**Management Plan of**

**Dongzhaigang National Nature Reserve, Hainan, China**

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**Wetlands International-China Program**

**Hainan Provincial Forestry Bureau**

**Hainan Dongzhaigang National Nature Reserve**

**Supported through the**

**Small Grants Fund of the Ramsar Convention Bureau**

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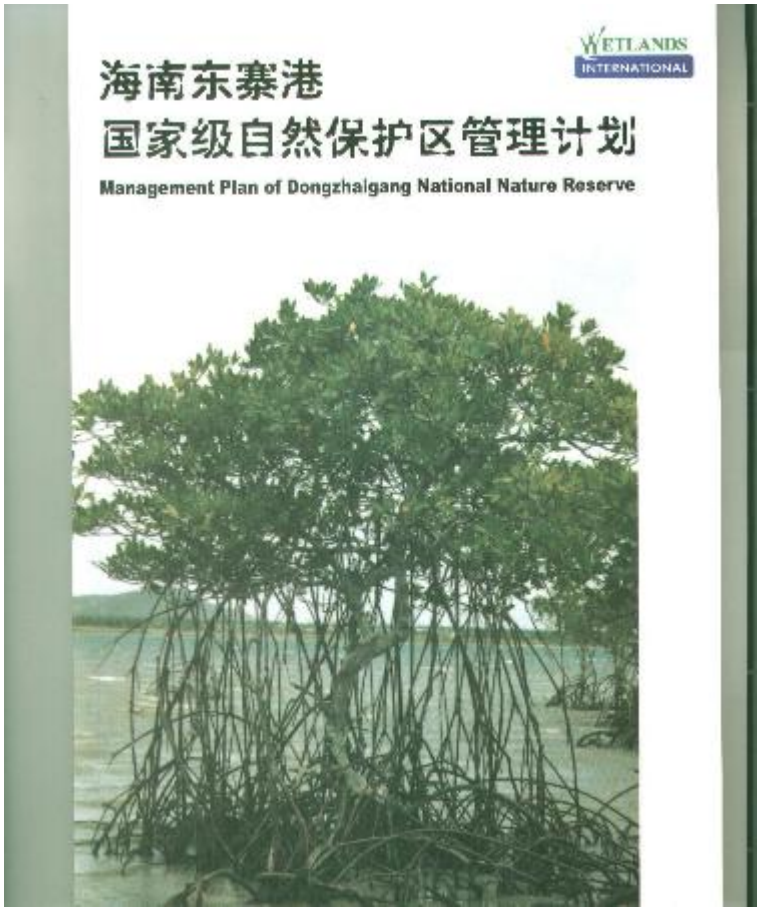


**Contents**

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**Preface**

Mangroves are a unique woody plant community of inter-tidal coasts in the tropical and sub-tropical zones. Due to their unique physiology and ecology, mangroves provide optimal breeding areas for many kinds of fish and shrimps, as well as feeding habitats for resident and migrant water birds. Furthermore, mangroves protect fresh water resources against salt water intrusion, they protect the land from eroding waves and winds and stabilize the coastal land. The mangroves can be considered as a natural barrier protecting the lives and property of coastal communities from the frequent typhoons occurring in southern China.

General speaking, mangroves are distributed in the tropical and sub-tropical zones between the Tropic of Cancer and the Tropic of Capricorn with the Malaysian and Indonesian region supporting the most diverse mangrove communities in the world. Mangroves also naturally occur in China where they reach almost their northern-most limits in the southern provinces of Hainan, Guangxi, Guangdong, Fujian and Taiwan. Dongzhaigang in north-east Hainan province is one of China's main concentrations of mangroves with a wide variety of naturally occurring and introduced species in relatively well preserved forests. The mangroves at Dongzhaigang are therefore of high value in terms of conservation, research and tourism.

In order to protect the mangrove resources of Dongzhaigang, the People’s Government officially established Dongzhaigang Nature Reserve on January 3rd 1980. Dongzhaigang Nature Reserve was the first mangrove nature reserve in China and has since been promoted to a national level (National Nature Reserve status) by State Council in July 1986. China ratified the Convention on Wetlands of International Importance (The Ramsar Convention) in 1992 and recognizing the international importance of the mangrove and inter-tidal ecosystem at Dongzhaigang National Nature Reserve nominated the area as one of its first six Ramsar sites. Since its establishment nearly 20 years ago the Dongzhaigang National Nature Reserve has undertaken a lot of management and research work in the fields of water bird protection and mangrove ecosystem management. The area has therefore played an important role in fulfilling China's obligations to conserve and manage its wetlands under the Ramsar Convention.

With the aim to enhance the protection and management of mangrove resources at Dongzhaigang, the experts of Wetlands International in collaboration with counterparts from the Hainan Forestry Bureau conducted a field visit to Dongzhaigang National Nature Reserve in 1997. As a result of this visit, a project proposal entitled "Preparation of a Management Plan for Dongzhaigang National Nature Reserve, Hainan Province" was formulated and submitted to the State Forestry Administration, SFA (formerly the Ministry of Forestry, MOF). SFA submitted this proposal to the Small Grants Fund of the Ramsar Bureau and was approved by the Standing Committee of Ramsar Convention in late 1997. Following mangrove management workshops and field visits during 1998 and 1999, the following management plan has been developed.

The Management Plan of Dongzhaigang National Nature Reserve, Hainan is based on the management planning guidelines developed by the Ramsar Bureau and consists of four basic components:-

a) Baseline data and an outline of the present situation within the reserve;
b) Conservation assessment and prioritization of current resources leading to a long-term development objective and immediate management objectives;
c) Management scenarios and action plan for implementation;
d) Financial support and planning.

The Management Plan of Dongzhaigang National Nature Reserve, Hainan will provide the Hainan Forestry Bureau and other stakeholders with working guidelines for day-to-day management of the Reserve. It will also provide management and development direction for the longer term. It is not only hoped that the Management Plan will play an active role in development of the reserve but that it will stimulate international organizations such as Wetlands International and the Ramsar Bureau to facilitate further financial and technical assistance to the reserve for implementing the Plan.

Lastly we would like to acknowledge the significant assistance of Mr. Song Chaoshu, Mr. Lin Peng and Mr. Zheng Dezhang during the preparation of the Management Plan.

**Chen Kelin** (Chief Editor)

Director of Wetlands International-China Programme

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## Executive Summary

**Purpose of the Management Plan**

The Management Plan provides both guidelines for management of the reserve and a blue print for directing management, sustainable use and development of resources within the reserve. The main objectives of the Management Plan are to:-

- Establish clear targets for management and the operational measures necessary to achieve those targets;

- Provide a guide for protection and research in the fields of management and conservation of coastal wetlands/mangroves to ensure that the Reserve is managed effectively and sustainably on a scientific basis;

- Promote participation of communities in conservation and wise use of wetlands resources in and around the Reserve;

- Strengthen the capacity of managerial staff of the Reserve in terms of organization, management and decision making;

- Create the necessary awareness amongst Government decision-makers and donor groups (both domestic and international) to understand the values of Dongzhaigang National Nature Reserve and to facilitate necessary funding to realize the objectives of the Reserve.

The overall objective of the Management Plan is to conserve wetland ecosystems and their biodiversity within the National Nature Reserve. This will be achieved through innovative scientific approaches to mangrove and protected area management, integrated development planning, staff capacity development, information exchange and local participation in management of the protected area. The emphasis of the Plan is targeted on increased development of human skills and resources, improvement of field protection, strengthening the management and monitoring systems.

**Scope of the Management Plan**

The Management Plan describes in detail the boundaries, area, organizational structure, management, research, monitoring, natural resources and socio-economic situation of the Dongzhaigang National Nature Reserve and provides an analysis of the resources and needs. It also clearly specifies the overall and immediate objectives of management within the Reserve and based on the overall objective and the threats /constraints faced by the reserve, management measures

have been identified. A five year action plan (2000-2004) based on necessary management measures and priorities is presented.

**Overall Objective of Dongzhaigang National Nature Reserve**

The overall objective of Dongzhaigang National Nature Reserve is the long-term conservation and sustainable management of mangrove and inter-tidal ecosystems and resources.

**Main Threats and Constraints Faced by the Reserve**

The main threats and constraints faced by the reserve are:

Human resource/socio-economic factors:

- Insufficient staffing and financial resources;
- Inefficient protection system;
- Poor working and living conditions within the Nature Reserve discourage staff to live in the reserve long term;
- Lack of interpretation and communication facilities;

Protected area management capacity:

- Daily intrusions into all zones of the protected area by surrounding communities and inhabitants for fishing and oyster collection resulting in high levels of disturbances to ecosystems and biodiversity (especially water birds);
- Lack of an enforced buffer zone leading to direct encroachment into the protected area and destruction of mangroves and other resources for aquaculture pond construction;
- Lack of involvement by local communities and other stakeholders into the management of the protected area due to low levels of awareness on the mangrove values of maintaining the reserve and its resources;
- Gaps and irregularities in existing data of resources for the Reserve;

- Insufficient funds for building infrastructure, undertaking research, creating tourist facilities and conducting public education.

**Baseline Description**

The Dongzhaigang National Nature Reserve is located in the north-east sector of Hainan island. The Reserve comprises largely of an estuary with inter-tidal sand- and mudflats and a fringing mangrove forest zone. The focus of Reserve management to date has been on the conservation and regeneration of mangrove, with some research focussed on migratory and wintering bird populations using the inter-tidal sand- and mudflats.

26 "true" mangrove species and 40 "mangrove associate" and "Semi-mangrove" species, accounting for 90% of the total number of the mangrove species recorded in China have been found within the Reserve. Of the 81 species of migratory water bird specified under the China-Australia Migratory Bird Agreement (CAMBA) 35 species have been recorded within the Reserve. In addition, 75 species of migratory bird specified under the China-Japan Migratory Bird Agreement (CJMBA) have been recorded. Dongzhaigang National Nature Reserve is therefore one of the most important stop-over sites for migrating water birds and a key link in the conservation of migratory birds of different biological zones.

