles to pass in two directions and some parking and turning points must be provided. Furthermore, specific access routes between it and the tar road must also be demarcated. These access routes must not cross the main area of the Damara tern breeding colony.

Van der Merwe (1988) notes that the impact on nesting birds is minimal where breeding colonies have been fenced off to keep out ORVs. This is particularly true on wide beaches where there is enough space for everyone. It is therefore recommended that the main part of the Damara tern breeding colony be fenced off with an aesthetically attractive and durable fencing, for example a low wooden pole fence. The whitefronted plovers breed along the driftline above the high water mark, making it impossible to fence off breeding areas. Keeping vehicles away from this zone will contribute much to the protection of the eggs and young birds.

5.4.3 PEDESTRIANS

People and dogs are more disturbing to birds than vehicles, therefore they must not be allowed inside the fenced off breeding area during the breeding season either. The pedestrian traffic will disturb the waders as well, but the impact is low on non-breeding birds unless very large numbers of people frequent the area. Information boards must be erected around the perimeter of the fenced area to inform people about the birds. A shelter can be built from where people can observe the birds. This can become popular as a tourist attraction, especially for bird lovers. Furthermore, dogs must not be allowed on the beach north of Langstrand. People can let their dogs run on the beach between Langstrand and Dolphin Beach.

5.4.4 OIL SPILLS

The draft Oil spill contingency plan for Namibia (O'Toole, 1993) rates this stretch of coastline as high priority for protection, but does not suggest

protective measures; only clean-up after spills have happened. It is suggested that spills should be dispersed at sea before they reach the coast to prevent Damara terns from being contaminated by oil as well as to protect food organisms of waders. Contaminated birds that land here must also be captured and rehabilitated. Contaminated birds from the platforms will most probably also land here after spills, as was found in June 1974 (Berry, 1976). Damara tern chicks should be hand-reared if large numbers of adult birds are contaminated by oil during the breeding season.

5.4.5 TOWN PLANNING AND DEVELOPMENT

According to the main objectives set in the Langstrand- Dolphin Beach final draft structure plan (Stubenrauch, 1994), Dolphin Beach and Langstrand must not be allowed to combine so that the resort feeling is not lost. Langstrand must therefore not be allowed to develop further south. Langstrand is furthermore considered as residential where single plots is sold, while Dolphin Beach must be kept as a resort with only chalets to rent. The combined beach front distance of the two resorts must not be allowed to exceed 2.5 km.

These objectives are directly in opposition to conservation of the Damara tern breeding colony and wader habitat. Langstrand will expand more than Dolphin Beach in future, since it is already popular as a holiday destination, and plots will be sought after. Furthermore, Langstrand can only expand south or north, with development to the south being against the objectives of the structure plan. Development to the north will reduce the buffer area and bring people and dogs closer to the birds, increasing the impact. This must, therefore, never be allowed.

Other developments such as the roadworks taking place presently must be planned and executed in such a way that the terns are taken into account. Projects which will disturb breeding activities of the terns must be carried out during the non-breeding season. The road works were started during the

breeding season, making large areas unsuitable for breeding as well as disturbing birds. This happened despite requests from the Directorate of Resource Conservation to delay the project for a month or two (Braby, pers. comm. 14/02/96). The environment should play a bigger role in decision making about projects and the comments of the Directorate of Resource Conservation should be taken more seriously.

5.5 CAPE CROSS SEAL COLONY

The seal colony is located in a nature reserve managed by the Directorate of Resource Conservation, and does not need further protection. The size and status of the nature reserve must not be changed, since it also includes the predators of the seals, some lichen fields as well as the replica of the Diaz cross and some historical sealing facilities. These facilities can be upgraded to be a tourist attraction.

5.5.1 SEAL CULLING AND TOURISM

The matter of culling or not culling is not a scientific argument, but rather an ethical one. Sustainable culling will not threaten either the colony or the tourism potential of it. The culling issue will therefore not be discussed any further.

