# CONSERVATION MASTER PLAN FOR SUSTAINED DEVELOPMENT OF THE BAZARUTO ARCHIPELAGO PEOPLE'S REPUBLIC OF MOZAMBIQUE

Notes

A PROJECT SPONSORED BY THE WORLD WIDE FUND FOR NATURE (WWF)

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and

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Report to the Honourable Minister of Agriculture Mozambique

on

## A CONSERVATION MASTER PLAN FOR SUSTAINED DEVELOPMENT OF THE BAZARUTO ARCHIPELAGO.

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ISW, Mozambique
Conservation
resource conservation
economics
environmental legislation
environment management
resource management
fishery management
tourism
archipelagoes

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# EXECUTIVE SUMMARY

## INTRODUCTION

### Objectives

The Bazaruto Archipelago Master Plan Project, sponsored by the World Wide Fund For Nature (WWF) and Southern African Nature Foundation (SANF) is intended as a guide to assist the Mozambique Government in deriving maximum benefits from this unique coastal area through sustainable development and long-term environmental strategies.

The main challenge for the Mozambique Government will be to ensure maximization of benefits from tourism and other developments in the Archipelago, to maintain and protect the vitally important artisanal fisheries and to retain the ecological integrity of the Archipelago.

The Mozambique Government is commended for taking the initiative in freezing development in the Archipelago, pending the submission and acceptance of the Master Plan, this at a time when there is enormous interest being shown towards the developmental potential in the area. This attitude is totally in line with the latest response of International Union for Conservation of Nature and Natural Resources (IUCN) to the United Nation's World Commission on Environment:[21,17,40,41]

> **"The best strategy for the world is to work diligently to build the capacity to direct change and to adapt to it when it comes. Such adaptability will require using the available resources in ways that sustain their long-term productivity."**
>
> - From Strategy to Action: IUCN, 1989.[40]

### Plan of Action

In order to formulate the Master Plan and make recommendations the following broad based investigations were conducted:

1. Terrestrial and marine ecosystems and their processes
2. Demography and resulting impacts
3. Tourism and resulting impacts
4. Crocodile farming and resulting impacts
5. Habitat management strategies

As a basis for the management strategies it was necessary to create an inventory of the Archipelago's natural resources, their usage and ecological impacts:-

| Terrestrial & Freshwater Environments | Marine Environments |
|---|---|
| Vegetation | Vegetation |
| Mammals | Mammals |
| Reptiles | Turtles |
| Fishes | Fishes |
| Birds | Birds |
| | Sea cucumbers (Holorthuria) |
| | Lobsters and crabs |
| | Ornamental shells |
| | Corals |

**PHYSICAL ENVIRONMENT**

The Archipelago, comprising the five islands of Santa Carolina, Bazaruto, Benguérua, Magaruque and Bangué, is situated off the mainland, between Vilankulo and Inhassoro. The entire area occupies approximately 600km$^2$.

The islands represent a dynamic sandy coastal system with a geomorphology that has been drastically modified during periods of glaciation and melting which resulted in their separation from the continent. The islands' soils are composed of silica sands and therefore prone to erosion when the fragile vegetation cover is disturbed.

Precipitation over the past 21 years has averaged 978 mm, varying from 466 mm (1980) to 1928 mm (1961). Summer temperature averages about 30°C, winter 18°C. The average annual occurrence of hurricanes in the Mozambique channel is 3.1, however, the Archipelago is by-passed by most of these.

**ECOLOGY**

The Archipelago embraces in close proximity a wide diversity of ecosystems, including pelagic waters, coral reefs, dynamic beaches, tidal flats and associated marine grass meadows, mangrove communities, freshwater lakes, swamp forests, climax evergreen forest, savanna grassland, bare and vegetated sand dunes.

There is evidence of serious environmental perturbation, especially on the more sensitive sand dune habitats. Nevertheless, the overall ecological status of the Archipelago still appears good and worthy of remedial action and management.

## COMMERCIAL OPPORTUNITIES

### Trade in Marine Products

Approximately 1 500 people from 60 artisanal fishing communities in the Archipelago commercialized over 1 500 tonnes of dried marine products on the continent during 1989/90. The recipients of the fish protein were mainly refugees at Vilankulo, Inhassoro and inland areas, displaced by the war situation. The value of the Archipelago's artisanal fisheries in terms of social and economic benefits for the entire region should take priority over all developments envisaged for the Archipelago. However, the PLAN suggests that certain controls be introduced to address the over-exploitation of Holorthuria (Magajojo) and destructive forms of fishing such as seine-netting over coral reefs.

Mapalo sand oysters, gleaned from the sheltered tidal flats, have been a staple food for the islanders for many centuries. At the moment collection is effectively controlled by voluntary traditional conservation actions. The PLAN suggests that, because of increasing pressure from mainland people, a management strategy be implemented to ensure a sustained supply for the island communities.

Nesting female turtles and eggs are exploited by the islanders and represent a potential resource. Present stocks are too small for exploitation, hence the PLAN suggests that islanders be dissuaded from this practice, with the explanation that by protecting the nesting females, egg exploitation may be allowed in future.

There is a well organized semi-industrial fisheries operating from Inhassoro and, to a lesser extent, Vilankulo exporting over 4 000 tonnes of frozen fish, 42 tonnes crayfish, and generally commercializing over 7 000 tonnes of dried marine products. Athough there is a July to October closed season for seine netting, there is none for crayfish. The PLAN suggests that a closed period for industrial crayfishing during the reproductive season, October to February, be implemented in order to conserve and replenish stocks.

Gill netting for sharks causes high mortality of dugongs. The PLAN suggests that these operators should resort to baited hook and line.

### Crocodile Farms

The existence of crocodile farms on Bazaruto and Benguéra represent valuable adjuncts to the tourism complexes, however, there are problems related to obtaining sufficient fish feed for the crocodiles. For example, the existing farm on Bazaruto experiences difficulties in obtaining 43 200 kg of fish per year to feed the present population of 5 000 crocodiles. The projected fish requirements for 14 000 crocodiles in 1995 will be 221 760 kg. This will place undue pressure on fish stocks and deprive people of much needed protein. Furthermore the use of fuelwood in the heating of incubation rooms poses serious limitations to the overall fuelwood budget of the two islands involved. The PLAN, therefore, suggests that there be no expansion of the crocodile farm enterprises.

### Wildlife

The islands already have an interesting fauna. It would be possible nevertheless to increase diversity and biomass of suitable species as an additional attraction for tourism and to benefit the island people. This would only be possible if the present livestock population were to be reduced. If this can be achieved, then the PLAN suggests that those islanders affected should be given complete custodianship of the replaced wildlife resource, and be assisted in managing the animals as a multiple use resource.

## Tourism

The opening up of the Archipelago for tourism development was the the main reason for initiating the Master Plan Study. At the moment there are only four hotel developments authorized for the Archipelago. The PLAN suggests that to accommodate tourism, a concept of **CONCENTRATION AND CONSERVATION** should be adopted in order to maintain the naturalness and ecological integrity of the Archipelago and sustain the productive life-support systems of the artisanal fishing communities. Furthermore, the PLAN warns against ribbon-type development which has degraded many coastal tourist areas worldwide. The PLAN suggests that the entire Archipelago can sustain, but should not exceed, a maximum of 750-800 tourists weekly. These numbers would be made up as follows:-

- Bazaruto Island restricted to one tourist complex on the extreme northern end, but expanded to accommodate a maximum of 250 tourists
- Benguérua Island restricted to the existing two complexes with a maximum of 40 beds each
- Magaruque Island* with existing complex increased to a maximum of 200 beds
- Santa Carolina* Hotel be demolished and reconstructed as a top-class complex with casino, to accommodate up to 300 tourists.

* Freshwater is a limiting factor on the islands of Magaruque and Santa Carolina thus alternatives to water derived from wells will have to be investigated.

A major part of the tourist pressure can be taken off the islands if infrasturctures can be rehabilitated at Vilankulo and Inhassoro, with the option of creating a large Marina/Hotel complex at Chuambo (Fig 15).

The PLAN suggests that Vilankulo be the major gateway to the Archipelago. Consequently, proper facilities should be provided to handle incoming flights, customs and immigration procedures. Furthermore, the creation of parallel facilities on the various islands should be discouraged. The Tourism Department should approach the Director of Civil Aviation with a view to bringing landing fees, airport taxes, etc. in line with international tariffs (Appendix K).

## CONTROLLING INSTITUTION

The PLAN recommends that all applications for concessions in the Archipelago and adjacent mainland first come under the scrutiny of the Office of the Prime Minister (Gabinette do Primeiro Ministro) before submission to the Office of the Governor of Imhambane. The latter should consult with a committee composed of representatives from the Direccao Nacional de Florestas e Fauna Bravia, from Physical Planning and from Tourism. Once the plans and terms of the concession have been accepted by the proposed advisory committee, the developer should be bound to remain within the constraints set down in the agreement.

Wherever possible, 50% joint venture projects with potential developers should be sought by the Mozambique Government.

Any modification or development of the natural environment, other than in the immediate precincts of a concession area, should first be scrutinized by the proposed Government Agency and subjected to a professional Environmental Impact Assessment.

## RECOMMENDATIONS

### Present Status

The southern three islands of the Archipelago were proclaimed a National Park in 1972, but control was never enforced. The PLAN recommends that the Direcção Nacional de Florestas e Fauna Bravia (DNFFB) take the opportunity of establishing a presence in the Archipelago in order to initiate management strategies, with maximum emphasis on conservation education programmes.

### Administration

The existing administrative structures are unable to accommodate the various entrepreneural developments on the islands. The administration has not the necessary infrastructures nor personnel to document and control the movement and settlement of people from the mainland. This has serious implications for resident fishing communities and for the resources that sustain them. Slum conditions, with all their negative social aspects, are likely to develop in the vicinity of the hotel and crocodile complexes, unless proper planning and controls are undertaken. As a matter of extreme urgency, the PLAN recommends that a more effective administrative structure should be created to work in close collaboration with the representative of DNFFB.

In order to have a strong and effective conservation presence in the Archipelago, the PLAN recommends that the various developers pay a levy into a Trust fund to be used directly for conservation programmes on the islands.

### Demography

#### Human Populations

Bazaruto has a human population of approximately 2 600, concentrated mainly in the vicinity of the Lodge and Zingarema; Benguérua 900; Magaruque 250; Santa Carolina 50. The overall population of the islands has increased by about 300% over the past 10 years, which is considered to be in excess of the carrying capacity. The PLAN recommends that, as soon as possible, suitable conditions be created on the mainland for the resettlement of refugees from the islands.

#### Domestic Livestock

Bazaruto supports approximately 1 800 goats and 372 sheep; Benguérua 100 goats and 20 head of cattle; Magaruque 30 goats; and Santa Carolina 20 goats. The Archipelago's fragile habitats are being seriously degraded. The stock owners are reluctant to commercialize these animals. The PLAN recommends that all goats be removed from Santa Carolina and Magaruque, and stock be reduced on Bazaruto and Benguerua in accordance with the recommendations made in the PLAN's section dealing with WILDLIFE 7.3.

#### Cultivation

Shifting cultivation on sand dunes and the removal of trees for fuelwood are the major causes of denudation, leading to erosion and soil nutrient loss. Magaruque, as an example, has lost 80% of its vegetation cover in 6 years. The PLAN recommends that those people whose only activity is agriculture, be resettled on the mainland. No cultivation should be permitted on the mobile sand dunes.

## CONCLUSION

The Archipelago has enormous potential for sustained development that will benefit its resident people, be viable for lucrative tourist development and be ecologically acceptable.

The PLAN recognizes these three prime objectives and recommends three major actions:-

### Zoning

The PLAN recommends that all the islands together with their contiguous marine environment be proclaimed a National Park, i.e. **Parque Nacional do Archipelago do Bazaruto**, according to the norms established by the International Union for Conservation of Nature and Natural Resources (IUCN). This should allows for zonation, accommodating various forms of resource use which, with careful planning and careful planning and management, would achieve sustained development.

### Habitat and Resource Management

Certain habitats, such as the sand dunes and the productive sand flats on the protected bay shores, need careful management. No construction or modification should be permitted unless preceded by an Environmental Impact Assessment by a competent ecologist.

The major marine resources targeted by artisanal fisheries should be managed to ensure their sustained use. Recreational fisheries, ornamental shells, turtles and other valuable resources should be monitored as a matter of urgency.

A major impact will be placed upon ornamental shells and corals with increasing tourism. This will require the implementation of a permit system for both seller and purchaser.

### Implementation

Once the PLAN has been studied, modified and finally accepted, it recommends that a 5 year action plan be drawn up to ensure maximum benefits for the people of Mozambique.

The 5 year plan includes:-

1. Appointment of Project Manager
2. Preparation of budgets
3. Provision of infrastructures and equipment
4. Recruitment and staff training
5. Drafting of regulations
6. Initiation of monitoring and research programmes

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# 1. INTRODUCTION

## 1.1 The Bazaruto Archipelago[1]

Five islands make up the Archipelago: Bazaruto, the largest covers approximately 12000ha; Benguérua 2500ha; Magaruque 600ha; Santa Carolina 500ha; and the minuscule island of Bangué about 5ha. The islands are located off the Mozambique coast within latitudes 21°30'-22°10'S and longitudes 35°22'-35°30'E. They are situated in the Province of Inhambane, and districts of Vilankulo and Inhassoro **(Figure 1)**. Although there are local names for the island, this report uses those illustrated on the 1:50 000 topographic map.