The Management Plan of the Dongzhaigang National Nature Reserve identifies five short term operational objectives for management and establishes 15 management targets within these objectives. To meet these targets a total of 30 management activities are identified:

**Operational Objective 1: To maintain and enhance mangrove ecosystems and natural resources**

**Management Target 1.1: To strengthen protection for the mangrove ecosystem:**

Activity 1: Identifying and demarcating functional zones of the Nature Reserve and identifying main functions of each zone

Activity 2: Demarcating the reserve’s boundary and setting up stakes and information signs

Activity 3: Strengthening organization and capacity of management staff

Activity 4: Strengthening Reserve infrastructure

Activity 5: Reinforcement of Reserve management regulations

Activity 6: Establishment of Joint Leading Group to oversee Reserve management

**Management Target 1.2: To restore mangrove forest in appropriate areas:**

Activity 7: Restoration of mangrove ecosystem

**Management Target 1.3: To expand area of mangroves through planting:**

Activity 8: Increase area of rare mangrove species

**Management Target 1.4: To increase economic benefits within the reserve:**

Activity 9: Development of sustainable ecotourism based on mangrove forest resource

Activity 10: Promotion of community development in and around protected area

**Management Target 1.5: To strengthen research on mangrove ecosystems:**

Activity 11: Undertake applied and targeted research on mangrove ecosystems to benefit Reserve management

**Operational Objective 2: To maintain and enhance conservation of biodiversity and important species**

**Management Target 2.1: To conserve and increase rare or endangered species populations:**

Activity 12: Strengthening protection of rare bird species

Activity 13: Increased protection of rare and endangered mangrove species

Activity 14: Protection of endangered mammals

**Management Target 2.2: To survey and monitor natural resources:**

Activity 15: Baseline survey of resources in the reserve

Activity 16: Establishment of an ecological monitoring programme

Activity 17: Developing a Dongzhaigang Biodiversity Database

**Management Target 2.3: To ensure wise use of biological resources in the Reserve:**

Activity 18: Wise use of marine and inter-tidal resources

Activity 19: Development of medicinal plant resources

**Management Target 2.4: To strengthen applied research into endangered species:**

Activity 20: Develop and implement an applied research programme for endangered species conservation

**Operational Objective 3: To promote awareness building and public education**

**Management Target 3.1: To raise public awareness on the values of mangrove and biodiversity:**

Activity 21: Increase public education and outreach to local communities

Activity 22: Increase environmental education to local schools and children

**Management Target 3.2: To promote environmental awareness through mangrove-based ecotourism:**

Activity 23: Promotion of awareness through ecotourism

**Management Target 3.3: To strengthen management capacity of Reserve staff:**

Activity 24: Strengthening of staff training

**Operational Objective 4: To maintain and enhance protection and wise use of the mudflat resources**

Activity 25: Scientific planning and management of inter-tidal mudflat resources

**Operational Objective 5: To maintain water resources and control pollutants**

Activity 26: Controlling point-source of land based pollutants in the Reserve catchment

Activity 27: Controlling potential polluting impacts of tourism

Activity 28: Controlling oil pollution caused by boats

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## Chapter 1 General Information

### 1.1 Biogeographical Province of Dongzhaigang Nature Reserve

The Dongzhaigang National Nature Reserve is located in Dongzhaigang Bay bordering the administrative regions of Qiongshan City and Wenchang City, in north eastern Hainan Province. The area trans-bounds the tropical and sub-tropical zones of southern China and has a correspondingly diverse transitional fauna and flora with the southern sub-tropical species dominant. The transitional climatic and hydrological conditions, specific topographic features (estuarine ecosystems) and its rich biodiversity ensure its global significance as a wetland of international importance. Its relatively large area of mangrove forest and wide inter-tidal sand- and mudflats provide migratory water birds and fish with rich feeding grounds and breeding habitats.

### 1.2 Climatic and Geographic Conditions

#### 1.2.1 Climate

The Dongzhaigang National Nature Reserve has a tropical monsoon marine climate with an average annual rainfall of 1676.4 mm and a mean annual temperature of 23.3-23.8$^{o}$C. The mean temperature in July is 28.4$^{o}$C and in January 17.1$^{o}$C. The rainy season starts in early May and ends in late October. The region is usually affected by typhoons during the summer months.

#### 1.2.2 Hydrology

Four rivers enter into the Dongzhaigang Bay, these are Yanzhou River, Sanjiang River, Yanfeng River and Xi River, with a total water discharge of 700 million cubic meters. During the rainy season, the four rivers carry large amount of silts which are largely deposited within the bay to create the extensive inter-tidal mudflats. It is the mudflats that provide a suitable environment for mangrove growth in this area.

The seawater temperature is high due to the low latitude and warm winter currents that affect the area. Within the Dongzhaigang estuary, the annual mean temperature of the sea water is 25.4 $^{o}$C, while the highest mean water temperature from the May to July is 31.5 $^{o}$C and the lowest in January is 17.7 $^{o}$C.

Salinity within the estuary ranges from 9.31‰ to 34.4‰ in different parts of the estuary and at different states of the tide. The salinities in the dry season are higher than those in the rainy season. Mangroves are known to tolerate a wide range of water salinities and can grow in coastal areas and along rivers with salinities between 2.17-34.5‰.

The Dongzhaigang Estuary has irregular semi-diurnal tides with an average high tide elevation of 2.09 meters and low tide elevation of 1.19 meters. The maximum tidal range is 1.8 meters while the average tidal range is 0.89 meters.

### 1.2.3 Geology

The bed rock of the Dongzhaigang Estuary has formed over a long geological period and is therefore quite rigid. The estuary has a dense network of tidal canals and a deep soil layer.

### 1.2.4 Topography

The Dongzhaigang Estuary has an irregular rectangle shape with a south-north orientation. It is the largest bay in Hainan Province with a total area of nearly 100 square kilometers. The estuary is thought to have formed due to subsidence of the coastal zone in northeast Hainan during the Qiongzhou Earthquake of 1605. The estuary forms a nearly closed lagoon having only two narrow channels connected it to the South China Sea in the north. Beigang Island, situated at the mouth between the two channels, is large enough to block the effects of strong storms from the South China Sea. The eastern side of the estuary consists of an alluvial plain and the western side is bordered by low hills.

### 1.2.5 Soils

The base rocks in this area are mainly basalt and olive basalt and these are the origin of overlying soils. Typical acid red soils have been developed under the sub-tropical and tropical climate. The soil layer is generally between 1 and 1.5 meter thick and the acidity is pH 5-6.The soils under the mangroves are mainly saline marsh soils.

## 1.3 Biological resources

### 1.3.1 Flora

The major vegetation community in this area is mangrove and its associated salt-tolerant species termed mangrove associates. Historically Dongzhaigang Estuary was more forested than it is today, in the early 1950s 3,414 ha of mangrove forest was recorded, this was reduced to 1,773 ha by the

1960s and 1970s due to intensive agricultural reclamation and mangrove forestry operations. Through annual replanting programmes and the cessation of logging operations the area of mangrove forest today stands at 2,006 ha.

Dongzhaigang mangrove forest has 26 "true" mangrove species belonging to 12 families, and 40 semi-mangrove and mangrove-associated species belonging to 22 families. The rarer species include *Nipa fruticans, Lumnitzera littorea, Sonneratia hainanensis, S. ovata, S. paracaseolaris, Xylocarpus granatum, Rhizophora apiculata* and *Acrostichum speciosum*, of which *S. hainanensis* is believed to be an endemic species restricted to Hainan Island. In addition, *N. fruticans, L. littorea, S. hainanensis, S. paracaseolaris* and*X. granatum* have been listed in the China Plant Red Book (For a comprehensive plant list refer to Appendix 2).

The major mangrove communities are outlined below:

(1) *Bruquiera gymnorrhiza* community

It appears dark green with a regular crown canopy. The trees are 4-8 meter tall with a diameter at breast height (dbh) of 8-15cm. Mainly distributed in the upper reaches of Sanjiangxi and lower reaches of Yanfengdonghe.

(2) *Bruquiera sexangula* community

It appears emerald green with a regular crown canopy. The trees are 8-15 meter tall with a dbh of 20-32cm. Mainly distributed in front of Yanfenghe Harbor Village, Longwei Village and Qukouyunlu Village.

(3) *Ceriops tagal* community

It appears yellow green with a lot of branches. Forms almost a pure single-species forest. The trees are 1-3 meter tall with base diameters of 8-15cm. Large areas of this community are situated to the south of the core area at Tashi and at the river mouth of Yanfengdonghe.

(4) *Avicennia marina* community

The community appears silver-grey green with trees of between 2-4 meter tall. The base diameter is 10-15cm. *A. marina* is the main pioneer species found predominantly along the accreting front edge of the mangrove and beside tidal channels. It is a highly adaptable species and the crown can be partly or totally submerged during high tides.

(5) *Kandelia candel* community

*K. candel* is a pioneer species which grows along the front edge of the forest in the accretion zone. The community appears yellow green and the trees are 3-4 meter tall with a dbh of 5-10 cm.

(6) *Rhizophora stylosa* community

*R. stylosa* is a pioneer species and usually grows along the accreting front edge of the mangroves at the interface with the mudflats. The community appears dark green forming a dense and regular forest. The trees are 2-5 meter tall. It is distributed in the mudflats from the core area Tashi to Dalin.

(7) *Nipa fruticans* community

It normally grows in the high tidal zones near the mainland. This community is easily identified as it consists of dwarf green palm forest. The palms are 3-4 meter high. It is naturally distributed in the experimental zone near Lonshuyuan Village and Shangyuan Village.

(8) *Acrostichum aureum* community

*A. aureum* is a fern that normally grows in the drier landward margins of the mangrove forest. The community appears brown green and is 0.4-1 meter high. It is found at Hegang, Sanjianghe and in the upper reaches of Yanfengdonghe.

(9) *Aegiceras corniculatum* community

*A. corniculatum* is another pioneer mangrove species. It sprouts easily and usually grows along the banks of the estuary and on the seaward edge of the mangrove forest, especially in previously cleared mangrove areas. The community appears yellow-green. The shrubs are around 1 meter tall with a regular crown and usually grow in dense clusters.

(10) *Lumnitzera racemos*a community

This grows only in areas reached by the spring tides. The community appears pale green and the plants are 1-3 meter high with a base diameter of 5-12 centimeters.

(11) *Rhizophora stylosa+Ceriops tagal* community

This community grows in the mid- to high tidal mudflat. *R. stylosa* trees are 1.5-3 meter tall with *C. tagal* forming dense stands of 1-2.5 meter tall.

(12) *Ceriops tagal+Aegiceras corniculatum* community

This community is restricted to the solid sand clay areas and appears yellow green. The average height of the plants is 1 meter. *C. tagal* grows densely with a lot of seedlings whilst*A. corniculatum* is relatively dispersed. This community is distributed in Shatushi and Gongxi.

(13) *Sonneratia caseolaris+Kandelia candel* community

*S. caseolaris* has been planted at Dongzhaigang in the low tidal flat areas. After three years the trees are 8-10 meter high with a dbh of 8-20cm. It has dense breathing roots enabling the seeds of *K. candel* to establish naturally.

The mangrove-associated communities include:

(1) *Pandanus tectorius* community

This distinctive palm-like plant grows in relatively high areas reached only by the Spring tides. The plants are 3-6 meter high with a dbh of 10-15 cm.

(2) *Pogamia pinnata* community

*P. pinnata* forms a deciduous broadleaf forest and grows along the inside edge of the mangrove forest neighboring the mainland. The trees are 2-6 meter high with a base diameter of 10-25 cm.

**1.3.2 Fauna**

(1) Mammals (for a provisional list of mammals refer to appendix 7)

8 species of mammal have been recorded. Of these, the common otter *Lutra lutra hainana*is listed as a Grade 2 Nationally Protected Animal in China.

(2) Birds (for a complete list of birds refer to appendix 3)

A total of 159 bird species have been recorded at Dongzhaigang National Nature Reserve. These include the following Grade 2 Nationally Protected Animals for China, Chinese egret*Egretta eulophotes*, black-faced spoonbill *Platalea minor*, spoonbill *Platalea leucorodia*, Saunders' gull *Larus saundersi* and little bitten *Ixobrychus minutus*. It is possible that the white-eared night heron *Gorsachius magnificus* might occur.

Of the 227 species listed in the China-Japan Migratory Bird Agreement (CJMBA), Dongzhaigang supports 75 species and of the 81 species in the China-Australia Migratory Bird Agreement (CAMBA), 35 species have been found in the Reserve. Many of these are wintering water birds which form large concentrations in Dongzhaigang Bay, especially around Wugoukou in the core area and Zhamen mudflats in the experimental zone.

(3) Amphibians and Reptiles (for a provisional list of amphibians and reptiles refer to appendix 8)

The major amphibians are frogs and major reptiles are snakes.

(4) Insects (for a provisional list of insects refer to appendix 6)

27 species of butterflies belonging to 6 families have been recorded throughout the Reserve.

(5) Fish (for a provisional list of fish refer to appendix 4)

A total of 57 fish species have been recorded in the Reserve. Most of these are estuarine species and some are of high economic value.

(6) Benthic invertebrates (for a provisional list of fish refer to appendix 5)

Dongzhaigang is rich in benthic invertebrates, with different species adapted to life in the inter-tidal sand- and mudflats, within the mangroves themselves and even in the freshwater influences parts of the estuary. Many benthos species have high economic value and fishing pressure for these species is intensively high throughout the Reserve. A total of 92 benthic invertebrates have been recorded at the Reserve.