The tourism value of the colony, however, must not be harmed, since it is an important source of income for the study area. The culling of seals must therefore never take place in December when the peak tourist season starts. Seal pups are born from late October to December, with a peak around the end of November (Smithers, 1983).

5.5.2 OIL POLLUTION

The real threat to the colony is oil pollution originating from fishing vessels. Off-shore drilling for oil and gas can potentially pose a great hazard to the colony. Cape Cross is rendered a high priority area for protection from spills

in the draft Oil spill contingency plan for Namibia (O'Toole, 1993). Protection measures that are prescribed are protecting the colony with booms and dispersing the oil at sea. Clean-up after spills is also a high priority. Furthermore, action must be taken against vessels dumping oil at sea.

5.6 BIRDROCK GUANO PLATFORM

The only real threat to the colony is large oil spills. Chemical and plastic pollution also kill birds, but on a smaller scale.

5.6.1 OIL SPILLS

The platform itself needs no attention, but the birds on it do. This platform is rated as a high priority area for protection from oil spills in the draft Oil spill contingency plan for Namibia (O'Toole, 1993). Measures that are suggested for protection and clean-up are dispersing oil at sea and rehabilitating birds that have been contaminated by oil. Pelican chicks should be rescued and hand-reared if severe oil spills occur during their breeding season.

The pollution prevention measures suggested for the Walvis Bay wetland will also benefit the birds on the platform, therefore it is unnecessary to elaborate.

5.6.2 OTHER THREATS

Apart from the management of these threats, the platform must be managed as at present with annual guano collection and maintenance. This, and the other platforms, are good examples of man and nature benefiting from an artificial development.

5.7 CAPE CROSS LAGOONS

These lagoons are currently adequately protected, being in a private nature reserve. The human activities taking place in them do not threaten the

lagoons either. In fact, they are the least disturbed of all the wetlands in the study area (Williams, 1991). The status quo can therefore be maintained.

5.7.1 OIL SPILLS

The lagoons themselves will hardly be affected by oil spills, but the birds on the platform as well as other birds that forage in the sea (e.g. Damara terns) will be affected by oil. Cape Cross and the coast down to Mile 72 is rated as a high priority area for protection from spills in the draft Oil spill contingency plan for Namibia (O'Toole, 1993). Protection measures that are prescribed are protecting the colony with booms and dispersing the oil at sea. Clean-up after spills is also a high priority. The rehabilitation of contaminated birds will be necessary. Action must be taken against vessels dumping oil at sea to prevent these disasters from happening.

5.7.2. CONSERVATION AND DEVELOPMENT

These lagoons are worthy of international recognition and should be registered as a Ramsar site. It should also be listed as one of the sensitive sites in the Environmental Assessment Act. No further development should be done in the lagoons, including mining and guano platforms. If tourism to the lagoons is increased, the numbers of people as well as their movements in the area should be restricted to limit the disturbance to the birds.

5.8 SWAKOPMUND SALT WORKS

This artificial wetland is a good example of a man-made system that benefits both man and nature. It is adequately protected in a private nature reserve, but should also be registered as a Ramsar site. The status quo can be maintained with the management of the salt works.

5.8.1 TOURISM

The salt works can be used as an eco-tourism attraction, if it is compatible with the mining activities. The numbers and activities of people should, however, be kept at a level of low disturbance to the birds.

5.8.2 OIL SPILLS

The lagoon and salt works are supplied with sea water by pumping the water into the salt pan. It is rated as a high priority area for protection from spills in the draft Oil spill contingency plan for Namibia (O'Toole, 1993). The protection measure that is prescribed is notifying the mining company immediately of oil spills to allow them to close off the intake channels. Clean-up after spills and the rehabilitation of birds contaminated by oil is also a high priority. Dispersal of oil at sea will protect both the birds and the salt works and should be prescribed.