The Archipelago was formed from the present Cabo Sebastião Peninsula. The incisions took place during the various sea level changes resulting from glaciation and subsequent melting.

### 1.1.1 The People[18,26]

The island people are part of the overall Tsonga ethnic group whose distribution extends from Rio Save southwards. However, the people along the coastal littoral from Inhambane northwards including the Archipelago, are part of the sub-group Khokha. This sub-group includes the Machengua people on the mainland opposite the Archipelago, while the island people have their own distinct dialect, Xitsonga (refer **Appendix J**). Portuguese and multi-secular Asian cultures further influenced the local traditions, particularly with the introduction of new fishing technologies and food crops.

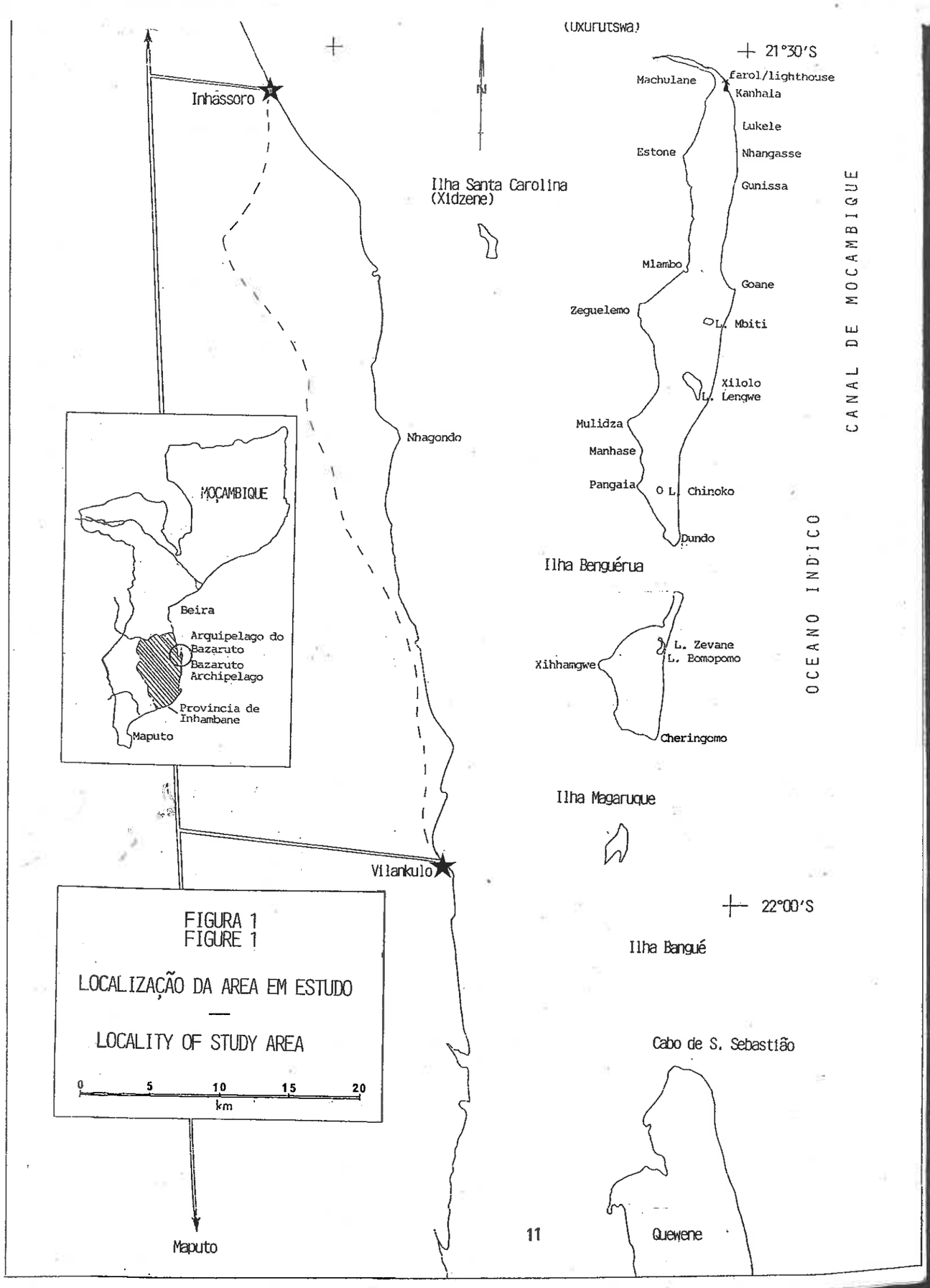
### 1.1.2 Legal status of the Archipelago and environmental protection[33,36,42]

The marine fauna, principally dugong and turtles, were first protected by legislation, Decreto No.40.040, on 20 January 1955, under the jurisdiction of the Maritime Services (Serviços de Marinha).

Acting on recommendations made by ecologist Ken Tinley, in 1970, and a subsequent visit by the Conselho de Protecção da Natureza, the three southern islands of Bangué, Magaruque and Benguérua were proclaimed National Parks. The area of sea bounded by the 100 mètre bathymetric line east of the islands and 5km west was included in the Legislative Diploma No. 46 of 1971. Bazaruto and Santa Carolina were proclaimed Zonas de Vigilância.

There has never been a permanent presence of the Wildlife Department (Departamento de Fauna Bravia - DFB) in the Archipelago. Apart from specific laws protecting certain marine fauna, no regulations exist under which the environment is protected.





### 1.1.3. Present form of resource use and tourism

The islands of Bazaruto, Benguéra, and Magaruque have a long history of artisanal fisheries. Some of the middens containing clay pottery and a variety of shells have well established /secondary vegetation growing on top of them, attesting to their considerable age.

There are at least 60 fishing camps in the Archipelago, commercializing large quantities of dried sea foods on the mainland. Harvesting of *Holothuria scabra* (magajojo) is a relatively new innovation. Traditional methods of fishing, i.e. using stake nets (gamboas), have been replaced by synthetic gill and seine nets. Increasing use is being made of diving apparatus to spear fish.

There is limited trade in ornamental shells, but this is increasing with the proliferation of the tourist industry.

Hotels, previously established by Joaquin Alves on Bazaruto, Santa Carolina and Magaruque, are being renovated to draw and handle increasing tourism. Two new tourist complexes have recently been built on Benguérua, together with a commercial crocodile rearing enterprise. A similar crocodile enterprise exists on Bazaruto.

## 1.2 Background to project

Mr. Dan Landrey, one of the early post-independence tourist entrepreneurs, invited Dr. Jeremy Anderson, Director of Kangwani Parks, to visit Bazaruto in order to assess the ecological situation on the island. His observations, supported by a report by Mr. Roberto Zolho, Chief Warden of DNFFB, prompted the Worldwide Fund for Nature and the Southern African Nature Foundation to provide funding for a ten months study of the Archipelago. The objective was to formulate a Master Plan to assist the Mozambique Government manage the Archipelago for sustained development.

The project base for operations was established on the north point of Bazaruto.

### 1.2.1 Terms of reference

The brief was to formulate a Master Plan, based on sound conservation principles, that would safeguard the ecological integrity of the Bazaruto Archipelago but, at the same time, permit the Mozambique Government to maximize social and financial benefits from tourism on a sustained development basis.[40,41]

### 1.2.2. Objectives

**Primary objectives**

Since development in the Archipelago is dependent on the continued attraction of the environment and its components, conservation objectives must logically be primary. In other words, no Master Plan can be formulated, accepted or implemented which does not have as its objectives the conservation, development, control and management of the Archipelago. These must be integrated so that they can each be achieved without conflicting with one another. The primary objective may, therefore, be stated as:-



*"To preserve and where possible to restore the diversity of landscapes, ecosystems, species and processes in the Archipelago. The traditional lifestyle of the island people will be encouraged, provided this is not in conflict with the primary objectives."*

The sustained exploitation of the renewable natural resources of both the terrestrial and marine ecosystems will be permitted, subject to the utilization of the primary objectives.

**Secondary objectives**

(a) Development objectives:
The development of the Archipelago will be encouraged, as long as the impacts of tourism do not impair the landscapes or prevent the achievement of the primary objective.

(b) Control:
Control of all forms of development will be exercised by education, guidance and regulations. This is to ensure that the Archipelago continues to provide a source of traditional livelihood for its inhabitants, and to attract tourists to Mozambique to generate employment opportunities and foreign exchange.

# 2. ENVIRONMENTAL COMPONENTS

## 2.1. Ecological Systems and Processes

### 2.1.1 Geomorphology and evolutionary processes involved in the formation of the Archipelago[8,23,25] (Figure 2)

The Bazaruto Archipelago is situated offshore from the Mozambique coastal plain, which is largely composed of ancient delta deposits of the Rio Limpopo and Rio Save. The Bazaruto Archipelago is located south of the modern delta of the Rio Save.

The east coast of Africa has experienced a recent sea level history similar to other tectonically stable parts of the world. These sea level changes strongly influenced the geomorphological development of coastal areas. Particularly important in this regard is the documented occurrence in South Africa, Mozambique and Tanzania of a post-glacial high sea level rise of about 2 metres 5000 to 7000 years ago. The previous time the sea level was higher than its present level was approximately 120 000 years ago, during the last Interglacial period.

The formation of barrier islands has been the subject of considerable debate, but they are common around most of the world's coasts. The islands appear to form during a period of relatively stable sea level and probably emerge as a result of wave action. Once they are exposed, additional sand is added to them, intertidally, to form a linear island feature, backed by a sheltered lagoonal system and fronted by the open sea. When sufficient sand has accumulated by wave action, prevailing winds begin to transport sand around and form sand dunes aligned perpendicular or parallel to the prevailing or strongest wind direction.

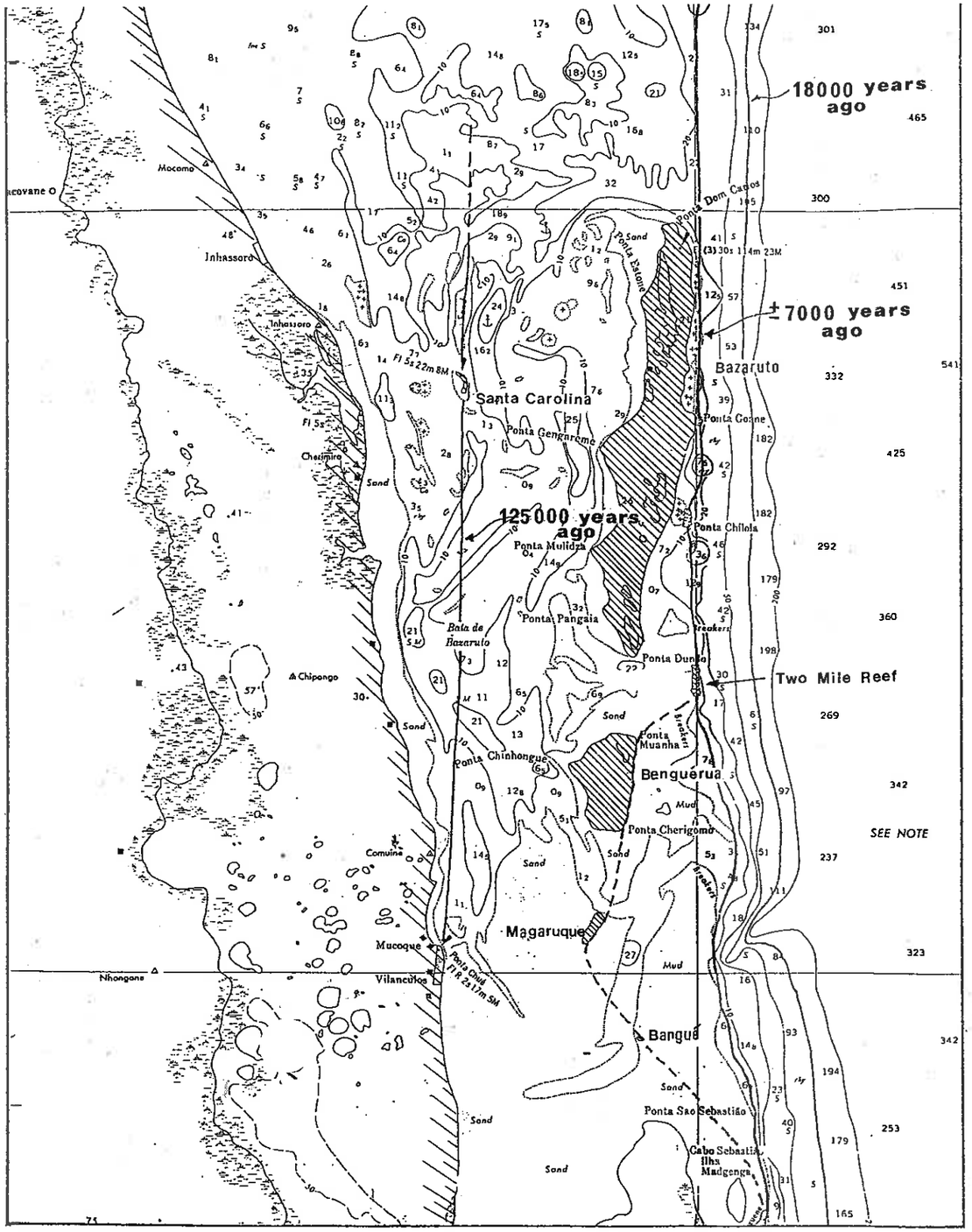



**Fig. 2.** Carta batimetrica do Arquipelago do Bazaruto mostrando as ultimas mudancas do Pleistoceno e do Holocene na linha de costa, deduzidas dos niveis do mar e geologia geral.