**1.4 Conservation status**

**1.4.1 Geographic location**

Dongzhaigang National Nature Reserve is situated in the northeastern part of Hainan Province, at coordinates of 110° 32¢ -110° 37¢ E and 19° 51¢ -20° 01¢ N. The estuary is adjacent to Luodou State Farm of Wenchang Municipality, Sanjiang State Farm of Qiongshan, Sanjiang Town, Yanfeng Town and Yanhai Town. The coastline of the reserve extends for 84 km and the estuary has a total area of 5,400 ha.

The areas surrounding Dongzhaigang National Nature Reserve are mostly farmlands, salt pans, aquaculture ponds and forestry plantations. Dongzhaigang National Nature Reserve has good

transportation infrastructure and communication facilities. The location of the reserve administration office is only 30 km from the provincial capital city of Haikou and 10 km from the Haikou Meilan International Airport currently under construction.

### 1.4.2 Land tenure

Official documents show that the Dongzhaigang Nature Reserve has a total area of 3337.6 ha under the administration of the Qiongshan County Government. The Reserve land is state owned and as such the Reserve administration (Hainan Forestry Bureau) has clear land tenure and rights to manage and utilize the land.

### 1.4.3 Land use status

Land use within the reserve area is very intensive. In most parts of the protected area the inter-tidal sand- and mudflats are intensively used by local communities for the collection of shellfish, fish and other marine and estuary resources. In many places the communities have demarcated large areas for oyster production (using wooden stakes driven into the sediment as settling substrates for the oyster spat) and these areas have clear community or family "ownership" or rights that exclude others. In other parts of the estuary, permanent fishing traps and nets are intensively laid out. Throughout areas which are not fished in this way or used for oyster culture, large numbers of local people gather on the falling tides to exploit the sand- and mudflats as they emerge above the receding waters.

Exploitation of the mangroves trees themselves (i.e., wood cutting, fodder gathering) is strictly forbidden and is largely adhered to by the local communities. There is very little illegal cutting or gathering.

The mangrove channels are however fished and crabs and some shellfish widely collected throughout the mangrove forest.

In peripheral areas there has been historical encroachment into mangrove areas to create salt pans (many of which have been recently converted to fish and shrimp ponds). Small-scale encroachment may still occur in some areas around the estuary.

### 1.4.4 Conservation management

Mangrove conservation throughout the area was significantly enhanced when the Dongzhaigang Nature Reserve was established in 1980. In subsequent years (1980, 1983, 1984 and 1996) the Qiongshan County Government issued notices underlining the need for conservation and sound

management within the Dongzhaigang National Nature Reserve. This was followed by the enactment of the "Hainan Mangrove Conservation Regulation, 1998" by the Provincial People's Council in September 1998. With subsequent support from government agencies of different levels, the Dongzhaigang National Nature Reserve conducted the following activities:-

a) The municipal government established a Joint Conservation and Management Committee including representatives from relevant towns and villages to enhance the management of nature reserve.

b) Two management stations-Sanjiang and Tashi, were established with full time wardens.

c) A police station were established to investigate and deal with illegal activities.

d) Permanent display boards have been erected to raise local public awareness.

**1.5 Institutional framework**

a) Jurisdiction and funding sources

The Dongzhaigang National Nature Reserve is under the direct jurisdiction of Hainan Provincial Forestry Bureau. The Hainan Wildlife Conservation Station provides technical supervision to the reserve. The former Ministry of Forestry provided a lump-sum fund of RMB 750,000 at the beginning of the establishment of the nature reserve. The running costs and other investments are provided by Hainan Provincial Forestry Bureau and the Financial Bureau of Qiongshan City. A total of RMB 4.25 million has been invested to the reserve since its establishment.

b) Institutional structure

Several divisions have been set up within the Dongzhaigang Nature Reserve Administration, including a general office, scientific research group, tourism service, resource protection group, Tashi management station, Sanjiang management station and a police station. The reserve has a total of 32 staff.

c) Infrastructure

The reserve administration has one research and office building with a total area of 464 m2, one dining-room of 353 m2 and staff living apartments of 2010 m2. The reserve also own one tourism jetty, one patrol boat, one car and three motorcycles.

**1.6 Scientific research**

Under the previously formulated management guidelines of "Conservation, restoration and development", a number of scientific research projects have been implemented in Dongzhaigang National Nature Reserve. These include baseline biodiversity and resource surveys, determination of benthic biomass and inter-tidal productivity, mangrove fruiting and flowering phenology, mangrove afforestation trials, calculation of energy flows and pathways within mangrove ecosystems. The results of these studies have been published in several journals and internal documents. A summary outline of scientific research is given below:-

a) mangrove resources survey

Wide-scale surveys on mangrove resources at Dongzhaigang have been conducted on two occasions, in July-August 1980 and from July 1982 to June 1983. These surveys showed that the Reserve supported a total of 18 natural mangrove species belonging to 12 families and covered an area of 1773 ha. An island-wide mangrove survey for the whole of Hainan from July 1982 to June 1983 showed that Hainan supports a total of 27 mangrove species belonging to 16 families with a total area of 4836 ha. At that time the Dongzhaigang estuary supported nearly 40% of the mangroves in Hainan.

b) Introduction of exotic species: *Sonneratia caseolaris*

A four year research project entitled "The maintenance, reproduction and classification of*Sonneratia caseolaris* trees in China" was implemented in 1986 in cooperation with the South China Institute of Botany. As a part of this research, two recently described*Sonneratia* species from southern Hainan, *S. hainanensis* and *S. paracaseolaris* were also planted and bred at Dongzhaigang.

c) Biomass and productivity of *Bruquiera gymnorrhiza* forest

This project was carried out from January 1985 to 1990 in cooperation with the Department of Biology, Xiamen University.

d) Afforestation trials for important mangrove species

As part of the Eighth Five Year Plan a major research initiative entitled "Afforestation trials for important mangrove species" was conducted in cooperation with South China Institute of Botany between 1990-1995. A follow-up project entitled "Comparative trials of mangrove seed germination" was included in the Ninth Five Year Plan and was initiated in 1996.

e) mangrove afforestation trials in different inter-tidal zones

Afforestation trials have been carried out each year since 1981. During these trials a total of 285 ha of naturally-occurring mangrove species have been planted and 251 ha of them have been preserved. Appropriate techniques for mangrove afforestation have been developed and the most appropriate species for artificial plantation have been identified.

f) Establishment of a mangrove tree arboretum

A mangrove tree arboretum has been established within the Reserve. The arboretum contains mangrove species found locally, species that have been introduced from other parts of Hainan (from Wenchang, Lingshui and Sanya) and exotic species introduced from Bangladesh.

**1.7 Economic status of local communities**

The Nature Reserve is adjacent to 12 villages belonging to Yanfeng Township, Yanhai Township, Sanjiang Township and the Sanjiang State Farm. The total population size of these municipalities is 21,774 from 4,122 households. Local communities are supported both through agricultural and fisheries activities and the average annual income is about RMB 2,240 per capita. Each village has good transportation and electrical power supply.

**1.8 Public education and tourism**

Public education activities have focused on improving local awareness of conservation issues with a particular emphasis on mangroves and water bird conservation. In addition, limited activities to increase public awareness amongst tourists and local students have been undertaken.

The mangroves at Dongzhaigang have become a popular tourist spot and the Reserve management authority and local entrepreneurs have established tourism facilities to cater for their needs. A small area of 136 ha near Changning Village was set aside for promotion of ecotourism as part of the Reserve management. Other facilities include a number of hotels and seafood restaurants, a boat tour service and a short mangrove trail with look out posts and picnic areas. As a result tourist numbers have increased dramatically and in 1997 there were 60,000 registered visitors.

**1.9 International cooperation and exchange**

The Dongzhaigang National Nature Reserve has drawn national and international attention since its establishment. Over 300 specialists and experts from Australia, Finland, Hong Kong, Japan, Malaysia, Thailand, The Netherlands, UK and USA, and have visited the Reserve since 1980.

## Chapter 2 Evaluation and Goals

### 2.1 Evaluation indicators

#### 2.1.1 Size and position in the ecological unit.

The Dongzhaigang Estuary has a total area of 5,400 ha. The land area of the Dongzhaigang National Nature Reserve covers approximately 3,337.6 hectares, and at low water, the open water area is 2,062.4 hectares. The Reserve consists principally of one ecological unit - tropical, inter-tidal mangrove forest with associated mud- and sand-flats and shallow water sub-zones. Of these sub-zones, 2,006 hectares are forested with mangrove and 1,331.6 hectares are inter-tidal mud- and sand-flats. The surrounding water catchment area is largely outside the protected area.

#### 2.1.2 Biological diversity

Dongzhaigang National Nature Reserve is one of the highest biodiversity mangrove wetlands in China. This is largely due to its climatic characteristics (tropical and sub-tropical) and the southern extremity of Hainan Island. This richness is also somewhat artificial as species occurring in other parts of Hainan and from overseas have been planted and are growing successfully. 17 species of true mangroves (trees and shrubs) grow naturally within the Reserve. An additional eight species have been introduced from Qinglan Gang further to the south and one from Bangladesh (see Annex I: flora). In addition, 40 species of semi-mangroves and mangrove-associated plants have also been recorded.

The most important biodiversity features of Dongzhaigang are the numbers of threatened birds species it supports, particularly during the non-breeding, wintering and passage migration periods. A total of 159 species of bird have been recorded, including three species classified by Collar, *et. al*., (1994) as "globally threatened" - Saunders' gull, *Larus saundersi*, black-faced spoonbill, *Platalea minor*, and Chinese egret, *Egretta eulophotes*. Although numbers of each of these species are believed to be low.

The area is known to support a large number species of fish and marine invertebrates, but this aspect of its biodiversity has not been surveyed in detail.

#### 2.1.3 Naturalness

Virtually no wetland in Asia can be classified as "natural". Centuries of influence by man have modified most habitats and ecosystems and Dongzhaigang is no different. Although the natural

ecosystem in the area is mixed mangrove forest associated with inter-tidal flats, this has been modified by the following anthropomorphic and historical factors:

- Harvesting of mangroves for wood, fuel, tannin and other non-timber products.
- Reclamation of mangroves and inter-tidal areas for agriculture, aquaculture and housing.
- Introduction of exotic or alien species of mangrove tree.
- Development of plantation mangrove forests.
- Intensive fishing and shell-fish collection in and around the estuary.
- Pollution from domestic, agricultural and industrial sources in the catchment.

This has resulted in a severely modified habitat in the buffer zones of the N.N.R. where the mangrove trees are of a smaller size, where regeneration is sparse and consists of scrubby species and where reclaimed areas have been abandoned.

On the other hand a relatively "natural" core zone of mangrove has developed since the creation of the protected area in 1980. In this area the mangroves are close to optimal size (for the climatic conditions) and reflect the natural species composition and age structure for a forest of this type.

**2.1.4 Rarity**

Nearly 80% of mangrove forest in southern China has been reclaimed and destroyed in the last 40 years. Therefore the mangrove ecosystem at Dongzhaigang represents a rare wetland habitat in China. Of national importance are the populations of mangrove plant species (particularly *Nypa fruticans*, *Lumnitzera littorea* and *Sonneratia alba*) and the Hainan Island endemic *Sonneratia hainanensis*.

Of principal and global concern are the populations of the three "globally threatened" bird species supported by Dongzhaigang. Population sizes for all three species are small and may be declining. Mid-winter waterfowl counts between 1992 and 1997 show that black-faced spoonbill populations have decreased from 13 (in 1992), 6 (1995), 4 (1996) to 3 (1997 and 1999). Whilst no accurate census figures are available for Saunders' gull and Chinese egret they are known to be very rare.