6. CONCLUSIONS

The coastal area of the Erongo Region is not as barren and desolate as meets the eye, but has plants and animals that are highly adapted to the harsh environment and are sensitive to disturbances. This environment also house a wealth of features which are important for the economy of Namibia. Exploiting these features, however, has negative effects on the environment. The conservation authorities are very much aware of this and have identified sites which need special management attention for their continued existence.

There are 16 of these sites that demand management attention. It is therefore necessary to determine priorities according to which sites can be managed. The most commonly used conservation evaluation methods as described in Usher (1986) and Spellerberg (1992) are not suitable for determining management priorities in this case. This is because these sites are ecologically dissimilar and no single site will be selected for acquisition as a nature reserve. Furthermore, tourism and recreation value and threat of disturbance also need to be taken into account, apart from conservation value.

The method that is regarded as best suited for evaluating the sites, is using pair-wise comparison to obtain weighted values and cluster analysis to obtain groupings. The results of this evaluation are outlined below.

The first group consists of the highest priority sites for management, and is called the "imperative" group. The sites falling in this group are Walvis Bay wetland, Wlotzkasbaken lichen field, Lagunenbergl lichen field, Damara tern breeding sites and Patryberg. These sites need immediate management attention from the authorities.

The next group of sites consist of sites which are of a slightly lower priority, but also need attention at some stage. This is the "important" group, of

which the sites are Lichen fields (general), Cape Cross seal colony, Birdrock platform, Swakopmund salt works and the Cape Cross Lagoons.

The remaining sites, apart from the dunes between Walvis Bay and Swakopmund, fall into the "desirable" group of sites that are not in immediate threat and can wait until the other two groups have been dealt with. The dunes between Walvis Bay and Swakopmund have a low conservation value and are therefore not considered important for conservation management.

It is recommended that conservation managers, as well as other interested and affected parties in the study area, scrutinise this priority list and repeat the evaluation process if necessary.

These sites are all, to some extent, threatened by human activities. The activities that pose the most wide-spread threats are oil spills, residential and non-residential development, mining, and off-road driving. General recommendations for managing the activities that cause these threats, are:

Oil spills:

- Namport should provide adequate storage facilities for bunker oil in the harbour.
- Acquire equipment that will restrict as well as clean up and disperse oil spills.
- Take against vessels dumping oil in the bay area and elsewhere.
- Train certain officials in the study area to treat oil contaminated birds.
- Acquire and store equipment for treating and rehabilitating birds contaminated by oil spill events.

Development:

- Include these sites in the list of sensitive areas in the Environmental Assessment Act which is presently drafted.

- The Townships Board and the Namibia Planning Advisory Board must be given the responsibility of taking the environment into consideration when assessing a development application.
- Comments on the ecological impact of development plans in the study area should be gained from the officials of the Directorate of Resource Conservation.
- Developments that are planned as well as structure plans must take the sensitivity of these areas into account.

Mining:

- Reserve special areas in the Minerals Act 33 of 1992 to restrict mining activities.
- Strict guidelines for protecting the environment during mining in the Recreation Area as well as rehabilitation afterwards must be included in the licence conditions of all new prospecting and mining licences.
- Ministry of Environment and Tourism must be allowed to comment on mining or prospecting proposals and proposed licence conditions.
- Mining in this area must be listed in the Environmental Assessment Act as an activity for which an assessment is required.
- Attempt to reduce off-road driving by prospectors and miners.

Off-road driving:

- A regulation that prohibits the driving in any other place than a public road can be proclaimed under the Namibian Nature Conservation Ordinance (4 of 1975).
- Start a campaign to educate the people of Namibia on the sensitivity of the Namib Desert and the organisms living in it.
- Demarcate popular access routes and trails as acceptable routes and close off other tracks.
- Set aside areas for recreational use of off-road vehicles.

Despite time and other limitations to this study, the priorities and management suggestions should in this study should make authorities aware of the characteristics of the environment for which they are responsible, as

well as what can be done to protect the most important aspects of this environment. It is up to these authorities and the public of Namibia to see to it that these environments are not destroyed.

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