**Fig. 2.** Bathymetric chart of the Bazaruto Archipelago showing the late Pleistocene to Holocene coastline trends deduced from sea level data and general geology. After Ramsay 1990.



Once the dunes have been established, rain water passing through them dissolves calcium carbonate and carries it downward through the porous sand. When the carbonate-laden waters reach salt water, the carbonate precipitates and binds sand grains together to form beachrock at the margins of the island. Thus beachrock outcrops delineate present or past shoreline positions. Movement of the island is therefore clearly indicated wherever the modern shoreline is located some distance landward of a beachrock outcrop. Beachrock forms when sediment in the intertidal environment is cemented by calcium carbonate derived from shelly material. Rainwater, being slightly acidic, dissolves shell fragments in the dune and upper beach areas. The ground water, now saturated with calcium carbonate, flows towards the sea when it mixes with the more alkaline sea water, calcium carbonate precipitates between the sand grains. Precipitation of cement is triggered due to a rise in pH of the ground water at the sea water/freshwater interface. In this way the sediment just below the low-water mark is cemented to form beachrock. Beachrocks that occur at different depths are generally good indicators of the changes in sea level that have occurred in the past.

In the Bazaruto Archipelago, there were two main phases of island formation. The first appears to have taken place about 120 000 years ago, to form Santa Carolina by the processes outlined above. Submerged beachrocks north of Santa Carolina probably represent an eroded extension of this former barrier island chain. Evidence for this older island chain comes from the elevated beachrock outcrops on Santa Carolina which were formed at a higher sea level.

After the formation of Santa Carolina the sea level fell and, when it rose again, a new barrier island stabilized in the position of Bazaruto, Benguérua and Magaruque. This took place between 7000 and 5000 years ago. The islands have subsequently been modified by modern conditions. It is most probable that they were formerly a continuous sand body, possibly joined to the mainland in the south. The breaks between the islands are probably the result of particularly severe tropical cyclones. A similar process, under hurricane influence, is responsible for forming inlets in the barrier islands of the Gulf of Mexico.

The islands of Bazaruto, Benguérua and Margaruque have been transported landward in the past 7000 years. Since the original island formation, the central to southern margin of Bazaruto together with the northern sand-split have migrated towards the mainland at an assumed rate of 600 m/1000 years. Evidence for this is found in the exposed beachrock at Two-Mile reef, which was the shoreline. Most of the other reefs (for example, Coral Gardens) are also formed on exposed beachrock which marks the former shorelines but, in these cases, the distance through which the islands have migrated are considerably smaller. Sand contained in the extensive sand dunes probably originated on the now eroded beach sections.

Bangué appears to have a different origin to the other islands and seems to have arisen through wave action causing a part of the flood-tidal delta to emerge. Since these deltas formed only after the main island chain, Bangué is the youngest of the islands in the Archipelago and is probably no more than 3000 to 4000 years old at most.

### 2.1.2. Geology and soils[8]

The islands are composed mainly of unconsolidated quartz sand with a minor carbonate component derived from the skeletons of marine organisms. As such, they are susceptible to movement by natural processes. The dunes are either bare or sparsely vegetated. The vegetation stabilizes the loose sand and also acts to trap continuously wind-blown sand to enable continual dune growth. Beach sands are moved by wave action until they reach a state of dynamic equilibrium with prevailing conditions. This is reflected in the occurrence of small half-hearted bays on the seaward side of the island. The alignment of these bays indicates dominant littoral drift towards the north. Sand transported northward has been deposited to form the extensive spit on the north end of Bazaruto. The presence of beachrocks around the islands form the framework of the modern island system and profoundly influence wave refraction patterns. Beachrock formation is an ongoing process, so it is to be expected that the shoreline will produce new beachrock outcrops as it moves landward and restabilizes itself from time to time. The abandoned beachrock outcrops provide the only suitable substrate on which coral growth can take place on this largely unconsolidated sedimentary coastline.

Peat deposits are developed to a limited extent on the landward side of the islands due to the accumulation of decaying vegetal material. They may be important in forming the lower horizon of the aquifer.

### 2.1.3. Hydrology[8]

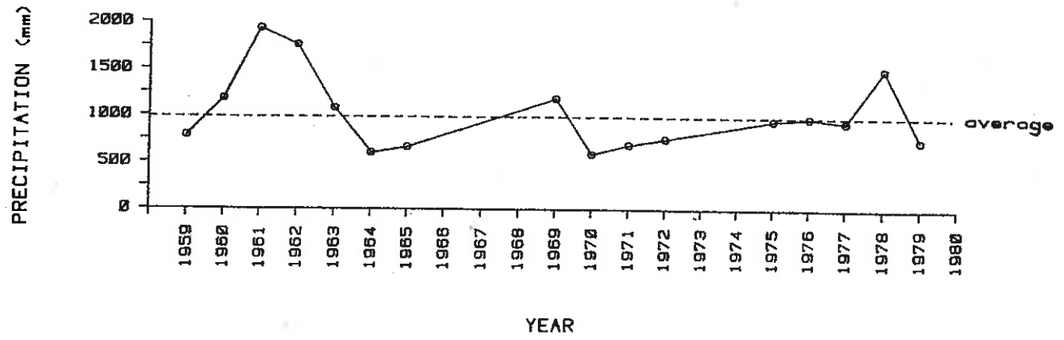
The major storage area for groundwater on the islands is in the dunes, but because the dunes are relatively small and the islands comparatively narrow, the storage capacity is small and sea water will be encountered at shallow depths. The dune aquifer probably has a rapid recharge rate after rains, owing to the porous nature of the sand. However, given its small volume, it will be susceptible to faecal contamination with increased habitation.

### 2.1.4. Climate[34]

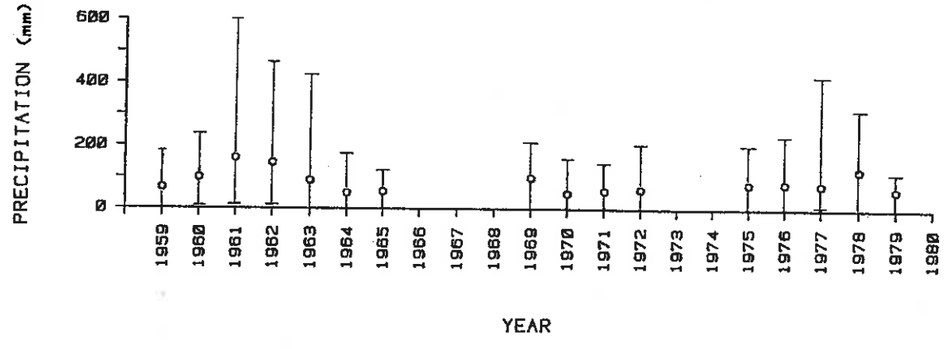
**Ambient temperatures:**
Summer maximum 30°C
Winter minimum 18°C
Average annual 24°C

**Precipitation: (Figure 3a)**
The Archipelago's rainfall is dominated by two climatic systems: the Indian Ocean Subtropical Anticyclone System of the SE Trade Wind Zone from the Zambezi southwards, the rains falling with the passage of the depressions; and the southern end of the East African Monsoonal System. The irregularity of the precipitation is reflected in **Appendix A.**






Annual variation of precipitation at the lighthouse, Northern Bazaruto




Monthly variation of precipitation at the lighthouse, Northern Bazaruto

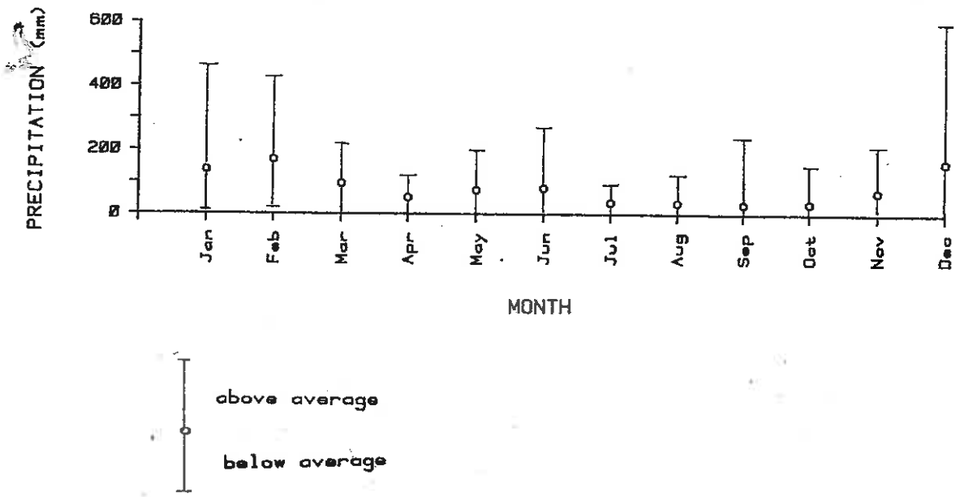



**Fig. 3a** Precipitation data derived from recordings made at the lighthouse, northern end of Bazaruto, 1958-1980.

**Wind, storms and hurricanes: (Figures 3b and 3c)**
The energies generated by these elements are most important in shaping coastlines by direct ablation and deposition, and indirectly their effect on wave form, ocean currents and longshore drift.

The annual average occurrence of hurricanes in the Mozambique channel is 3.1 with the heaviest concentration down the west coast of Madagascar. In fifty years twelve high intensity hurricanes, and thirty eight medium intensity hurricanes have occurred in the region. On one occasion during October 1989, a violent but brief windstorm cut a 40 metre wide path of destruction through the Bazaruto Lodge Complex.

## 2.1.5 Terrestrial Environment

### 2.1.5.1 Habitats (Figures 4-6)

Vertical photographs were taken, in colour, from an altitude of 5000ft, in order to map the various habitats and to truth the 1989 Landsat image of the Archipelago. There are eleven distinct terrestrial habitats on the islands, based upon geomorphic, physiognomic, and floristic components:

* Bare coastal sand dunes
* Pioneer plants on primary sand dunes
* Casuarinas
* Adaphic grassland
* Swamp forest
* Savanna grassland
* Scrub thickets
* Thickets associated with the perched water table at base of west facing coastal dunes.
* Remnant dune forest along western (bayside) shores.
* *Dialium schlegteri* and *Julbernadia* woodland.
* Remnant climax mesic forest with epiphytes.

All these habitats indicate signs of modification by the actions of humans and their domestic livestock. Apart from the remnant climax forest patches on the north western shore of Benguérua and the southern shore of Margaruque, all other vegetation types are in various stages of serial successional change. Refer to **Appendix B** for a list of the prominent woody species found in the Archipelago.[20,22]

### 2.1.5.2 Mammals[12,29] (Figure 7)

Bazaruto still has indigenous populations of samango monkey *Cercopithecus mitis*, night ape *Galago moholi*, red duiker *Cephalophus natalensis*, bushbuck *Tragelaphus scriptus* and the Tonga red squirrel *Paraxerus palliatus*. Only the Tonga red squirrel is represented on Benguérua, and Santa Carolina has one indigenous species of rodent *Mus minutoides*. The mammalian fauna of the Archipelago represent isolates from the era when the islands were once part of the continent. For a complete list of mammals occurring in the Archipelago and their ecology refer to **Appendices Ca** and **Cb.**