**2.1.5 Fragility**

Mangrove and inter-tidal flat ecosystems are relatively simple, generally robust and can withstand fairly high pressures of exploitation, degradation and modification. However, it is very difficult and expensive to restore mangrove systems following drastic changes in the hydrology, soil drainage and chemistry (e.g., following drainage and formation of acid sulphate soils, or following oil spills). Natural events such as typhoons and tidal surges may also pose a significant threat to the mangrove system in Dongzhaigang. Other man-induced fragility concerns the high levels of pollutant inputs to the bay, continued reclamation of inter-tidal areas outside and adjacent to the protected area and excessive exploitation of shell-fish and other inter-tidal organisms.

### 2.1.6 Typicalness

Dongzhaigang is a typical example of the mangrove and inter-tidal mud- and sand-flat ecosystem of southern China. Furthermore the area is the largest contiguous area of protected mangrove forest remaining in China (perhaps with the exception of Mai Po Marshes and Deep Bay in Hong Kong SAR and adjacent Shenzhen.

### 2.1.7 Research

Dongzhaigang has long been a research focus for Chinese marine scientists and botanists interested in the mangrove ecosystem. Many publications have resulted from research carried out over the last 10 years, ranging from studies on soils, plant morphology and phylogeny, ecosystem functioning and management, mangrove restoration and planting, biodiversity and ecotourism potential (see Section 1.6 for details).

### 2.1.8 Recreation and Tourism

Ecotourism at Dongzhaigang is well established. Since 1989 there has been a local mangrove based ecotourist industry centered on boat trips through the mangroves and consumption of seafood at local hotels/restaurants.

Prior to 1997 the estimated number of visitors to the Reserve was 50,000 per year and revenue for the management authority from boat hire and organized tours was estimated at RMB 250,000 per year of which 15% contributes to the total Reserve budget. In response to this demand two hotels and restaurants and a boat jetty with ornamental pagoda were constructed adjacent to the Reserve management offices. These were financed by private companies and sponsored by the Hainan Provincial Tourism Authority. In addition to this, in 1997 a concrete elevated mangrove walkway was constructed illegally within the Reserve "tourism zone". This walkway was designed to allow paying tourists a view of the mangroves and also access to boats in the main channel. This operation was established in direct competition to that at the main jetty complex.

The impact of ecotourism and other recreational activities at Dongzhaigang has not been fully investigated. Up to 50,000 visitors per year is bound to have some adverse impacts on the mangrove environment, particularly where visitors leave the boats and follow a trail through the mangrove forest. In addition, pressures on fisheries resources to supply the demand of tourist restaurants may be unsustainable. There is no doubt that the illegally constructed mangrove walkway in the Reserve has a negative impact aesthetically. Illegal construction of such infrastructure in a National Nature Reserve also raises questions of local planning laws and land tenure in and around the protected area. Hotels and restaurants built adjacent to the mangroves may also have inadequate waste disposal systems that may impact the ecosystem.

### 2.1.9 Education and Public Awareness

Excellent potential for education and public awareness for schools and universities, tourists and local communities exists at Dongzhaigang National Nature Reserve as the area is about 1 hour from the Provincial capital, Haikou and easily accessible by highway/major road from the city. In addition a new international airport is currently under construction (1998) about half an hour from the site.

## 2.2 Management goals

### 2.2.1 Long term management goals

The long term goals of management at Dongzhaigang National Nature Reserve are:-

- To maintain and enhance the integrity and global biodiversity importance of the mangrove and inter-tidal mud- and sand-flat ecosystem within the bay through stronger protection, better management and restoration of degraded areas.

- To ensure that development and exploitation of wetland resources in the N.N.R. and surrounding area is conducted in a sustainable manner.

- To enhance the potential for tourism, research and environmental awareness at the site and ensure it is developed in a responsible manner.

## 2.3 Factors influencing the achievement of long term management goals

### 2.3.1 Internal natural factors:

Maintaining the integrity and global biodiversity importance of the mangrove and inter-tidal mud- and sand-flat ecosystem relies on maintaining a balance between mangrove accretion and erosion and the corresponding extent of inter-tidal areas for feeding birds.

Current low information base on resources and their management exists. For instance, little is known of wintering habitat and migratory habitat needs of globally threatened water birds, and of cycles of mangrove accretion and erosion at Dongzhaigang.

**2.3.2 Internal human-induced factors:**

High levels of exploitation of the wetland resources (particularly shell-fish and inshore fisheries) within the National Nature Reserve may be unsustainable in the long term.

High visitor use and disturbance may effect wintering populations of globally threatened species.

Pollution and the associated effects of increased development of infrastructure and visitor facilities may lead to localized erosion, disturbance, litter, waste management problems.

Past management rationale has been focussed on development of mangrove tree plantations, often with alien or introduced species, and not on natural ecosystem management.

**2.3.3 External natural factors:**

Frequency and force of typhoons effecting the Dongzhaigang coastline can lead to severe erosion of mangroves and inter-tidal mud- and sand-flats and loss of wetland resources.

**2.3.4 External human-induced factors:**

Aquaculture development in areas immediately adjacent to the Reserve will effect freshwater supply to the mangroves having impacts on erosion cycles and mangrove species composition. Other aquaculture related factors include the leaching of acids from acid sulphate soils developed by drainage and bunding of former mangrove lands and aquaculture pollutant/waste disposal.

Associated tourism development adjacent to the Reserve will create waste management and disturbance impacts.

**2.3.5 Factors arising from legislation or tradition:**

Despite Ramsar site status and National Nature Reserve status local development plans have impinged and impacted upon the protected area. Dongzhaigang National Nature Reserve is managed by the Hainan Forestry Bureau, but decision-making powers lie with the local county government.

Local communities exercise "traditional rights" over resource exploitation within the National Nature Reserve. Exploitation of inter-tidal shellfish and fish in particular is widely practiced throughout the protected area with no difference in use pressure between a "core zone" and a "utilization zone". There may also be localized hunting of birds and other wildlife in and around the Reserve. Local communities however appear to respect the no-cutting policy of mangrove wood in all zones.

Local communities are traditionally not involved in protected area decision making and planning.

**2.3.6 Physical considerations:**

Ease of access to the area may impose limitations on resource management and protection.

**2.3.7 Available resources:**

Financial resources to manage Dongzhaigang National Nature Reserve are low. Since 1993 no or little central funding from S.F.A. has been available for operations. The annual staff salaries and operational budget for the N.N.R. is estimated at RMB 390,000. these costs are met through ecotourism revenues and local Forestry Bureau funds.

There are about 32 staff employed by Dongzhaigang N.N.R. Of these few are involved in protection works.

There are 2 protection "stations", a HQ administration and management office, staff housing and a large meeting room. In addition, there is some infrastructure associated with a small mangrove nursery.

**2.3.8 Summary of factors influencing the achievement of the long term management goals:**

- Dynamic internal factors associated with inter-tidal ecosystems present both constraints and opportunities for long term wetland management and ecosystem restoration.

- Ecosystem functioning, such as use of habitats by globally threatened water birds and cycles of mangrove accretion and erosion at Dongzhaigang are currently poorly understood.

- Man-induced internal factors, principally lack of control over sustainability of resource use, disturbance to wildlife and uncontrolled development present obstacles to reaching long term goals.

- Lack of control over external factors (e.g., natural: typhoons and man-induced: pollution, peripheral aquaculture and other developments) prevents complete control over ecosystem management by Hainan Forestry Bureau staff.

- Local legislation and land use planning and decision making take little account of National Nature Reserve priorities and recommendation for biodiversity conservation.

- Adequate person-power resources are available, but currently focussed on ecotourism activities, not ecosystem management. Training and capacity are currently low.

**2.4 Short term operational objectives**

**Operational Objective 1: To maintain and enhance mangrove ecosystems and natural resources**

Management Target 1.1: To strengthen protection for the mangrove ecosystem.

Management Target 1.2: To restore mangrove forest in appropriate areas.

Management Target 1.3: To expand area of mangroves through planting.

Management Target 1.4: To increase economic benefits within the reserve.

Management Target 1.5: To strengthen research on mangrove ecosystems.

**Operational Objective 2: To maintain and enhance conservation of biodiversity and important species**

Management Target 2.1: To conserve and increase rare or endangered species populations.

Management Target 2.2: To survey and monitor natural resources.

Management Target 2.3: To ensure wise use of biological resources in the Reserve.

Management Target 2.4: To strengthen applied research into endangered species.

**Operational Objective 3: To promote awareness building and public education**

Management Target 3.1: To raise public awareness on the values of mangrove and biodiversity.

Management Target 3.2: To promote environmental awareness through mangrove-based ecotourism.

Management Target 3.3: To strengthen management capacity of Reserve staff.

**Operational Objective 4: To maintain and enhance protection and wise use of the mudflat resources**

**Operational Objective 5: To maintain water resources and control pollutants**

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## Chapter 3 Management Scenarios

**Operational Objective 1: To maintain and enhance mangrove ecosystems and natural resources**

**Management Target 1.1: To strengthen protection for the mangrove ecosystem:-**

***Activity 1: Identifying and demarcating functional zones of the Nature Reserve and identifying main functions of each zone***

The Reserve is currently divided into 3 functional zones (see Table 1). These will be maintained (or adjusted accordingly) but their protection and management strengthened. The three zones are:-

1) Core area: The area around Tashi will be maintained as the core zone of the Reserve as it is the best remaining example of a mangrove ecosystem in the estuary with populations of the rarer mangrove species and less human disturbance than elsewhere. Historically the mangrove ecosystem of the core zone was well protected. The total area of the core zone is 940 ha.

All forestry-related activities such as tree felling, and other activities such as land reclamation, fishing, hunting and breeding of marine lives will be absolutely forbidden in the core zone.

2) Buffer zone: The buffer zone consists of the inter-tidal mudflats surrounding the core zone and has a total area of 122 ha. In the buffer zone some forestry-related activities and resource exploitation activities, if consistent with protection of the natural ecosystem and biodiversity, will be allowed. The buffer zone will also be used for education and research activities, to monitor

biodiversity and will continue to be used as a shellfish production area and fishing area for local communities. Hunting and land reclamation will continue to be forbidden.

3) Extensive use zone: This area was formerly termed the "experimental zone" and consists of all areas within the Reserve that fall outside the core and buffer zones. The extensive use zone consists mostly of the lowest inter-tidal sand- and mudflats and scattered mangroves. The total area of this zone is 2275 ha including 1066 ha of scattered forest land and 1209 ha of mudflat, and is located mainly in Sanjiang area.

Besides on-going community based fisheries this zone will be used for field research and trials on mangrove afforestation, sustainable use of inter-tidal resources and limited ecotourism. Tree felling and other exploitation of the mangroves will be forbidden.

**Table 1. Area of functional zones of Dongzhaigang National Nature Reserve**

| Functional zone | Locality | Forested area | Mudflat | Subtotal |
|---|---|---|---|---|
| Core zone | Tashi | 940 | - | 940 |
| Buffer zone | Coastal area | - | 122 | 122 |
| Extensive use zone | Sanjiang | 1066 | 1209.6 | 2275.6 |
| Total | - | 2006 | 1331.6 | 3337.6 |

Activity Budget: 50,000 RMB.

Implementation responsibility:

Protection Stations of Dongzhaigang National Nature Reserve.
Protection Section of the Dongzhaigang Nature Reserve.
People’s Government of Qiongshan County

Implementation period: 2000-2001

***Activity 2: Demarcating the reserve's boundary and setting up stakes and information signs***

The boundaries of the Dongzhaigang National Nature Reserve are currently inadequately demarcated leading to frequent intrusions and disputes over land tenure and rights. Clear demarcating of the Reserve boundary is an important prerequisite for implementing management activities at the Reserve and will be critical from the point of view of guaranteeing the rights of using land and resources.