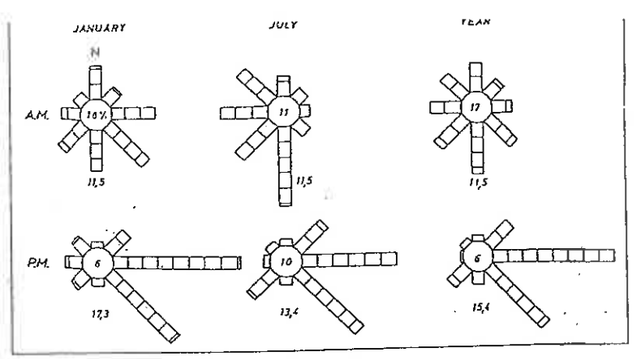



**Fig. 3b** Prevailing wind force and direction in the region of the Archipelago. After Tinley 1971.

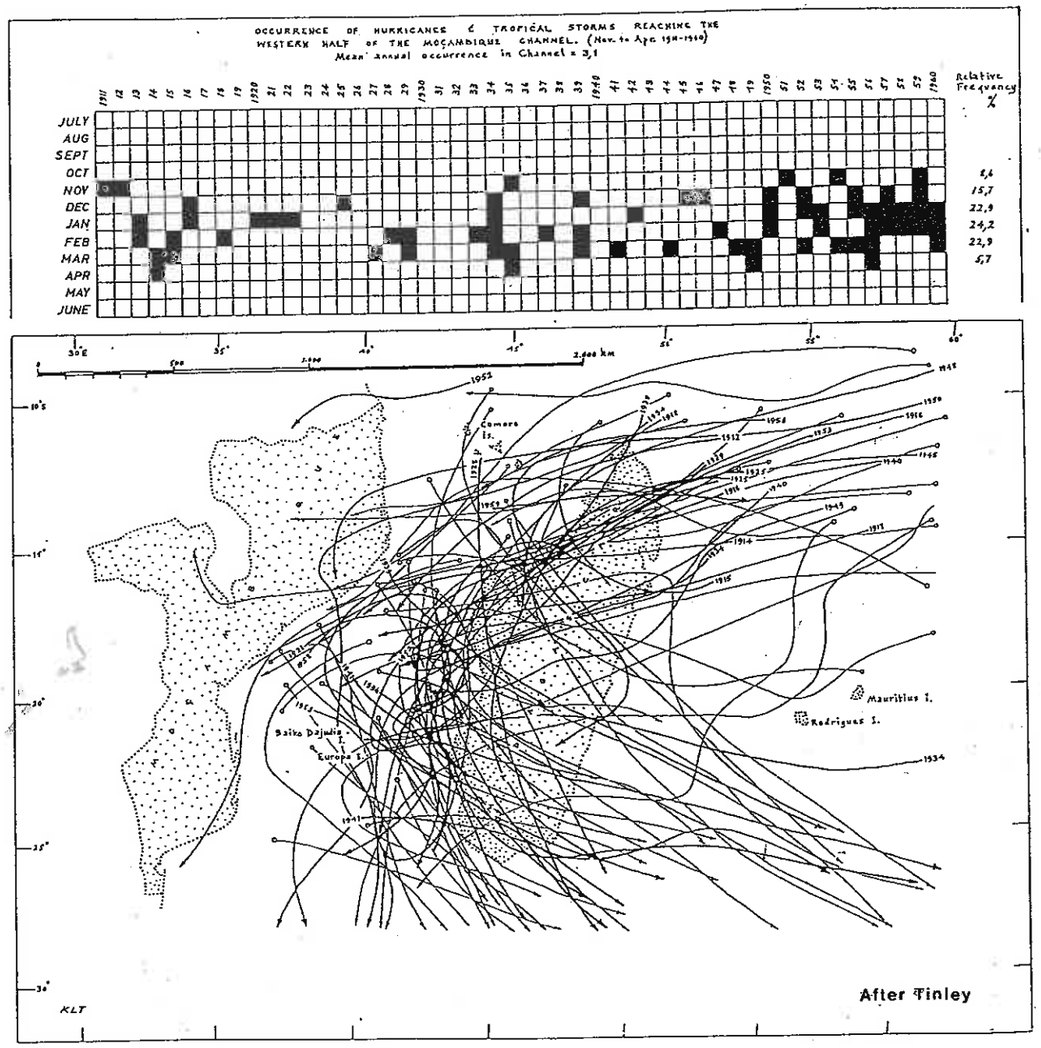



**Fig. 3c** Distribution of hurricanes which pass Madagascar and effect the Mozambique coast. After Tinley 1971.

## HABITATS

- Capim marinho e bancos de Mapalo (*Pinctada Imbricata*)
  Marine grass and Mapalo (*Pinctada Imbricata*) beds
- Praia rochosas e recifes
  Rocky shore and reef
- Praia e dunas desnudadas
  Beach and bare dunes
- Dunas poineiras
  Dune pioneers
- Mangais
  Mangroves
- Salinas
  Salinas
- Lagoas de agua doce
  Freshwater lakes
- Pântanos
  Edaphic grassland
- Floresta de pântano
  Swamp forest
- Pradarias e savanna
  Savanna grassland
- Brenhas de matagais
  Scrub thickets
- Floresta higrófila na base das dunas
  Seep forest at base of dunes
- Remanescente de Floresta das dunas
  Remnant dune forest
- Casuarianas
- Floresta de *Dialium schlechteri* e *Julbernadia*
  *Dialium schlegteri* & *Julbernadia* woodland
- Remanescente de floresta climax mesica com epifitas
  Remnant climax mesic forest with epiphytes
- Vegetação secundaria
  Secondary vegetation

Banguérua.

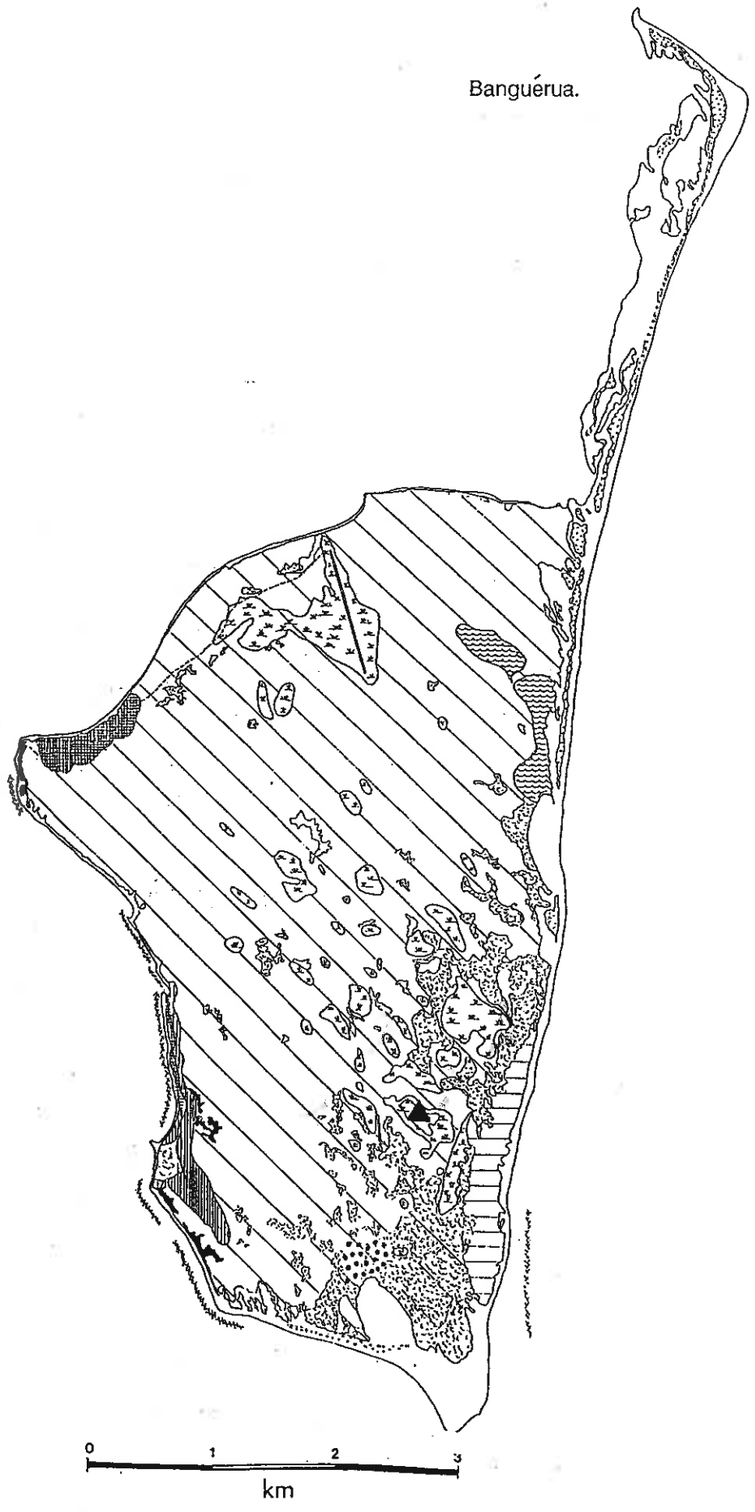



**Fig. 4** Habitats principais de Benguérua.

**Fig. 4** Principal habitats of Benguérua.

Bazaruto.

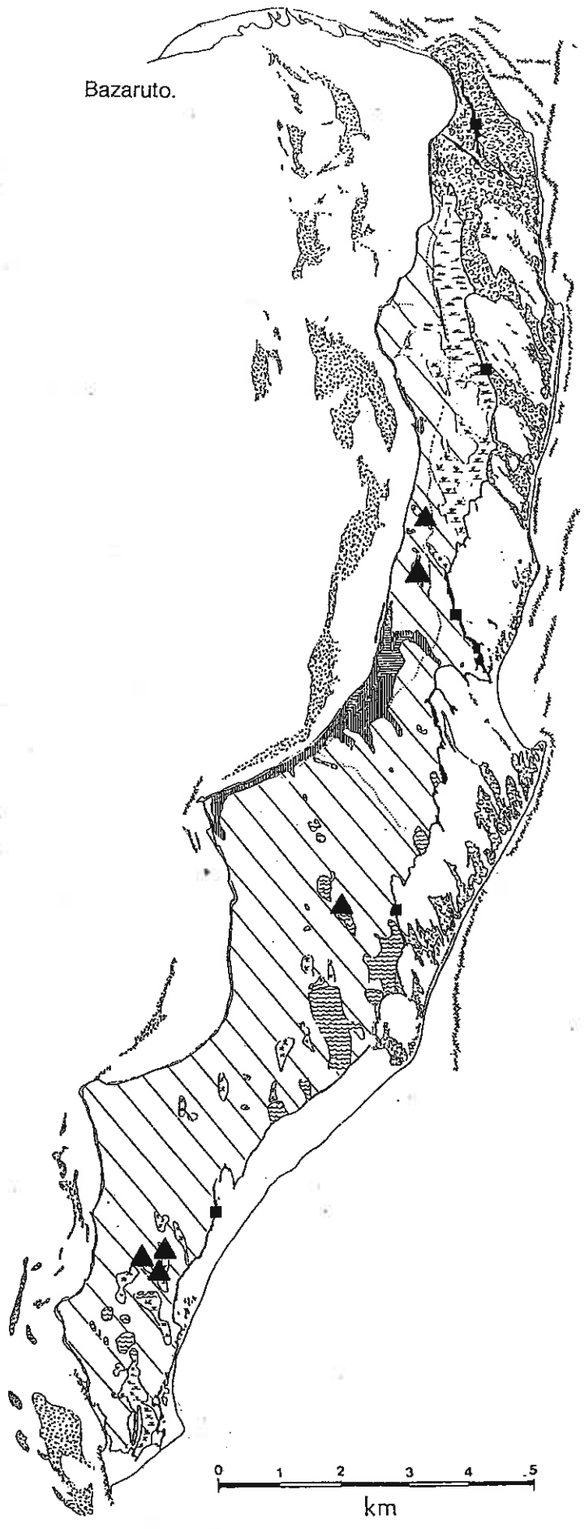



**Fig. 5** Habitats principais do Bazaruto.

**Fig. 5** Principal habitats of Bazaruto (Destorted due to survey techni

Capim marinho e bancos de Mapalo (*Pinctada imbricata*)
Marine grass and Mapalo (*Pinctada imbricata*) beds

Praia rochosas e recifes
Rocky shore and reef

Praia e dunas desnudadas
Beach and bare dunes

Dunas poineiras
Dune pioneers

Mangais
Mangroves

Salinas
Salinas

Lagoas de agua doce
Freshwater lakes

Pântanos
Edaphic grassland

Floresta de pântano
Swamp forest

Pradarias e savanna
Savanna grassland

Brenhas de matagais
Scrub thickets

Remanescente de Floresta das dunas
Remnant dune forest

Casuarianas

Floresta de *Dialium schlechteri* e *Julbernadia*
*Dialium schlegteri* & *Julbernadia* woodland

Remanescente de floresta climax mesica com epifitas
Remnant climax mesic forest with epiphytes

Vegetação secundaria
Secondary vegetation

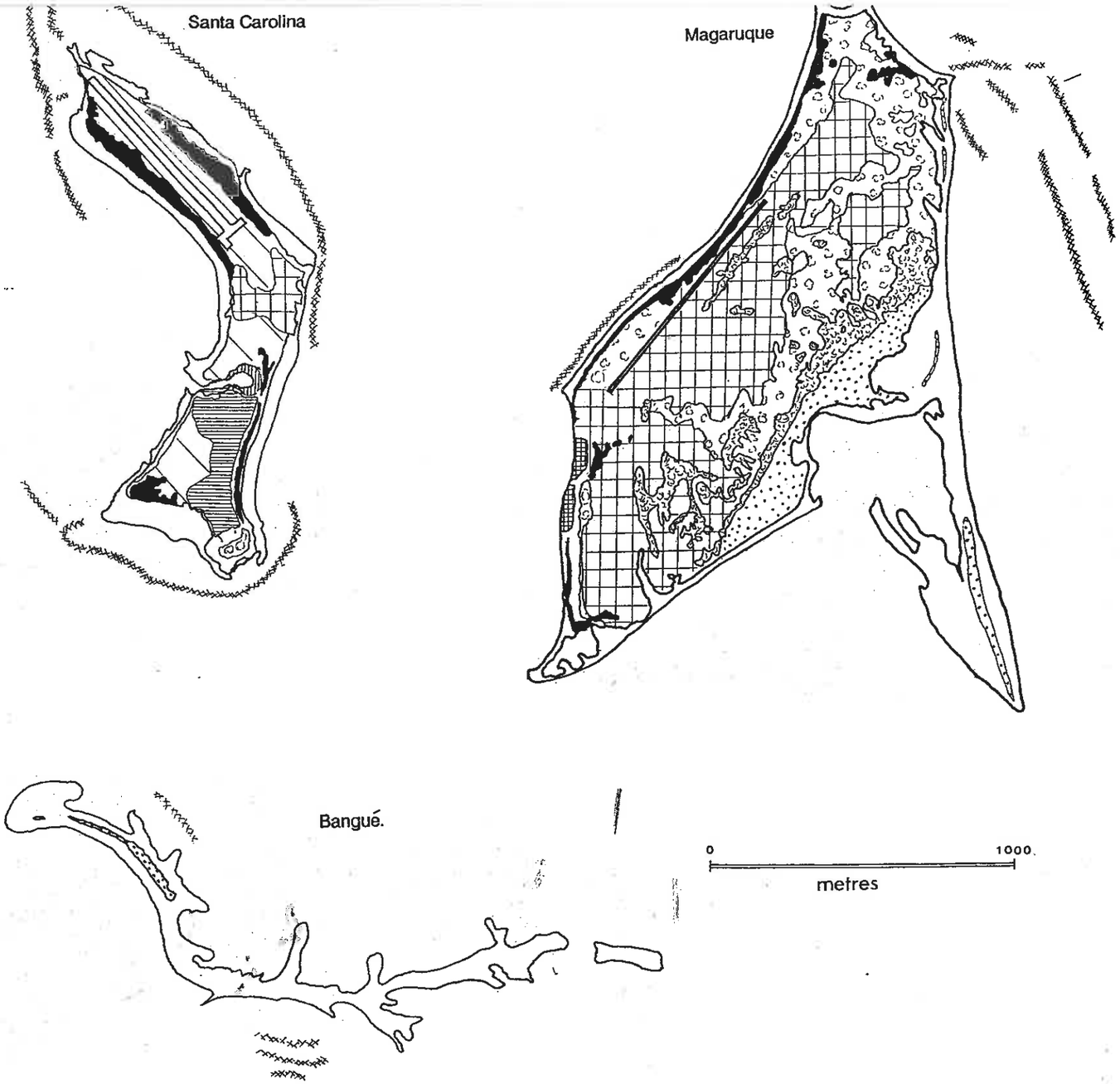



**Fig. 6.** Habitats principais de Magaruque, Santa Carolina e Bangué.

**Fig. 6.** Principal habitats of Magaruque, Santa Carolina, and Bangué.

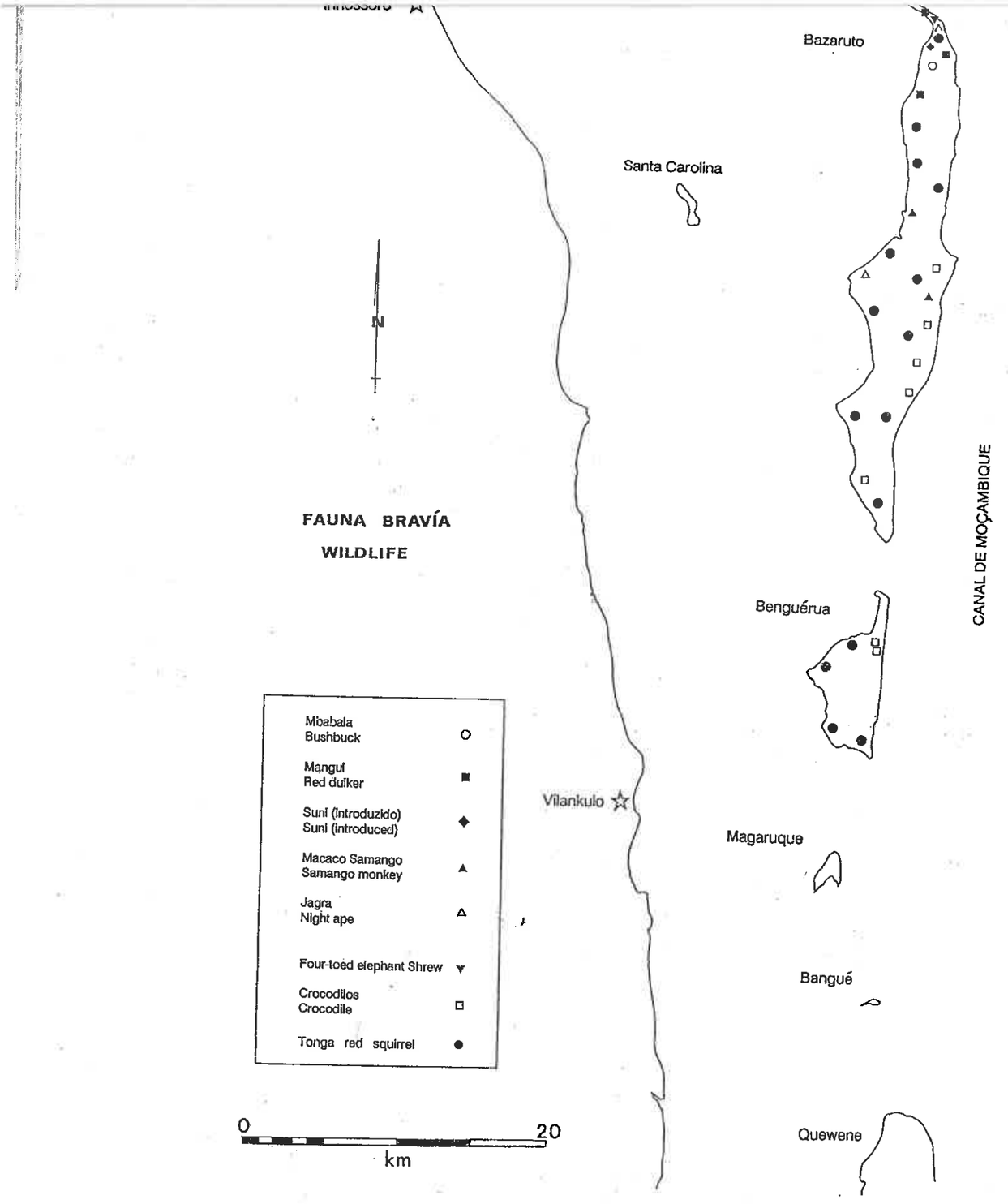



**Fig. 7.** Diversas especies bravias do Arquipelago.

**Fig. 7.** Various wildlife species in the Archipelago.



None of the older residents on Bazaruto or Benguérua could recall seeing hippopotamus in the freshwater lakes.

Feral cats and the domestic rat *Rattus rattus* are unfortunate introductions to the Archipelago causing the destruction of indigenous fauna.

**2.1.5.3** **Avifauna**[4,19]

A total of 148 bird species have been recorded for the Archipelago.

The Archipelago is an important stop-over for migrating avifauna. The extensive sand flats on the leeward shores of the islands are vitally important habitats attracting large numbers of Palaearctic waders. Rarities, such as the Palaearctic form of the Peregrine Falcon, have been recorded on Bazaruto and Benguérua. For a complete list of the avifauna which occur in the Archipelago refer to **Appendix D.**

**2.1.5.4** **Herpetofauna**[2,12]

A total of forty-five different species of reptiles and amphibians are recorded for the Archipelago.

This fauna provides evidence of the geomorphic changes that have taken place since glacial melting and the subsequent successional forces that have resulted from natural and human perturbations. For example, the occurrence of two forest snakes, *Naja melanoleuca* and *Dasypeltis medici*, suggest that the islands were heavily forested at the time of their excision from the mainland.

Two new species and three new subspecies of the family SCINICIDAE were collected from the last remaining climax forest patches on Bénguerua and Margaruque. The occurrence of these rare isolates makes it vitally important to protect their habitats. The reptiles play a major role in controlling populations of rodents, particularly *Rattus rattus*. Refer to **Appendix E** for a complete list of the herpetofauna which occur in the Archipelago.

**2.1.6** **Marine environment**[31]

**2.1.6.1** **Physical environment**

The Bazaruto Archipelago is washed by the south flowing Mozambique Current which is fed Tropical Surface Water by the Equatorial Current. Current velocities of up to 2m/sec have been recorded. The temperature of the water ranges from 23°C in winter to 27°C in summer, and the salinity is 35,4°/$_{oo}$ in winter and 34,7°/$_{oo}$ in summer. The open ocean littoral of the Archipelago experiences extremes of low and high tides approximately 40 minutes ahead of Durban, while tides on the inner bay (north eastern Bazaruto) coincide with Durban. The average tidal amplitude is about 3 metres during normal spring tides with 4,39 metres being measured during the equinox of March 9, 1989. Richards Bay, in comparison, recorded 2,34 metres equinoxial tide during the same period.

The tidal range at high spring tides produces strong currents in the channels between the islands. These currents have transported large quantities of sand to form extensive flood- and ebb-tidal deltas. These currents also maintain the deep channels on the landward side of the islands and transport sand across the tidal flats. Wave action is restricted to the seaward margin of the islands and prevents the formation of extensive tidal flats in that area. The back-barrier area is sheltered from direct wave action and this produces tranquil, low energy conditions.

2.1.6.2 **Habitats (Figures 4-6)**

A number of distinct habitats are present on the eastern shores of the Archipelago. For example, there is the pelagic environment in which game fishing is practiced; the coral reefs which are fringing assemblages developed on submerged carbonate-cemented beach rocks; and the surf-washed littoral zone. The stability of intertidal rocky areas enables colonization of these areas by a variety of organisms. Rocky areas which have been stranded from the shoreline owing to island migration provide areas for corals to colonize and form small reefs with suitable conditions to support a typical reef-associated fauna.

Sandy beaches on the seaward side of the island are subjected to wave action, which dominates sedimentary dynamics there, as opposed to tidal currents.

On the western side, low energy conditions create sand tidal flats which provide a range of habitats for various organisms. These sand flats, with associated algal growth, provide browsing for molluscan fauna. Areas stabilized by algae are also suitable for the habitation of infauna, such as burrowing bivalves, etc. The algal mat is important in stabilizing the sand flats. This is illustrated by the fact that, where vehicles traverse the substratum, the algal mat is distributed and subjected to redistribution by current action. The current also appears to keep the sand in periodic motion, thereby possibly preventing permanent habitation by infauna.

Associated with the sand tidal flats are distinct patches of marine grass angiosperms[24], principally *Thalassiodendron ciliatum*, *Cymodocea rotundata*, *Halodule uninervis* and *Zostera capensis*. These grass "meadows" are habitats for a rich marine fauna, including the dugong which graze largely on *C. rotundata*.

Of the five islands, only Bazaruto, Benguérua and Santa Carolina support mangrove communities and salinas. Five species are represented, *Rhizophora mucronata, Bruguiera cylindrica, Ceriops tagal, Avicennia marina* and *Sonneratia alba*. The mangrove substrate is sandy and anoxic approximately 5cms below the surface and is inundated only during spring tides. The salinas are sparsely vegetated with *Arthrocnemum perenne*, *Sesuvium portulacastrum, Salicornia perrieri, Sporobolus virginicus, Digitaria littoralis* and *Juncus krausii* on the slightly elevated margins.

2.1.6.3 **Marine mammals[29]**

The greater Bazaruto area provides a highly suitable habitat for marine mammals. The combination of rich shallows and the close proximity of oceanic conditions contribute to this. During the brief period of research a number of sightings were made.



Humpback whales *Megaptera novamanglea* are a threatened species known to migrate along the coasts of Natal, southern Madagascar and Mozambique. The positive and repeated sightings of humpbacks around the Archipelago suggests their preference for the region, especially as they were observed to be actively feeding, possibly on the blue-line herring *Herklotsichths quadrimanculatus*.

Bottlenose dolphins *Tursiops truncatus*, an inshore species, were observed on numerous occasions on the seaward edge of Bazaruto, usually close inshore. It is probable that these sightings were all from the same school resident in the area.

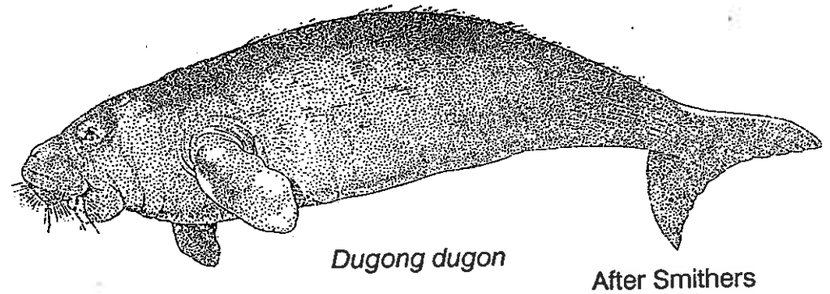
One school of common dolphins *Delphinus delphis* was observed just off the southern tip of Bazaruto, apparently feeding. The presence of this more migratory species is a good indication of the region's attractiveness to dolphins.

On several occasions spinner dolphins *Stenella longirostris* - small, more tropical dolphins - were observed "porpoising" behind the surf line. These usually timid species are not frequently reported. Nevertheless research revealed that strandings of this species had previously occurred on the island, hence they may be more abundant than originally thought.

Humpback dolphins *Sousa chinensis* a shallow water species, are normally associated with river mouths and estuaries, often in turbid water. It was surprising and pleasing to observe healthy schools of this species in the Bay area. These animals were surprisingly tame and lived in exceedingly shallow water. The presence of this species is considered important as its status in other regions is severely depressed and threatened.

Dugong *Dugong dugon* **(Figure 8)** occur mainly in the sheltered bay between the islands and the mainland, grazing the marine grass meadows. Individual animals have been encountered close inshore on the open ocean littoral. They normally occur in family groups, but a large aggregation of 36 animals was counted south of Santa Carolina during an aerial survey in March 1990. Earlier Tinley (1970) had counted 18 dugong in the bay between Vilankulos and Inhassoro. A sample count of 67 adults and 13 juveniles was made in the entire bay area between the islands and mainland. The groups were unevenly distributed, therefore it was impossible to arrive at an estimated total. However, a total population of 110 seems a reasonable estimate. Full details of the census are shown in **Appendix F**.

Reports are often received of these animals falling victim to gill nets set for shark. Though protected, no attempt is made to enforce the law regarding the killing of dugongs.