Following the establishment of the protected area in 1980, the People's Government of Qiongshan County issued a declaration stating the area and boundary of the Reserve. Whilst the area of the Reserve was accurately stated, its boundaries were not precisely defined. In 1989 the County Government established a working group to precisely demarcate the area and boundaries of the reserve. An ownership certificate was issued to the Forestry Bureau, but due to a lack of clear and permanent landmarks in the inter-tidal zone (and because no border posts were erected) it remains difficult to manage the boundaries of the Reserve. It is therefore proposed that the following actions take place:-

1) The Reserve management office will invite consultants from the State Land Administration to the site to officially demarcate and map the extent and boundaries of the protected area. This will be strictly based on the decision made by the People's Government of Qiongshan County in 1989.

2) Based on the results of the mapping and demarcation activities, approximately 600 permanent, concrete marker posts will be erected around the reserve boundaries. In areas adjacent to residential areas there will be more marker posts erected. The size of each boundary marker will be 200 x 15 x 15 cm. In appropriate areas steel fencing will be erected.

3) Approximately 100 sign boards with information on the Reserve and its regulations will be erected at sites with high visitor use.

Budget: 350,000 RMB

Implementation responsibility:

People's Government of Qiongshan County
Protection Sections of the Dongzhaigang Nature Reserve and Police Station

Implementation period: 2000-2001

***Activity 3: Strengthening organization and capacity of management staff***

Organizational structure: The planned levels of staffing and positions for the Reserve are outlined in Table 2 below.

**Table 2. Organizational structure of the Reserve management.**

| Section/Division | Staff Positions | No. of staff |
|---|---|---|
| Management Division | Reserve Director | 1 |
| | Deputy Director | 2 |
| Administration Section | Section Chief | 1 |
| | Office staff | 2 |
| Research Section | Section Chief | 1 |
| | Deputy Section Chief | 1 |
| | Research staff | 3 |
| HQ Protection Section | Section Chief | 1 |
| | Deputy Section Chief | 1 |
| | Research staff | 3 |
| Protection stations | Tashi Station Director | 1 |

| | | |
|---|---|---|
| | Tashi protection staff | 3 |
| | Sanjiang Station Chief | 1 |
| | Sanjiang protection staff | 3 |
| Tourism Section | Section Chief | 1 |
| | Deputy Section Chief | 1 |
| | General staff | 4 |
| Experimental Section | Section Chief | 1 |
| | Deputy Section Chief | 1 |
| | General staff | 3 |
| Reserve Police Unit | Section Chief | 1 |
| | Deputy Section Chief | 1 |
| | Policemen | 3 |
| Total | | 40 |

In order to build the capacity of the Reserve staff to administer and manage the reserve effectively a number of training and capacity building activities will be undertaken. These are described under Activity 24 below. In addition to this, future staffing appointments and promotions will be based on the following principles:

1. The staff will be employed for different positions based on their expertise and abilities.

2. Staff promotions will be based on regular staff examinations and reviews of staff performance.

3. Staff must demonstrate a sufficient knowledge on nature protection at a level above that needed for the position.

4. Newly recruited staff should have enthusiasm for nature protection, be willing to work for an extended period and be based on site.

5. All section chiefs and scientists (researchers) must have education up to the diploma level. Preferred majors will be botany, zoology, ecology and environment sciences. A foreign language is preferred.

6. The reserve will attempt to provide staff security and increase their knowledge through training and future strategic planning.

   Budget: 3,000,000 RMB

   Implementation responsibility:

   Protection Stations of the Forestry Department of Hainan Province
   Administration of Dongzhaigang Nature Reserve

   Implementation period: 2000-2004

***Activity 4: Strengthening Reserve infrastructure***

To increase the effectiveness of current Reserve management and protection practices a number of infrastructure strengthening actions will be undertaken, these include:-

1) Strengthening of infrastructure of Administration of the Nature Reserve, and establishment of Reserve management stations at Tashi and Sanjiang.

2) Procurement of the following communication and patrol equipment: 6 motorcycles, 3 patrol boats, 2 cars and 10 mobile phones.

3) Erect at least one watchtower for every Reserve management station. Each watchtower will allow enhanced protection, serve as a water bird monitoring station and as a fire protection tower. In addition to the existing simple watchtower at Tashi, which requires improvement, additional watchtowers will be constructed at Tashi and Sanjiang.

Budget: 7,452,000 RMB

Implementation responsibility:

Administration of the Dongzhaigang Nature Reserve
Protection Section of the Dongzhaigang Nature Reserve and Police Station

Implementation period: 2000-2002

***Activity 5: Reinforcement of Reserve management regulations***

1) Revised "Regulations on Management of Dongzhaigang Nature Reserve" will be formulated in accordance with the Forest Law, the Law on Wildlife Protection, and the Regulations on Management of Nature Reserves of Wildlife Type.

2) Strengthening the Reserve Police Station as a reinforcement mechanism. The Police Station plays an important role in protecting the ecological environment and natural resources. The staff of the Police Station have to be trained and equipped with communication and transport facilities.

3) Strict adherence to the existing regulations and laws relating to protection of the ecological environment and natural resources will be ensured. Any transgressors must be dealt with by the Reserve Police Station and Protection Section in accordance with the regulations and laws outlined in 1 above.

4) Strengthening of patrol management. A daily and weekly protocol or schedule for patrolling the Reserve will be developed and implemented. Patrols may be conducted both by walking or using vehicles/boats. Patrol teams will have to report both legal and illegal activities and take prompt action.

5) Regular quarterly inspections will be made. Inspections should be coordinated with seasonal activities such as shellfish production, fishing activity, etc. Each inspection will produce a report analyzing the management problems and make proposals for related measures to be undertaken.

6) Strengthening cooperation with the local security sector, e.g. the Administration of Public Security, the Courts etc. Their support and understanding are of great importance to ensure that appropriate fines and sentences are imposed.

Budget: 50,000 RMB

Implementation responsibility:

Forestry Department of Hainan Province
Administration of Dongzhaigang Nature Reserve Police Station
Protection Section of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

***Activity 6: Establishment of Joint Leading Group to oversee Reserve management***

In order to enhance management options and involve local community leaders and other stakeholders a Joint Leading Group or Joint Committee for Protection of the Reserve will be established. In addition each Management station will also established a sub-committee. The Joint Leading Group and sub-committees will conduct 2-3 meetings per annum to discuss important issues and set management targets for their management.

Budget: 100,000 RMB

Implementation responsibility:

Forestry Bureau of Qiongshan City
Dongzhaigang Nature Reserve

Implementation period: 2000-2004

**Management Target 1.2: To restore mangrove forest in appropriate areas:-**

***Activity 7: Restoration of the mangrove ecosystem***

This activity aims to restore former mangrove areas or degraded mangrove areas through the planting of mangrove seedlings at appropriate sites (e.g. inter-tidal mudflats and scattered forest land). Actions under this activity will include:

1) Previous surveys have shown that there is about 135 ha of potential land and area for mangrove restoration in Daoxuecun village, Sanjiang farm and Sanjiang Chitu. Specific sites within this area will be identified and mapped for restoration. The annual target for planting is 27 ha over a 5 year period.

2) Mangrove species to be used for planting are: *B. sexangula, B. gymnorrhiza, B. sexangula var. rhynchopetala, K. candel, S. apetala and A. marina*. In the degraded forest fast growing species will be selected for supplementary planting.

3) Planting model: mixed forest planted with *B. sexangula, B. gymnorrhiza, B. sexangula var. rhynchopetala*, pure forest with *K. candel, S. apetala, A. marina*. The planting area of each species is shown in Table3.

**Table 3: Planting area and seedling size by species**

| Species | Mixed forest of *B. sexangula, B.gymnorrhiza,B. sexangula* var. *rhynchopetala* | *K. candel* | *A. marina* | *S. apetala* |
|---|---|---|---|---|
| Area in ha | 50 | 20 | 20 | 45 |
| Spacing (in metres) | 1 x 1 | 1 x 0.5 | 1 x 0.5 | 1 x 1.5 |
| Seedlings | Vertical hypocotyl | Vertical hypocotyl and 1-2 yr. Seedlings | 1-2 yr. seedlings | 1-2 yr. Seedlings |

4) Establishment of 2 ha nursery with annual production capacity of 300,000 seedlings including 100,000 seedlings for commercial sale. Nursery technicians will require appropriate training.

5) Monitoring sample plot will be set up for measuring the growth of planted mangroves.

Budget: 722,500 RMB

Implementation responsibility:

Research Section of the Dongzhaigang Nature Reserve
Experimental farm of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

**Management Target 1.3: To expand area of mangroves through planting:-**

***Activity 8: To prevent erosion of mangroves through planting of fast growing species and increase area of rare mangrove species***

In both land ward and intertidal areas within the extensive use zone where erosion is a problem fast growing mangrove species such as S. apetala and A. marina will be planted. The rare mangrove species S. hainanensis, S. alba, S. ovata, S. paracaseolaris, N. fruticans, L. littorea and X. granatum will also be planted in these areas. The proposed area and spacing of these species are provided in Table 4.

**Table 4. Planting area and seedling size by species**

| Species | *Avicennia marina* | *Sonneratia apetala* | Rare species |
|---|---|---|---|
| Area in ha | 20 | 10 | 40 |
| Spacing in m | 1 x 0.5 | 1 x 1.5 | - |
| Seedlings | 1-2 yr. seedlings | 1-2 yr. Seedlings | - |

Budget: 245,000 RMB

Implementation responsibility:

Research Section of Dongzhaigang Nature Reserve
Experimental Farm of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

**Management Target 1.4: To increase economic benefits within the reserve:**

***Activity 9: Development of sustainable ecotourism based on mangrove forest resource***

Mangroves provide an interesting and unique resource to promote tourism, and particularly ecotourism. They provide many environmental education opportunities as well as a supply of handicraft products and fresh produce for sea food restaurants and hotels. Dongzhaigang has the further advantage of being easily accessible, located only 30 km from Haikou, the capital city of Hainan Province.

The rationale for tourist development at Dongzhaigang National Nature Reserve will adhere to the principles outlined under Activity 1 relating to zonation within the Reserve. That is, the core zone will be totally protected from human disturbance and exploitation and that the main theme for tourism will be the promotion of ecological awareness and conservation of natural resources. As such, the future Dongzhaigang National Nature Reserve will be an integrated ecotourism area combining research, education and tourism.

Actions under this activity will include:

1) A carrying capacity analysis will be conducted to calculate how many visitors the reserve can accommodate.

2) Identification and establishment of boating routes and nature trails though the mangroves. Preliminary proposals suggest a route from Yanfeng to Management Station to Xiutian Island to Sanjiangwan and back. The boat trail will be 40 km.

3) Construction of ecotourist facilities. These include hides and towers for nature and bird watching, tour boats, watching pavilion, pier, boat jetty and walking paths.

4) Training of tourist guides 10 person and development of information sheets for visitors.

Management of tour operations

To ensure sustainability and adherence to the principles of ecotourism the following actions will be undertaken:-

- Development and implementation of "*Regulations for Tourism within the Reserve*". The Regulations must be followed by all tourist operators wishing to operate inside the Reserve. The Regulations will also provide management procedures and mandates for the responsible management units;

- Training of managerial staff in charge of tourism management;

- Increased patrolling to prevent negative impacts on natural resources and ecosystems within the tourist zones of the reserve;

- Improvements in the treatment of wastewater, sewerage and garbage in and adjacent to the Reserve. The us e of fuel and oil will be restricted and boats will be required to use battery power (or manual operation).

- An awareness building programme to promote a clean environment and proper sanitation will be implemented.

  Budget: 2,570,000 RMB

  Implementation responsibility:

  Tourism Section of the Dongzhaigang Nature Reserve

  Implementation period: 2000-2002

***Activity 10: Promotion of community development in and around protected area***

Following the establishment of the Reserve the economic development of local communities has been limited, due mostly to restrictions on land development and harvesting/fisheries activities. As a result local incomes have decreased. This has led to conflicts between the Reserve management authorities and the local communities.

In order to provide local communities with incentives to conserve the area and its resources, it is important to develop additional economic benefits from the mangroves and to involve the local communities in management decisions. The following actions are planned:-

1) Enrichment planting within the mangroves will provide local communities with the benefits of an improved ecological environment leading to increased production of fish, crabs, oysters and shrimps.

2) Technical assistance will be provided to rural households to improve agricultural techniques, promote sustainability on shellfish production and aquaculture, provide judicial assistance, education and dissemination of knowledge on environmental protection and sanitation.

3) Participation of local people in services related to ecotourism will be encouraged to provide direct benefits to local communities. These activities can reduce pressures on wetlands, and also promote development of the local economy.

4) Cage culture trials for marine resources (fish, shrimps, crabs and oysters) will be conducted in the extensive use zone. Positive results of such trials will increase income of local people and significantly reduce the pressure on the core zone.

5) Development of small-scale mangrove cash crops such as species of medicinal value and timber value, will provide economic incentives for local communities.

Budget: 1,000,000 RMB

Implementation responsibility:

Experimental Farm of the Dongzhaigang Nature Reserve

Implementation period: 2000-20004

**Management Target 1.5: To strengthen research on mangrove ecosystems:-**

***Activity 11: Undertake applied and targeted research on mangrove ecosystems to benefit Reserve management***

The proposed research fields will include:-

- Quantification of ecological, social and economic benefits generated by mangrove in the Reserve;
- Productivity of the mangrove wetland ecosystem;
- Ecological monitoring of the mangrove wetland ecosystem.

Budget: 500,000 RMB

Implementation responsibility:

Research Section of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

**Operational Objective 2: To maintain and enhance conservation of biodiversity and important species**

**Management Target 2.1: To conserve and increase rare or endangered species populations:-**

***Activity 12: Strengthening protection of rare bird species***

Dongzhaigang National Nature Reserve supports small populations of globally threatened bird species such as black-faced spoonbill, Saunders' gull and Chinese egret. These and other important species use the reserve during the migration and wintering periods. They do not breed at the Reserve. Annual monitoring over the last decade has recorded a slow but significant decrease in the numbers of these birds using the Reserve each winter. It is therefore a management priority to arrest this decline and provide suitable conditions for populations to increase in the future.

Actions identified under this activity include:

1) Identification of the main habitats/feeding areas of the endangered bird species;

2) Habitat management to ensure that habitat functions remain stable;

3) Creation of seasonal "exclusion zones" to prevent human incursions and disturbance into these areas at important times (November to March). Strict enforcement and punishment for those who poach endangered bird species in accordance with the regulations and laws.

4) Strengthened protection for shorebird roost sites during the high tidal periods. Because many shorebirds roost in areas adjacent to, but outside, the Reserve (in salt pans and fish ponds) it will be necessary to establish a buffer zone. The buffer zone should include important, traditional roost sites and its management must include local awareness building activities.

5) Establish a bird monitoring centre to study bird movements and behavior in response to Reserve management.

6) Join international conservation cooperation projects, such as East Asia- Australasian Shorebird Reserve Network.

Budget: 600,000 RMB

Implementation responsibility:

Research Section of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

***Activity 13: Increased protection of rare and endangered mangrove species***

Dongzhaigang National Nature Reserve supports several rare and restricted range mangrove species for China. Protection of these species will be enhanced through the following actions:-

1) Enrichment planting of these species in on-going mangrove restoration programmes (see Activities 7 and 8);

2) Strengthened protection and management of areas where these species occur;

3) Monitoring the state of growth and propagation of these species;

4) Establishment of a conservation and research centre for mangrove genetic resources and strengthening of research on ecology of mangroves in Hainan;

5) Research on genetic variation of important and endangered mangrove species to prevent species loss and habitat degradation.

Budget: 500,000 RMB

Implementation responsibility:

Protection Section and Research Section of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

***Activity 14: Protection of endangered mammals***

The endemic sub-species of common otter *Lutra lutra hainana* is reported at Dongzhaigang. Increased protection and research into this species will take place, including daily monitoring, enhanced patrolling activities and conservation of their habitats.

Budget: 100,000 RMB

Implementation responsibility:

Protection Section and Research Section of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

**Management Target 2.2: To survey and monitor natural resources:**

***Activity 15: Baseline survey of resources in the reserve***

Despite considerable national and international interest in the mangrove ecosystem at Dongzhaigang there has never been a comprehensive baseline survey to establish the true important of the area for biodiversity. Most data relates to the mangrove vegetation species and communities present, there is also some data on the seasonally occurring birds. However very little is known about the inter-tidal benthic communities, the fish fauna, mammals, reptiles and the non-mangrove vegetation (particularly phytoplankton, sea grasses, algae, etc). Virtually nothing is known about the population sizes, seasonal occurrences, ecological requirements and interactions of these species and communities. As a result, management decisions have historically been based on guesswork rather than data. For future management to have a scientific and ecological basis it is essential that a strong baseline survey of these resources is carried out and is available as the basis for future ecological management decisions. Actions under this activity include:-

1) Identification of gaps in data on biodiversity and natural resources (this management plan will provide the basis for the gap analysis);

2) Design and implementation of baseline surveys of biodiversity and natural resources;

3) Training for Research Section staff in methods of biodiversity survey and monitoring;

4) Development of a Dongzhaigang Biodiversity Database as a basis for management*t*decisions (see also Activities 16 and 17).

Budget: 582,000 RMB

Implementation responsibility:

Research and Protection Sections of the Dongzhaigang Nature Reserve

Implementation period: 2000-2002

***Activity 16: Establishment of an ecological monitoring programme***

Ecological monitoring can provide up-to-date information about the status and quality of the environment and biodiversity within the Reserve. Monitoring also helps us to understand change and can be used to design management strategies to prevent degradation of ecological systems and the species they support. Actions to be undertaken include:

1) A comprehensive ecological monitoring programme will be designed. The following environmental factors will be included:

a) Biodiversity: including species, quantity, biomass (outputs) and structure of the mangrove vegetation, birds (with an emphasis on water birds), insects, mammals, reptiles, bottom fauna and plankton.

b) Chemical-physical environment: including quality of water (DO, COD and BOD5, total nitrogen, total phosphorus, copper, lead, zinc, cadmium, mercury and petroleum, etc ), soil properties, change of tidal level and weather factors (light, temperature, rainfall and disastrous weather).

c) Ecological conditions: including changes in area of mangroves (and of different species), mudflats, water (low tidal), navigation routes, fishponds, farmland, and marginal forest and adjacent developments (houses/residential areas, highways, and commercial areas), local population.

2) Ecological monitoring will be conducted every 3 years, but each year only one of above-mentioned 3 factors will be monitored. As such there will be a continuous monitoring programme annually.

3) The following methodology for monitoring is proposed:-

a) Fixed monitoring stations: The fixed ecological monitoring stations of different types will make the data obtained comparable and sequential.

b) Fixed time monitoring: The items for measurement will be monitored in fixed time, as such the results obtained during the monitoring are comparable with that of last monitoring.

c) A combination of desk survey, field survey and laboratory analysis.

d) Remote sensing and GIS will be applied in dynamic monitoring of mangrove resources.

Budget: 800,000 RMB

Implementation responsibility:

Research Section of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004 and beyond.

***Activity 17: Developing a Dongzhaigang Biodiversity Database***

A database of biodiversity found within the Reserve will be established and updated regularly. The database will be established as a storage and decision-making tools for future Reserve management and monitoring programmes.

Budget: 200,000 RMB

Implementation responsibility:

Research Section of the Dongzhaigang Nature Reserve

Implementation period: 2002

**Management Target 2.3: To ensure wise use of biological resources in the Reserve:**

***Activity 18: Wise use of marine and inter-tidal resources***

The reserve is intensively used for fishing and culture of shellfish by locals. It is unknown whether current levels of harvesting and culture are sustainable or not. With increasing human populations and development pressure around the Reserve it is likely that these activities will increase, and as a result become even less sustainable than at present. It is therefore essential for the Reserve management authorities to work with local communities and cooperatives to ensure that inter-tidal resources are used sustainably. The following actions are planned:

1) "*Regulations on Fishing and Mari-culture within the Reserve*" will be developed in collaboration with local communities and co-operatives.

2) Based on these Regulations, the Reserve management authority, in collaboration with local government, will issue licenses for fishing, inter-tidal resource harvesting and mari-culture and collect appropriate management fees.

3) An intensive survey of current fishing, harvesting and mari-culture practices will be undertaken to determine a suitable fishing quota system. The quota system will limit the number of fishing boats allowed in the Reserve, numbers of fishermen issued with licenses and the quantity of fish and shellfish landings. The system will also stipulate the time, instruments and method of fishing. Any kind of fishing methods containing explosives, electricity, poisoning and other illegal means are forbidden.

4) In coordination with the Provincial Fishery Department the Reserve management authority will strictly follow regulations related to timing, zoning and fishing quotas. Illegal fishing will be deterred and punished.

Budget: 100,000 RMB

Implementation responsibility:

Protection Section of the Dongzhaigang Nature Reserve
Reserve Police Station

Implementation period: 2000-2004

***Activity 19: Development of medicinal plant resources***

To enhance opportunities for local communities and individuals, mangrove medicinal plants such as *A. ilicifolius, A. marina* and *B. sexangula* will be cultivated for research and utilization.

Budget: 200,000 RMB

Implementation responsibility:

Experimental Farm of the Dongzhaigang Nature Reserve

Implementation period: 2002-2003

**Management Target 2.4: To strengthen applied research into endangered species:**

***Activity 20: Develop and implement an applied research programme for endangered species conservation***

Urgent management action is required to prevent further declines and extinction of populations of rare and endangered species at Dongzhaigang National Nature Reserve. To combat this possibility an applied research programme targeting rare species conservation will be developed and implemented. This will include the following actions:

1) Development of Action Plans for endangered bird species (black-faced spoonbill, Chinese egret and white spoonbill and Saunders' gull);

2) Development of Action Plans for rare mangrove plant species (*S. hainanensis, S. ovata, S. paracaseolaris, L. littorea, N. fruticans, X. granatum)*;

3) Experiments on propagation of endangered and economically important mangrove species;

4) Experiments on culture of marine shellfish of high economic value;

5) Experiments on development and utilization of medicinal plants like *A. ilicifolius, A. marina* and *B. sexangula*.

Budget: 500,000 RMB

Implementation responsibility:

Research Section of the Reserve

Implementation period: 2000-2004

**Operational Objective 3: To promote awareness building and public education**

**Management Target 3.1: To raise public awareness on the values of mangrove and biodiversity:-**

***Activity 21: Increase public education and outreach to local communities***

Public awareness and education are important tools to harmonize interests between different stakeholders and to coordinate relationships between long-term and short-term interests. Education and awareness building should therefore be as diversified as possible. The following actions are planned:-

1) Public awareness activities focussed on mangroves, biodiversity and natural resources conservation will be conducted in conjunction with National Tree Planting Day, World Wetlands Day, World Environment Day and other such events.

2) Information boards and posters on the protection of the mangroves and resources at Dongzhaigang will be erected along the Reserve boundaries, at strategic locations used by visitors and in local communities adjoining the Reserve.