*Dugong dugon*

After Smithers

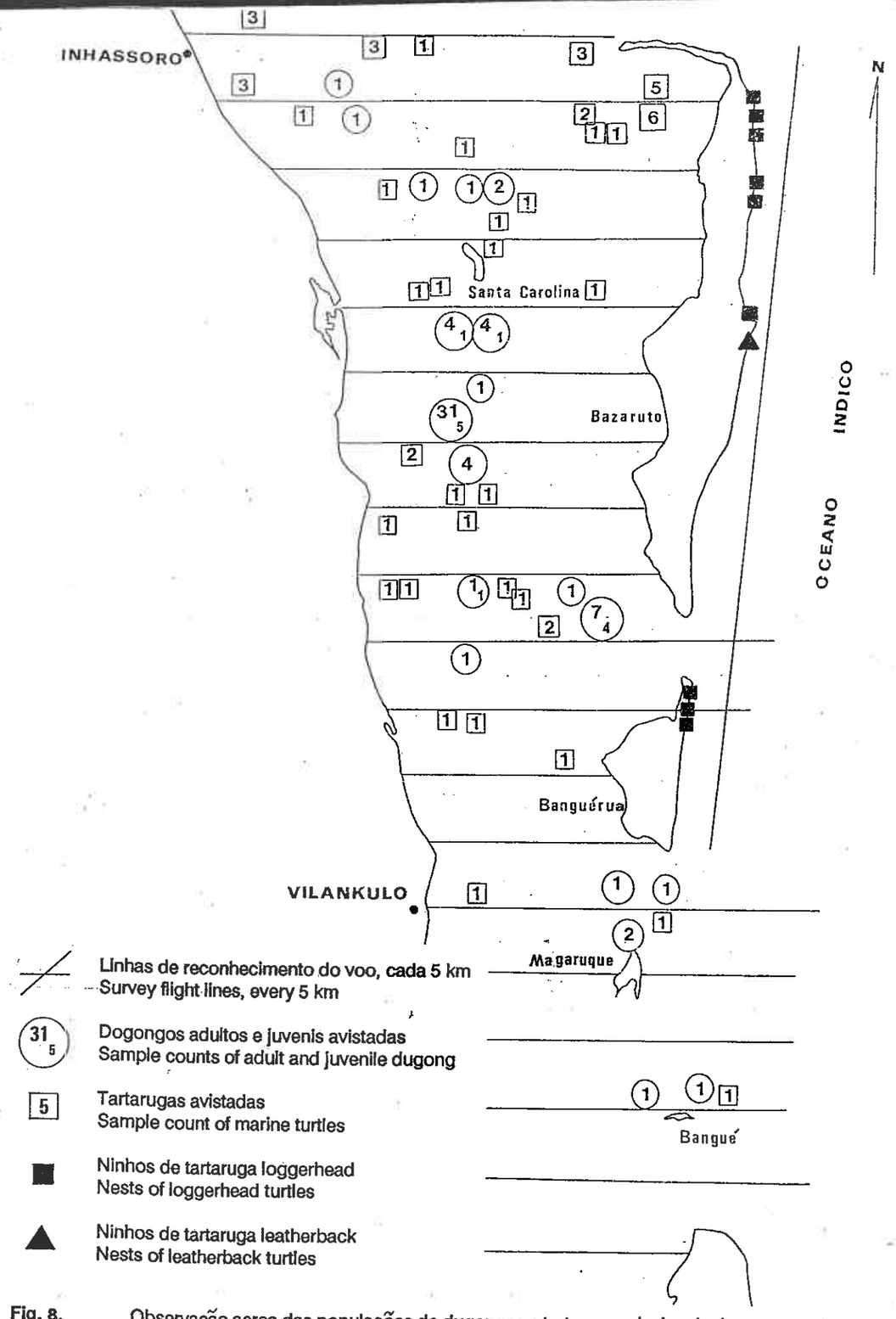



**Fig. 8.** Observação aerea das populações de dugongos e tartarugas do Arquipelago em 12 de Fevereiro de 1990, e localização dos ninhos das tartarugas.

Aerial survey of dugong and turtle populations in the Archipelago (12 February 1990), and nest localities of loggerhead and leatherback turtles.



### 2.1.6.4 Turtles[16]

Hughes (1974) records the occurrence of five species of turtles in the vicinity of the Bazaruto Archipelago. These are the green (ihasi) *Chelonia mydas*, hawksbill (xihambamutwitwi) *Eretmochelys imbricata*, loggerhead (xinholo) *Caretta caretta*), olive ridley *Lepidochelys olivacea* and leatherback (mukololo) *Dermochelys coriacea*. The response of local fishermen to photographs of the different turtles seemed to indicate that, with the exception of the olive ridley turtle, the other four species all nested on Bazaruto.

During the period from mid-November 1989 to the end of January 1990, the beaches on Bazaruto were intensively patrolled for nesting turtles. Five loggerhead turtle nests were recorded, all located between the north point sandspit and Sailfish Bay (**Figure 8**). Two loggerhead nests found on the northern tip of Benguérua island were subsequently raided by islanders. A report of a leatherback turtle nest on Bazaruto was received but not confirmed. Numerous green turtles and loggerhead turtles were seen on the reefs around Bazaruto. The results of the survey show that loggerhead and possibly leatherback and hawksbill turtles use the beaches on Bazaruto as nesting sites. The likelihood that green turtles also nest in the Archipelago cannot be excluded at this stage. The loggerhead turtle nesting season in the Archipelago is from November to March.

| NEST | DATE NESTED | DATE HATCHED | CLUTCH SIZE | NUMBER HATCHED | NO.INFERTILE & NAT-MORTALITY (nest & beach) |
|---|---|---|---|---|---|
| 1 | 19.11.89 | 19.01.90 | 109 | 61 | 48 |
| 2 | 04.12.89 | 26.01.89 | 63 | 45 | 18 |
| 3 | 09.12.89 | 07.02.90 | 71 | 51 | 20 |
| 4 | 10.12.89 | 08.02.90 | 74 | 49 | 25 |
| 5 | 26.12.89 | 24.02.90 | 64 | 18 | 46 |

Table 1 : Loggerhead turtle *Caretta caretta* nests monitored during survey.

### 2.1.6.5 Characteristic Ichthyofauna[30,37]

The East Coast of Africa is generally a region of high species diversity and it is noteworthy that the ichthyofauna of Bazaruto is particularly representative of the entire region. This is largely due to the diversity of habitats in close proximity to each other. It is thought that some 80% of all marine fish families are represented at Bazaruto and that the total species count is in excess of 2000. The origin of fishes found at Bazaruto is primarily Indo-Pacific, probably 80% or more. Consequently, recruitment of fishes to the Archipelago will be reasonably secure in view of the large area of their distribution. In fact, the incidence of endemism amongst marine fishes at Bazaruto is either absent or very low. The value of fishes with alternative distributions should not be overlooked. The highly migratory tunas, billfish and sharks enjoy global distributions but are a major asset to the islands and their people.

It is concluded, therefore, that the Archipelago sustains a highly representative ichthyofauna worthy of protection. It is also believed that the overall status of this fauna is good, with little sign of impoverishment or damage. The only exception could be amongst the rockcods SERRANIDAE known to be resident and most vulnerable to local exploitation. Furthermore, fluctuations in the presence and abundance of individual species can be induced by events far away from the islands.

Refer to **Appendix G** for a list of species that are exploited by artisanal and recreational fishing.

2.1.6.6 **Seacucumbers**[10]

A diversity of echinoderms are found in all the marine habitats but only one holothurian, *Holothuria scabra*, known locally as makajojo, is exploited as an economic resource (refer to 3.1.2.4).

*Holothuria scabra*

After Day

2.1.6.7 **Crustacea**[11,14]

Diverse crustacea are found in all the marine habitats. The major species found in the Archipelago are listed below.

Rock lobsters are the purposeful catch of spearfishermen for domestic consumption as well as resale to the hotel for its menu. They are of necessity speared in the typically deep recesses of the rock reefs they inhabit, as they cannot be reached by hand. Collection is thus indiscriminate, regardless of size or reproductive condition, and many are taken in berry. There is also a semi-industrial fishery that exports over 400 tonnes of lobster tails each year from Inhassoro. The lobsters are harvested by beach operated mechanical winches and local skin-divers in the Bay.

Species most often caught are:

| | **Carapace size range** |
|---|---|
| *Panulirus homarus,* | 71 - 103mm |
| *P. versicolor*, | 83 - 98mm |
| *P. penicillatus* | 64 - 138mm |
| *P. ornatus* | 75 - 115mm |

Crabs are of little economic importance. However, *Portunus pelagicus* is collected incidentally on the sand flats during seine netting operations and the gathering of sand oysters; these are used as subsistence food by the local inhabitants.



Species typical of the coral reefs include *Trapezia cymodoce*, *T. rufopunctata*, the rare *T. richtersi*, *Tetralia heterodactyla lissodactyla*, boxer crab *Lybia tesselata*, commensal coral shrimp *Alpheus lottini* (yellow variety), hermit crab *Pagurus euops* which is often found perched on a coral head, and the ubiquitous banded coral shrimp *Stenopus hispidus* which is usually found in pairs in caves.

The intertidal rocky shore harbours a plethora of various crab species which include the tiny grapsid *Pachygrapsus minutus*, the large xanthid *Eriphia smithi*, the boxer crab *Lybia tessellata*, *Atergatis floridus*, *Alpheus* sp. and several species of sponge and spider crabs.

Species most often encountered on the sandy beaches are the ghost crabs *Ocypode ceratophthalma*, *O. cordimana*, *O. madagascarensis* and ***O. ryderi***. The land hermit crab *Coenobita rugosus* occur higher up in the dunes.

Sandflats with the seagrass *Cymodocea* ***rotundata*** harbour a number of predatory species such as *Scylla serrata*, the chinaman or blue crab *Portunus pelagicus*, *Matuta* spp, *Thalamita crenata*, and the hermit crab *Dardanus megistos*. In deeper water the burrowing shame-faced crab *Calappa hepatica* occur.

Mangroves contain *Sesarma meinerti* and *Scylla serrata* and the associated salt marsh has *Uca annulipes*, *U. inversa*, *Sesarma ortmanni* and the large land crab *Cardisoma carnifex*. Where the estuary opens into the sea, the sand crab *Dotilla fenestrata* are found. However, there are many additional species still to be identified.

2.1.6.8 **Mollusca**

Whereas an abundance of marine molluscs is found in the Archipelago **(Appendix I)** only three groups are of economic importance to the local inhabitants:

a) Ornamental shells are collected for sale to the tourist and commercial trade **(Appendix I)**

b) A few species are collected incidentally during gleaning operations for food (e.g. turbo)

c) Sand oysters or mapalo, *Pinctada imbricata*, are collected extensively on the sand flats, partly for commercial, but mainly as a subsistence food.

There are six endemic gastropods in the Archipelago:

- *Conus pennaceus bazarutensis*
- *Epitonium pteroen* Kilburn, 1977
- *E. repandior* Kilburn, 1985
- *Fusiaphera eva* Petit, 1980
- *Thracia anchoralis* Kilburn, 1975
- *Limatula vermicola* Kilburn, 1975

**Mapalo ecology**:
Mapalo occur on the sand flats in the seagrass beds *Zostera capensis* and *Thalassodendron ciliatum* where they attach themselves to the grass stems by their byssus threads. The grass beds **(Figure 5)** occur in discrete patches and it is remarkable how productive yet closed each patch is. Mapalo are suspension-feeders and subsist on detritus particles as the water column clearly supports little phytoplankton. Indeed, the water clarity indicates that relatively little particulate material is freely available and the large numbers of mapalo in each patch subsist on the breakdown products of fallen leaves trapped within the tangle of its vegetation. Nutrients are in turn recycled back to the grass beds in the excretory products of the mapalo. Each bed may thus comprise a closed oasis system within the less productive sandflats.

The mapalo beds cover a total area of 494 ha of which 371 ha consist of the grass patches themselves. Three representative patches were completely cleared and yielded a mean density of 44 mapalo $m^{-2}$. The sex ratio and gonad index of a subsample was established in the single month of November 1989 and proved to be 57MM: 43FF with 79% of the specimens in a reproductively ripe condition. The animals appeared to be fairly precocious and manifested no protandry in the size range examined (36-81mm shell length).

An estimate of the stock from the above figures yielded a figure of $1.55 \times 10^8$ mapalo in the Archipelago. Field measurements of sample weight indicated that this number amounted to a total biomass of 1860 tonnes of flesh (wet weight) or 372 tonnes (dry weight).

Length frequency analysis was undertaken on harvest middens, exploited beds and unexploited beds to establish the impact of mapalo gleaning **(Table 2)**.

| Sample | Midden n=84 | Exploited n=124 | Unexploited n=99 |
|---|---|---|---|
| Size Class (mm) | | | |
| 0-9 | 0 | + | + |
| 10-19 | 0 | + | + |
| 20-29 | 0 | 6 | 5 |
| 30-39 | 4 | 7 | 3 |
| 40-49 | 61 | 58 | 22 |
| 50-59 | 29 | 27 | 25 |
| 60-69 | 7 | 1 | 39 |
| 70-79 | 0 | 0 | 5 |

Table 2: Percentage length frequency analysis of mapalo *Pinctada imbricata* collected on harvest middens, exploited beds and unexploited beds. (+ = <1)



These results show that the gleaners are fairly selective in the animals they collect (small animals are not harvested) but their fishing effort is having an appreciable affect on the size structure of the mapalo population. However, as small size classes are not exploited and are reproductively active, the population is not endangered at this stage.

**2.1.6.9 Corals[25] (Figure 9)**
The corals owe their existence to clear, subtropical water carried southward by the warm Mozambique Current, the absence of silt-carrying rivers in the coastal hinterland and suitable submerged substrata in the form of sandstone beachrocks.

Corals belong to the Phylum CNIDARIA and the Bazaruto Archipelago reefs host members of the two main orders: SCLERACTINIA (hard corals) and ALCYONACEA (soft corals). The other two subordinate anthozoan orders present are GORGONACEA (sea fans) and ANTOPATHARIA (black corals). Hard corals dominate the coral reef fauna as is typical in most Indo-Pacific reef systems; these include the genera *Porites, Acropora, Pocillopora, Stylophora, Montipora, Pavona, Favia, Platygyra Leptoria,* and *Dendrophyllia*. Soft coral are represented by the mushroom-shaped colony *Sarcophyton.*

The eastern and southeastern offshore coral communities of Bazaruto can be classified as patch reefs of the mid-Holocene (+/- 7000 years BP) ancient coastline. The coral communities of Two-Mile Reef and those further north display a physiographic zonation. The back-reef sand-flat environment is characterised by large *Porites* domes up to 2m in diameter. Smaller domes of *Porites* and extensive thickets of *Acropora irregularis* (staghorn coral) dominate the back-reef coral fauna together with smaller colonies of *Pocillopora, Montipora* and *Pavona.* Coral cover in this area is significant, up to 90%. The reef-flat environment is intertidal which results in a sparse coral fauna. Less abundant coral growth is evident on the fore-reef as this area is subjected to storm and turbulent conditions. *Acropora vasiformis* (plate coral) and *Pocillopora* are the most conspicuous genera. True coral reef growth is restricted to depths of 3m on the fore-reef: below this depth, scattered coral colonies occur. This type of depth constraint on reef growth is generally related to a reduction in light penetration below the limits tolerable for reef accumulation. In the reef-front environment sandstone outcrops occur down to a depth of +/-10m.

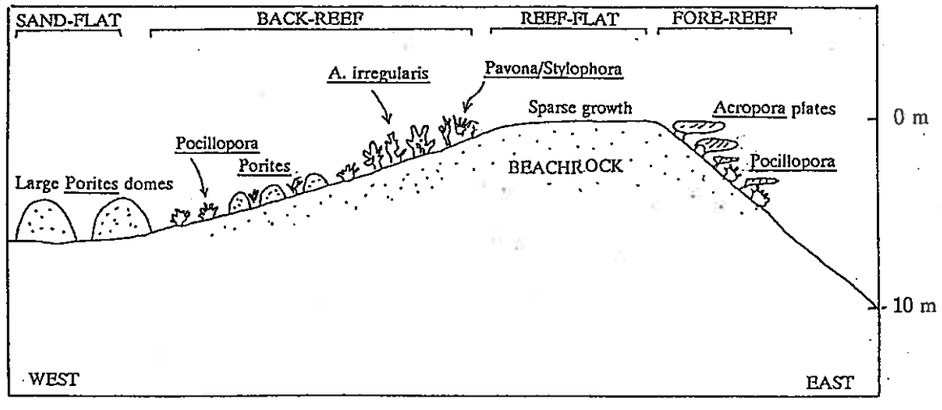



**Fig. 9.** Cross section of Two-Mile Reef showing coral zonation. From Ramsay 1990.

The fringing coral communities on the north-eastern shores of Bazaruto include the Coral Gardens area. These communities are dominated by the genera *Porites, Acropora, and Pocillopora*. The coral on the Bazaruto northern shore increases in thickness towards the northwest, due to its greater age and longer period of colonisation. There are sparse colonies of the coral tree, *Dendrophyllia*, to a depth of 12m on the sheltered western shore of Bazaruto.

### 2.1.7 Freshwater environment

#### 2.1.7.1 Habitats (Figures 4-5)

Freshwater lakes are a feature of both Bazaruto and Benguérua Islands. These are subcircular pans which appear to have formed due to the presence of impervious organic deposits which enhance the permanent nature of the pans. In some instances dunes are encroaching onto the pans on their seaward side. Most of these lakes are free of floating vegetation apart from a few shallow depressions on southern Bazaruto where a small form of *Nymphaea capensis* occurs. All have a heavy dense bloom of algae in suspension which, on settling, form a thick benthic carpet. The maximum depth of the deeper lakes is 3 metres. Fringing vegetation is composed of the reed *Phragmites communis*, bulrush *Typha australis*, and the sedge *Juncus krausii* merging with the surrounding grassland.

Wetlands in various successional stages cover extensive areas on Bazaruto and Benguérua, some supporting small remnant patches of swamp forest with *Ficus trichopoda* and a few *Syzygium cordatum* being the sole woody plant components, and the fern *Thelypteris inerrupta* as ground cover.

The few remaining swamp forest patches and associated wetlands are being used for sweet potato cultivation.

#### 2.1.7.2 Freshwater fish

Sample seine netting in Mbithi lake, with a surface area of approximately 125 ha, produced 780 kg of tilapia *Oreochromis mozambicus* in two sweeps. Sizes were small, varying in total length from 8 - 18cms. One *Clarius garipinis* of 47cm was the only other species encountered. The total biomass of the fish standing-crop in the lake might very well exceed 1 500 tonnes.

#### 2.1.7.3 Avifauna[4,19]

Lakes in various stages of successional change provide viable habitats for a large variety of wetland birds, many of which have been recorded nesting. Refer to **Appendix D** for a complete list of birds.

#### 2.1.7.4 Crocodiles

All the permanent lakes on Bazaruto and Benguérua have populations of crocodiles *Crocodilos niloticus*, which are probably isolates when the islands became separated from the continent. A total of 70 animals were counted from the air on two separate occasions in the winter of 1989 (**Figure 7**). There are very few juvenile crocodiles in the lakes owing to heavy predation of the eggs by the local people.



## 3. DEMOGRAPHY, IMPACTS AND RECOMMENDATIONS

### 3.1 Island Human Populations

#### 3.1.1 Distribution and numbers (Figures 10-11(b))

Travassos Dias[36] in 1971 estimated the population of Bazaruto to be 3 000, made up mainly of fishing communities. However, extrapolating from the present population, a more logical figure would have been about 1000. The war on the mainland has undoubtedly caused a considerable influx of people onto Bazaruto, Benguérua and Magaruque.

| | Bazaruto | Benguérua | Magaruque | Bangué | TOTAL |
|---|---|---|---|---|---|
| Dwellings | 644 | 222 | 62 | nil | 928 |
| Population | 2 576 | 888 | 248 | nil | 3 712 |
| Density (Av.ha/person on available habitable land) | 17 | 8 | 5 | nil | 10 |

Table 3: The population figures derived from aerial census, estimating an average of four persons per homestead (**Figures 10-11(b)**).

#### 3.1.2 Commerce and subsistence

#### 3.1.2.1 Domestic Livestock (Figure 12)

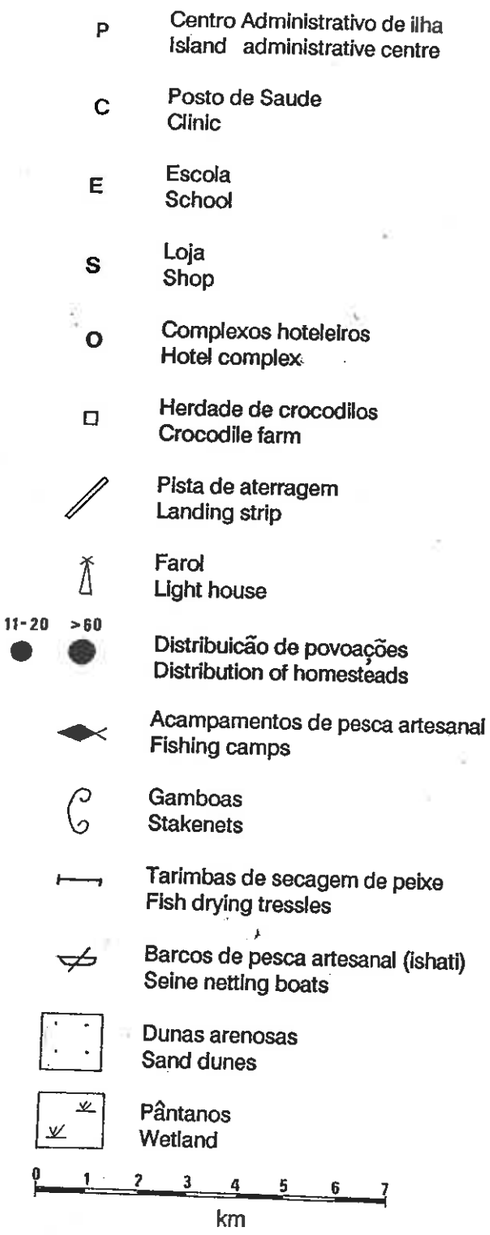
Populations and distribution of goats, sheep, and cattle on Bazaruto, Benguérua, and Magaruque were censused from the air and verified by ground truthing.

| Island | Goats | Sheep | Cattle |
|---|---|---|---|
| Bazaruto | 1 768 | 372 | 0 |
| Benguérua | 100 | 0 | 20 |
| Magaruque | 30 | 0 | 0 |
| Santa Carolina | 20 | 0 | 0 |
| TOTAL | 1 918 | 372 | 20 |

Table 4: The numbers and distribution of domestic livestock in the Bazaruto Archipelago in 1990.

While the populations of domestic livestock on the islands may not yet have exceeded the carrying capacity of the available habitat, they pose a problem which must be addressed in the very near future. Already on Bazaruto the impact of goat browsing, grazing and trampling is very noticeable in areas of high animal density.

Conservative estimates of the annual rates of increase of the populations are: goats 30%, sheep 20%, cattle 20%. As in most rural areas in Africa, livestock management is not directed towards production of an annual harvest, but towards accumulating numbers as a measure of wealth and status.



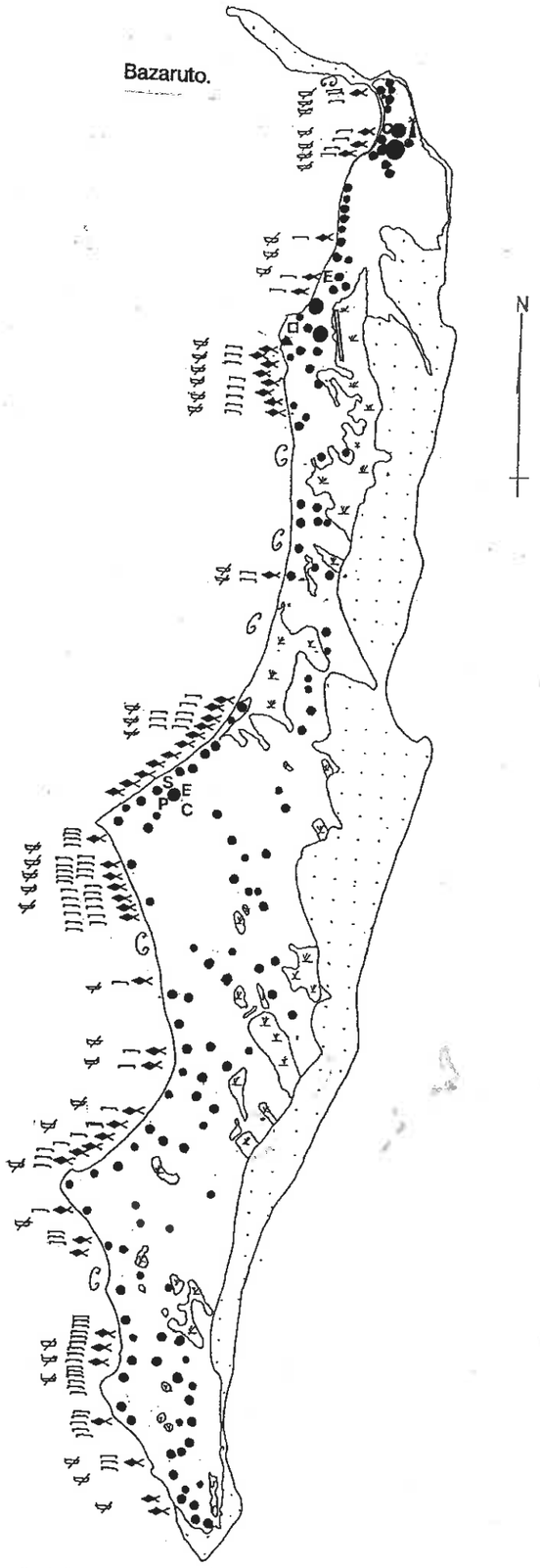




**Fig. 10.** Distribuição de população humana, localização dos acampamentos de pesca, centro administrativo, complexo turistico e herdade de crocodilos do Bazaruto.

**Fig. 10.** Distribution of human population, locality of fishing camps, administrative centre, tourist complex and crocodile farm of Bazaruto.