3) Community outreach programmes will focus on encouraging citizens to participate in formulation of a set of Common Obligations for Communities using Dongzhaigang. Those who strictly follow the Common Obligations, regulations and laws shall be awarded once a year. Through such schemes it is hoped that environmental protection will become a new community custom.

Budget: 200,000 RMB

Implementation responsibility:

Protection Section of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

***Activity 22: Increase environmental education to local schools and children***

The following outreach activities will take place in local schools and community centres:-

1) Schools and kindergartens will be invited to organize pupils to visit the reserve and Nature Interpretation Centre.

2) Pupils will be organized to spend their vacation in summer camps, where they will learn new knowledge about nature, observe and conduct small experiments. They will also participate in competitions involving report writing , composition and nature diaries.

3) Each year lectures and small exhibitions will be organized in the middle and primary schools.

Budget: 200,000 RMB

Implementation responsibility:

Information Centre of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

**Management Target 3.2: To promote environmental awareness through mangrove-based ecotourism:**

***Activity 23: Promotion of awareness through ecotourism***

A programme of on-site public awareness will be targeted towards visitors and tourists. This will consist of the following actions:

1) Booklets and posters on nature conservation will be printed and distributed to visitors/tourists.

2) A Nature Interpretation Centre (NIC) will be established. The main aim of the NIC will be to disseminate knowledge and information about nature, wetlands, birds and mangroves through posters, displays and interactive tools.

3) Eye-catching signs and exhibits will be erected in the protection zones and tourist zones of the Reserve.

Budget: 1,100,000 RMB

Implementation responsibility:

Information Centre of the Dongzhaigang Nature Reserve

Information period: 2001-2004

**Management Target 3.3: To strengthen management capacity of Reserve staff:**

***Activity 24: Strengthening of staff training***

Staff training is currently inadequate and unfocussed. The aim of the management authority is to raise training standards amongst staff at all levels and to raise morale and ownership of the reserve and its resources. A new staff motto "The Reserve is my Home" will be adopted and used by all staff.

The Reserve management authority will organize training courses of various types. The proposed content of the training will be based on a comprehensive training needs analysis. The following contents are envisaged: administrative management, public security, law reinforcement, bird protection, mangrove protection, environmental monitoring, biodiversity monitoring, tourism management, techniques of mari-culture, breeding and propagation of rare and endangered species of mangrove. It is believed that staff after training will have more scientific knowledge and improved capacity to manage the reserve. The following types of training are proposed:-

1) Long-term training: Every year, two management and research staff will attend Sun Yat Sen University and Hainan University for 1 year. Total of 10 persons will be trained. The Course will be Nature Reserve Management, Nature Resources Monitoring, Animal (Waterbird) Ecology, Database Management, etc. After one year training, these staff will have good knowledge to deal with different management and conservation work.

2) Short-term training: These will be based on-site, twice a year the Reserve management authority will arrange a one-week training courses for 20 participants. Resource personnel will consist of both reserve managers and invited specialists. Total of 200 people will be trained over 5 years.

3) Overseas training: The Reserve management authority aim to 3 key management personnel persons abroad for a 3-month training course (to be identified).

Budget: 750,000 RMB

Implementation responsibility:

Administration office of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

**Operational Objective 4: To maintain and enhance protection and wise use of the mudflat resources**

***Activity 25: Scientific planning and management of inter-tidal mudflat resources***

It is very important to plan rationally for the conservation of priority species at Dongzhaigang National Nature Reserve. Historically the Reserve management authority has focussed on mangrove planting to increase the area of mangrove forest. However this policy also certainly means that there is less inter-tidal sand- and mudflats for both local fisheries and culture and for rare bird species using these areas in winter. Conflicting management options such as these will be addressed with the following actions:

1) Important bird areas within the inter-tidal zone will be identified. These areas will be managed as exclusion zones where human disturbances will be minimized and no mangrove planting will take place.

2) There should be equal priority given to the conservation of water birds as to the protection and restoration of mangroves. Once factors affecting water bird movements and feeding ecology are better understood the reserve management authority will ensure that a rational proportion of the Reserve is maintained in the appropriate state for their needs.

Budget: 100,000 RMB

Implementation responsibility:

Research Section and the Experimental Station of the Dongzhaigang Nature Reserve

Implementation period: 2000-2004

**Operational Objective 5: To maintain water resources and control pollutants**

***Activity 26: Controlling point-source of land based pollutants in the Reserve catchment***

In cooperation with the Provincial Environmental Protection Agency the sources of all land based pollutants will be identified. Once identified the EPA will prohibit further discharge of pollutants from these sources into the Reserve catchment. The reserve management authority will ensure that farming of chicken, ducks, pigs, cattle and sheep will not be allowed within the Reserve. Disposal systems for locally generated garbage and pollutants will be implemented.

Budget: 200,000 RMB

Implementation responsibility:

Experimental Station of the Dongzhaigang Nature Reserve

Implementation period: 2000-2001

***Activity 27: Controlling potential polluting impacts of tourism***

Development of tourism and ecotourism activities may impact the Reserve in several ways.

1) Tourists will need to be educated against throwing their garbage into the river or along the roadside and against defecating and urinating beside the road or amongst the trees.

2) A sufficient number of garbage bins will be placed in tour boats and along the tourist routes/walking paths.

3) Toilet facilities will be provided at the main tourist spots and a small fee for their use will be charged to ensure cleanliness.

4) During the more intensive tourist seasons (e.g., Spring Festival) the Reserve staff will clean up pollutants more frequently.

Budget: 200,000 RMB

Implementation responsibility:

Tourism Section of the Dongzhaigang Nature Reserve

Implementation period: 2001-2002

***Activity 28: Controlling oil pollution caused by boats***

Tourist boats will be electric and / or oar driven. Noisy and polluting oil and diesel engines will be phased out and replaced by environmentally-clean engines. Licenses for tourist boat operators will only be approved following their adoption of the regulations. Operators found flouting the regulations and / or polluting the environment will have their operating license revoked.

Budget: 200,000 RMB

Implementation responsibility:

Protection Section of the Dongzhaigang Nature Reserve

Implementation period: 2001-2002

## Chapter 4 Budget

### 4.1 Budget

**Table 5. Budget for implementation of the 5 year management plan**

| Activities | Item (RMB) | Funding in RMB |
|---|---|---|
| 1: Identifying and demarcating functional zones of the Nature Reserve and identifying main functions of each zone | | 50,000 |
| 1.1 Demarcating functional zones, map publication | 50,000 | 50,000 |
| 2: Demarcating the reserve's boundary and setting up stakes and information signs | | 350,000 |
| 2.1 On-the-spot survey of the reserve boundary | 20persons*60day*200yuan/day | 240,000 |
| 2.2 Set up 600 concrete boundary stakes | 600*100yuan | 60,000 |
| 2.3 Set up 100 education boards | 100*500yuan | 50,000 |
| 3: Strengthening organization and capacity of management staff | | 3,000,000 |

| | | |
|---|---|---|
| 3.1 Nature Reserve running costs and salary (40 staffs) | 40persons*15000yuan/year*5year | 3,000,000 |
| 4: Strengthening Reserve infrastructure | | 7,452,000 |
| 4.1 Infrastructure | | |
| 4.1.1 one gate for the Nature Reserve | 1*100,000 | 100,000 |
| 4.1.2 Staff housing 1145$m^2$ | 1145$m^2$*750yuan/$m^2$ | 859,000 |
| 4.1.3 Research an working Building 2900 $m^2$ | 2900$m^2$*750yuan/$m^2$ | 2,175,000 |
| 4.1.4 Establish 2 management station(1080 $m^2$) | 1080$m^2$*750yuan/$m^2$ | 810,000 |
| 4.2 Road construction | | |
| 4.2.1 Cement road 1km | 1km*200000yuan/km | 200,000 |
| 4.2.2 Stone road 8km | 8km*20000yuan/km | 160,000 |
| 4.2.3 Asphalt road 4km | 4km*100000yuan/km | 400,000 |
| 4.3 Water and Power Supply | | |
| 4.3.1 Well 3 | 3*100000yuan | 300,000 |
| 4.3.2 Water tower 1 | 1*210000yuan | 210,000 |
| 4.3.3 Drainage works 1km | 1km*100000yuan/km | 100,000 |

| | | |
|---|---|---|
| 4.3.4 Power supply | | 67,000 |
| 4.3.5 Communication works | Telephone and radio etc. | 84,000 |
| 4.4 Patrol and transport facilities | | |
| 4.4.1 Establish 2 observation towers | 2*170000yuan | 340,000 |
| 4.4.2 two jeeps | 2*200000yuan | 400,000 |
| 4.4.3 six motorcycles | 6*12000yuan | 72,000 |
| 4.4.4 three boats | 3*150000yuan | 450,000 |
| 4.4.5 ten Hand-phones | 10*5000yuan | 50,000 |
| 4.5 Others | | |
| 4.5.1 Plantation | Hedgerow and grass | 60,000 |
| 4.5.2 Enclosing wall and sea dyke 1km | 1km*160000yuan/km | 160,000 |
| 4.6 Research and work facilities | | |
| 4.6.1 Jeep 1 | 1*200000yuan | 200,000 |
| 4.6.2 Mini bus 1 | 1*200000yuan | 200,000 |
| 4.6.3 Computer 2 | 2*12500yuan | 25,000 |
| 4.6.4 Duplicator 1 | 1*20000yuan | 20,000 |

| | | |
|---|---|---|
| 4.6.5 Facsimile 1 | 1*10000yuan | 10,000 |
| 5: Reinforcement of Reserve management regulations | | 50,000 |
| 5.1 Develop a regulation on management of the NR | 50,000 | 50,000 |
| 6: Establishment of Joint Leading Group to oversee Reserve management | | 100,000 |
| 6.1 Establish a joint management committee and running | 100,000 | 100,000 |
| 7: Restoration of the mangrove ecosystem | | 722,500 |
| 7.1 Establish a 2 ha nursery | 2$hm^2$*25000yuan/year*5year | 250,000 |
| 7.2 Restoration of mangrove ecosystem 135 $hm^2$ | 135$hm^2$*3500yuan/$hm^2$ | 472,500 |
| 8: Increase area of rare mangrove species | | 245,000 |
| 8.1 Mangrove reforestation 70 $hm^2$ | 70$hm^2$*3500yuan/$hm^2$ | 245,000 |
| 9: Development of sustainable ecotourism based on mangrove forest resource | | 2,570,000 |
| 9.1Conduct a carrying capacity analysis | 50,000 | 50,000 |

| | | |
|---|---|---|
| 9.2construction of eco-tourist facilities | | |
| 9.2.1 Establish three Piers | 3?*300000yuan/? | 900,000 |
| 9.2.2 Yacht 9 | 9*120000yuan | 1,080,000 |
| 9.2.3 Establish a pavilion | 220000yuan | 220,000 |
| 9.2.4 Walking path 1km | 1km*50000yuan/km | 50,000 |
| 9.2.5 Fishing facilities | 20*5000yuan | 100,000 |
| 9.2.6 Establish two bird watching towers | 2?*35000yuan | 70,000 |
| 9.3Training of tourist guides 10 | 10persons*10,000 | 100,000 |
| 10: Promotion of community development in and around protected area | | 1,000,000 |
| 10.1 Fish breeding | 1,000,000 | 1,000,000 |
| 11: Undertake applied and targeted research on mangrove ecosystems to benefit Reserve management | | 500,000 |
| 11.1 Research on quantification of ecological, social and economic benefits generated by mangrove in the Reserve | 200,000 | 200,000 |