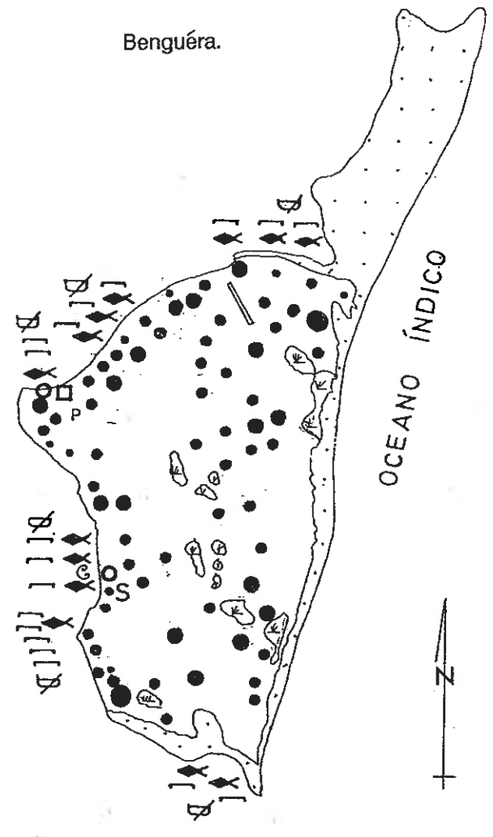



**Fig. 11a** Distribuição de população humana localização dos acampamentos de pesca, centro adminitrativo, complexo turistico e herdade de crocodilos de Benguéra.

**Fig. 11a** Distribution of human population, locality of fishing camps, administrative centre, tourist complex, and crocodile farm of Benguéra.

Magaruque

**Fig. 11b** Distribuicao de populacao humana localizacão dos acampamentos de pesca, centro administrativo, complexo turistico de Magaruque.

**Fig. 11b** Distribution of human population, locality of fishing camps, administrative centre, tourist complex on Magaruque.

P Centro Administrativo da ilha
Islands administrative centre

C Posto de Saude
Clinic

E Escola
School

S Loja
Shop

O Complexos Hoteleiros
Hotel complex

Herdada de Crocodilos
Crocodile farm

Pista de aterragem
Landing strip

Dunas arenosas
Sand dunes

Pântanos
Wetlands

100 66 Distribuição de rebanhos de Cabritos e Ovelhas
Distribution of goat and sheep

19 Distribuição de bovinos
Distribution of cattle

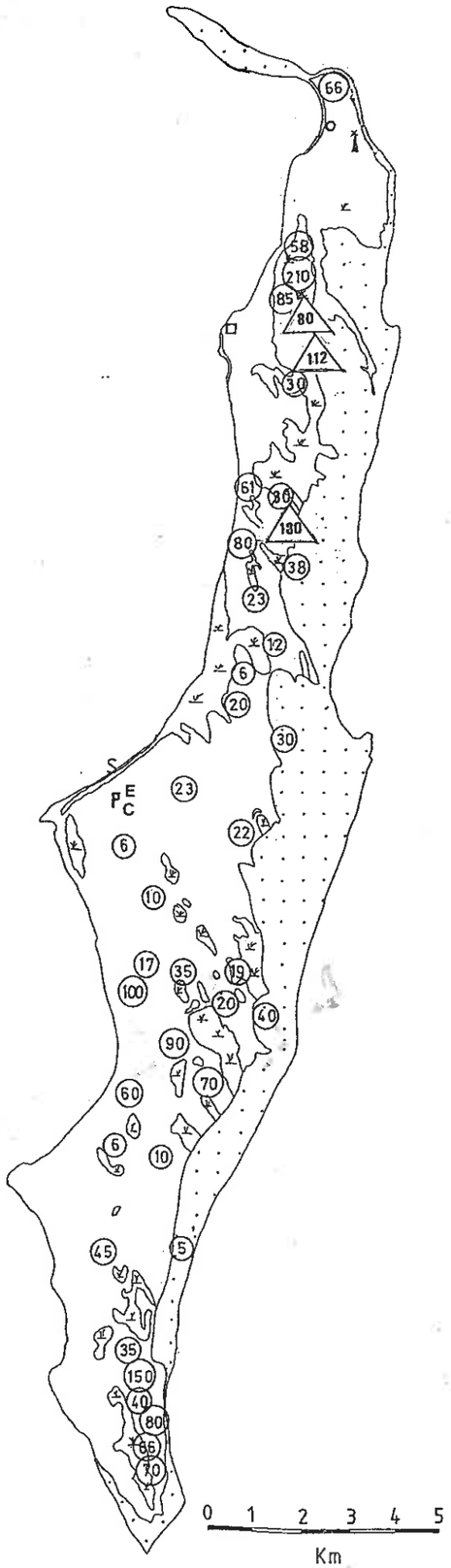



**Fig. 12.** Distribuição de gado domestico de Bazaruto.

**Fig. 12.** Distribution of domestic livestock on Bazaruto.

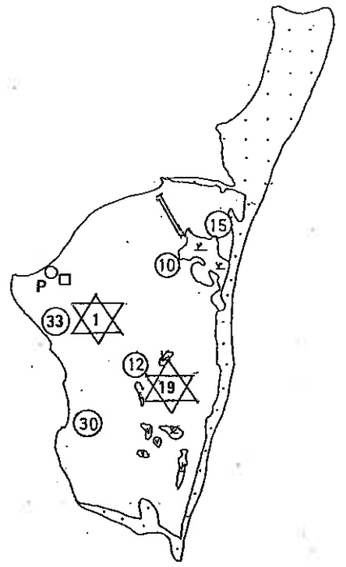



**Fig. 12.** Distribuição de gado domestico de Benguéra.

**Fig. 12.** Distribution of domestic livestock on Benguérua.


**Fig. 12.** Distribuição de gado domestico de Magaruque.

**Fig. 12.** Distribution of domestic livestock on Magaruque.

The projected population growth of the goat and sheep populations on Bazaruto and the increase in combined Animal Units (AU) is shown in **Table 5**. (1 animal unit = 1 domestic beast weighing 455 kg.)

| | TOTAL GOATS | TOTAL SHEEP | TOTAL AU |
|---|---|---|---|
| 1990 | 1 768 | 372 | 267 |
| 1991 | 2 298 | 446 | 343 |
| 1992 | 2 987 | 535 | 440 |
| 1993 | 3 884 | 642 | 565 |
| 1994 | 5 051 | 771 | 727 |
| 1995 | 6 567 | 925 | 936 |
| 1996 | 8 537 | 1 110 | 1 205 |
| 1997 | 11 098 | 1 332 | 1 553 |
| 1998 | 14 427 | 1 599 | 2 003 |
| 1999 | 18 755 | 1 919 | 2 584 |
| 2000 | 24 381 | 2 303 | 3 335 |

Table 5: Projected growth of goat and sheep populations on Bazaruto and the increase in combined Animal Units (AU).

The projected population growth of the goat and cattle populations on Benguérua Island and the increase in combined Animal Units (AU) is shown in **Table 6.**

| | TOTAL GOATS | TOTAL CATTLE | TOTAL AU |
|---|---|---|---|
| 1990 | 67 | 20 | 28 |
| 1991 | 87 | 26 | 37 |
| 1992 | 113 | 34 | 48 |
| 1993 | 147 | 44 | 62 |
| 1994 | 191 | 55 | 79 |
| 1995 | 248 | 67 | 98 |
| 1996 | 323 | 90 | 130 |
| 1997 | 420 | 120 | 172 |
| 1998 | 546 | 160 | 228 |
| 1999 | 710 | 210 | 298 |
| 2000 | 923 | 280 | 395 |

Table 6: Projected growth of goat and cattle populations on Benguérua Island and the increase in combined Animal Units (AU).

**Carrying capacity:**
It is considered that the carrying capacity of Bazaruto should not exceed 400 AU (based upon experience in similar acid grassland habitat) and that of Benguérua 80 AU. These may be considered low, but it must be realized that there will be a tendency for animals to concentrate on the low-lying areas where soil moisture is greatest, and on to the burnt patches where new growth has flushed.

On the basis of 8 sheep or goats being equivalent to 1 AU, reference to **Tables 5 and 6** will show that with the current rates of increase the livestock will have exceeded the carrying capacity of the vegetation of Bazaruto by 1992 and on Benguérua by 1995. Once this has occurred, excessive damage to the environment can be expected, and the primary objective will have been defeated.

**Competition with wildlife:**
Both goats and sheep compete directly in their food requirements with wild ungulates. The competition is greatest with small browsers, and with selective grazers and small mixed feeders (antelope which both graze and browse). The goat and sheep populations are already competing with, and therefore limiting the red duiker, suni and bushbuck populations. Left unchecked, they will continue to do so and will also jeopardize the successful re-introduction of species such as common reedbuck and oribi.

If the goat and sheep populations are maintained at the levels they are likely to have attained in 1991, it will be possible only to stock and carry an equivalent of 57 AU of wild ungulates on Bazaruto. If the wildlife is to be allowed to increase beyond an equivalent of 57 AU, then there will have to be a compensatory reduction in domestic livestock. This reduction could continue until wildlife has completely replaced the domestic livestock or until the latter have been reduced to levels which still allow the primary objectives to be achieved. It is considered that this level is one which must be reached by consensus, continuous monitoring and adaptive management.

### 3.1.2.2 Cultivation (Figure 13)

Cultivation is for subsistence in order to supplement a largely fish diet. The islands' soil is comprised of silica sand, which with the irregular precipitation on the islands is not suitable for agriculture.

Areas of natural bush are slashed and burned in order to accumulate ash as a fertilizer. New areas require the same treatment each year. These denuded areas become vulnerable to wind erosion. The principal crops on the sand areas are cassava, millet, beans, melons and indigenous herbs such as kakana. Maize cultivation is sometimes attempted but invariably fails.

Raised gardens in the wetlands are used mainly to cultivate sweet potato. Rare swamp forest patches are destroyed through this slash and burn method of agriculture. Only three viable patches of swamp forest remain in the Archipelago (**Figures 4-5**).

The majority of agriculturalists on Bazaruto and Benguérua come from the mainland. Some of these people have been displaced by the war on the mainland, while others are attracted to work opportunities offered by the various enterprises on these islands.

P Centro Administrativo da ilha
Islands administrative centre

C Posto de Saude
Clinic

E Escola
School

S Loja
Shop

O Complexos Hoteleiros
Hotel complex

□ Herdada de Crocodilos
Crocodile farm

Pista de aterragem
Landing strip

Dunas arenosas
Sand dunes

Pântanos
Wetlands

Zonas de agricultura de subsistência
Areas under shifting cultivation

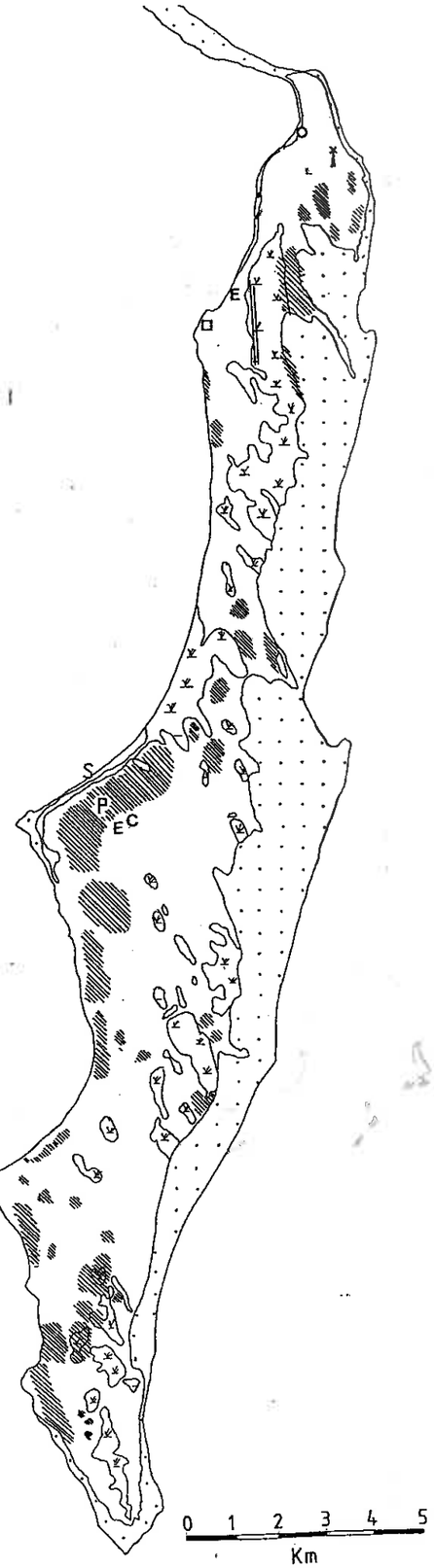



**Fig. 13.** Areas de agricultura de subsistência em Bazaruto.

**Fig. 13.** Areas under shifting cultivation on Bazaruto.

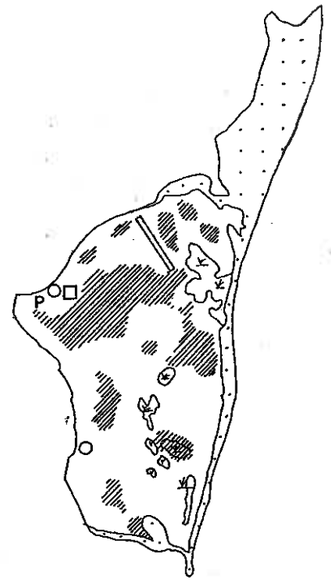



**Fig. 13.** Areas de agricultura de subsistência em Benguéra.

**Fig. 13.** Areas under shifting cultivation on Benguéra.

**Fig. 13.** Areas de agricultura de subsistência em Magaruque.

**Fig. 13.** Areas under shifting cultivation on Magaruque.