| | | |
|---|---|---|
| 11.2 Research on productivity of the mangrove wetland ecosystem | 200,000 | 200,000 |
| 11.3 Research on ecological monitoring of the mangrove wetland ecosystem | 100,000 | 100,000 |
| 12: Strengthening protection of rare bird species | | 600,000 |
| 12.1 Equipment for the field work | 100,000 | 100,000 |
| 12.2 Establish a waterbird monitoring center | 500,000 | 500,000 |
| 13: Increased protection of rare and endangered mangrove species | | 500,000 |
| 13.1 Establish a conservation and research center for mangrove genetic resources | 500,000 | 500,000 |
| 14: Protection of endangered mammals | | 100,000 |
| 14.1 Mammals resources monitoring and management | 100,000 | 100,000 |
| 15: Baseline survey of resources in the reserve | | 582,000 |
| 15.1 Baseline survey of | 6group*6persons*60day*200yuan/day | 432,000 |

| | | |
|---|---|---|
| resources in the reserve | | |
| 15.2 Report and map publication | 150,000 | 150,000 |
| 16: Establishment of an ecological monitoring programme | | 800,000 |
| 16.1 Establishment and running of ecological monitoring stations and system | | 500,000 |
| 16.2 Equipment for the mornitoring | | 200,000 |
| 16.3 Remote sensing and GIS apply in dynamic monitoring | | 100,000 |
| 17: Developing a Dongzhaigang Biodiversity Database | | 200,000 |
| 17.1 Set up a database of Reserve resources | 200,000 | 200,000 |
| 18: Wise use of marine and inter-tidal resources | | 100,000 |
| 18.1 Develop a regulation on fishing in the reserve | 100,000 | 100,000 |
| 19: Development of medicinal plant resources | | 200,000 |
| 19.1 Development of medicinal plant | 200,000 | 200,000 |

| | | |
|---|---|---|
| **20: Develop and implement an applied research programme for endangered species conservation** | | **500,000** |
| **20.1Development of Action Plans for endangered bird species** | **100,000** | **100,000** |
| **20.2Development of Action Plans for rare mangrove plant species** | **100,000** | **100,000** |
| **20.3Experiments on propagation of endangered and economically important mangrove species** | **100,000** | **100,000** |
| **20.4Experiments on culture of marine shellfish of high economic value** | **100,000** | **100,000** |
| **20.5Experiments on development and utilization of medicinal plants.** | **100,000** | **100,000** |
| **21: Increase public education and outreach to local communities** | | **200,000** |
| **21.1 Develop TV and broadcast education program** | **100,000** | **100,000** |
| **21.2 Develop information boards and posters** | **50,000** | **50,000** |

| | | |
|---|---|---|
| 21.1 Award to encourage community involve in the environment education activities | 50,000 | 50,000 |
| 22: Increase environmental education to local schools and children | | 200,000 |
| 22.1 Organizing of camps for pupils | 10times*20,000 | 200,000 |
| 23: Promotion of awareness through ecotourism | | 1,100,000 |
| 23.1 Print booklets on nature conservation | 100,000 | 100,000 |
| 23.2 Establish an education center | 1000$m^2$ *750yuan/$hm^2$ | 750,000 |
| 23.3 Education equipment and facilities | 200,000 | 200,000 |
| 23.4 Set up exhibition windows | 50,000 | 50,000 |
| 24: Strengthening of staff training | | 750,000 |
| 24.1 Long term training 10 person time | 10persons*20000yuan/person | 200,000 |
| 24.2 Short term training course 10 times | 10times*40000yuan | 400,000 |
| 24.3 3 persons overseas | 3persons*50000yuan/person | 150,000 |

| | | |
|---|---|---|
| study tour | | |
| 25: Scientific planning and management of inter-tidal mudflat resources | | 100,000 |
| 25.1 Scientific planning of mudflat resources | 100,000 | 100,000 |
| 26: Controlling point-source of land based pollutants in the Reserve catchment | | 200,000 |
| 26.1 Planning and implementation of control land sources of pollutants | 200,000 | 200,000 |
| 27: Controlling potential polluting impacts of tourism | | 200,000 |
| 27.1 Planning and implementation of Control pollutants brought by tourists | 200,000 | 200,000 |
| 28: Controlling oil pollution caused by boats | | 200,000 |
| 28.1 Planning and implementation of Control oil pollution caused by boats | 200,000 | 200,000 |
| TOTAL | | 23,571,500 |

**4.2 Funding sources**

The fund for implementation of the Management Plan will be provided by the responsible authorities of national, provincial and municipal governments. In the meantime financial and technical assistance will also be sought from national and international sources.

### 4.3 Project benefits and risk assessment

The effective implementation of the Management Plan will provide the following benefits:

- Environmental benefits: including the conservation of biodiversity and improvement of eco-environment;
- Social benefits: Ecotourism will increase employment opportunities. The living and cultural level of the reserve staff and surrounding communities will also be improved;
- Economic benefits: The diversified economy and the joint economy of local communities will increase economic income;
- Management benefits: The full use of human resources, improved institutional mechanism and community-involved management will improve management level.

The possible risks during the project implementation include:

The low institutional capacity of the nature reserve management office; insufficient involvement of local communities in nature reserve and uncertainty of funding sources. A major risk is the natural disasters such as unpredictable tropical storm surge.

### 4.4 Sustainable development of the National Nature Reserve

The management level and public awareness will be improved through the implementation of Management Plan and thus the sustainable development of the Reserve can be probably achieved.

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## Chapter 5. Review and Modification

### Independent review mechanism

The Reserve management authority will make timely modification and revision to the goals and corresponding activities of the management plan based on its implementation and regular

independent reviews. This will ensure coordination and compliance between the management plan and the actual situation.

An independent Evaluation Group for Management Plan Implementation will be established. The Evaluation Group will be responsible for the annual evaluation to the management plan. The evaluations should include the implementation progress of the management plan and a review of weaknesses in the plan itself. Suggestions to the modification of the management plan based on changed circumstances should also be made in the evaluation.

The Reserve management authority will appoint specialists to modify and revise the management plan based on the evaluation report produced by the Evaluation Group. The revised management plan will be implemented after review and adoption.

**Appendix 1. Annual plan for implementation of the Dongzhaigang management plan**

| Activities | 2000 | | | | 2001 | | | | 2002 | | | | 2003 | | | | 2004 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| **1: Identifying and demarcating functional zones of the Nature Reserve and identifying main functions of each zone** | | | | | | | | | | | | | | | | | | | | |
| **1.1 Demarcating functional zones, map publication** | x | x | x | x | | | | | | | | | | | | | | | | |
| **2: Demarcating the reserve's boundary and setting up stakes and information signs** | | | | | | | | | | | | | | | | | | | | |
| **2.1 On-the-spot survey of the reserve boundary** | | | x | x | x | x | | | | | | | | | | | | | | |
| **2.2 Set up 600 concrete boundary stakes** | | | | | x | x | x | x | | | | | | | | | | | | |
| **2.3 Set up 100 education boards** | | | | | | | x | x | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3: Strengthening organization and capacity of management staff** | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **4: Strengthening Reserve infrastructure** | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | |
| **5: Reinforcement of Reserve management regulations** | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **5.1 Develop a regulation on management of the NR** | | | | | x | x | x | x | | | | | | | | | | | | |
| **6: Establishment of Joint Leading Group to oversee Reserve management** | | | | | | | | | | | | | | | | | | | | |
| **6.1 Establish a joint management committee and running** | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **7: Restoration of the mangrove ecosystem** | | | | | | | | | | | | | | | | | | | | |
| **7.1 Establish a 2 ha nursery** | x | x | x | x | | | | | | | | | | | | | | | | |
| **7.2 Restoration of mangrove ecosystem 135 $hm^2$** | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **8: Increase area of rare mangrove species** | | | | | | | | | | | | | | | | | | | | |
| **8.1 Mangrove reforestation 70 $hm^2$** | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **9: Development of sustainable ecotourism based on mangrove forest resource** | | | | | | | | | | | | | | | | | | | | |
| **9.1Conduct a carrying capacity analysis** | x | x | x | x | | | | | | | | | | | | | | | | |
| **9.2construction of eco-tourist facilities** | | | x | x | x | x | x | x | x | x | | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.3Training of tourist guides 10 | | | | | x | x | x | x | | | | | | | | | | | | |
| 10: Promotion of community development in and around protected area | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 10.1 Fish breeding | | | x | x | x | x | | | | | | | | | | | | | | |
| 11: Undertake applied and targeted research on mangrove ecosystems to benefit Reserve management | | | | | | | | | | | | | | | | | | | | |
| 11.1 Research on quantification of ecological, social and economic benefits generated by mangrove in the Reserve | | | | | | | | | x | x | x | x | x | x | x | x | | | | |
| 11.2 Research on productivity of the mangrove wetland ecosystem | | | | | | | | | | | | | x | x | x | x | x | x | x | x |
| 11.3 Research on ecological monitoring of the mangrove wetland ecosystem | x | x | x | x | x | x | x | x | | | | | | | | | | | | |
| 12: Strengthening protection of rare bird species | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 12.1 Equipment for the field work | x | x | x | x | | | | | | | | | | | | | | | | |
| 12.2 Establish a waterbird monitoring center | | | | | | | | | x | x | x | x | | | | | | | | |
| 13: Increased protection of rare and endangered mangrove species | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 13.1 Establish a conservation and research center for mangrove genetic resources | | | | | | | | | | | | | x | x | x | x | | | | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **14: Protection of endangered mammals** | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **15: Baseline survey of resources in the reserve** | | | | | | | | | | | | | | | | | | | | |
| **15.1 Baseline survey of resources in the reserve** | | | x | x | x | x | x | x | | | | | | | | | | | | |
| **15.2 Report and map publication** | | | | | | | | | x | x | x | x | | | | | | | | |
| **16: Establishment of an ecological monitoring programme** | | | | | | | | | | | | | | | | | | | | |
| **16.1 Establishment and running of ecological monitoring stations and system** | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **17: Developing a Dongzhaigang Biodiversity Database** | | | | | | | | | x | x | x | x | | | | | | | | |
| **18: Wise use of marine and inter-tidal resources** | | | | | | | | | | | | | | | | | | | | |
| **18.1 Develop a regulation on fishing in the reserve** | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **19: Development of medicinal plant resources** | | | | | | | | | x | x | x | x | | | | | | | | |
| **20: Develop and implement an applied research programme for endangered species conservation** | | | | | | | | | | | | | | | | | | | | |
| **20.1Development of Action Plans for endangered bird species** | | | x | x | x | x | x | x | | | | | | | | | | | | |
| **20.2Development of Action Plans for** | | | | | x | x | x | x | x | x | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| rare mangrove plant species | | | | | | | | | | | | | | | | | | | |
| 20.3Experiments on propagation of endangered and economically important mangrove species | | | | | | | | x | x | x | x | x | x | | | | | | |
| 20.4Experiments on culture of marine shellfish of high economic value | | | | | | | | | | | | x | x | x | x | x | x | | |
| 20.5Experiments on development and utilization of medicinal plants. | | | | | | | | | | | | | | x | x | x | x | x | x |
| 21: Increase public education and outreach to local communities | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 22: Increase environmental education to local schools and children | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 23: Promotion of awareness through ecotourism | | | | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 23.1 Print booklets on nature conservation | | | x | x | x | x | | | | | | | | | | | | | |
| 23.2 Establish an education center | | | | | | | x | x | x | x | | | | | | | | | |
| 24: Strengthening of staff training | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| 25: Scientific planning and management of inter-tidal mudflat resources | | | | | | | | | | | | | | | | | | | |
| 25.1 Scientific planning of mudflat resources | | | x | x | x | x | | | | | | | | | | | | | |
| 26: Controlling point-source of land based | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **pollutants in the Reserve catchment** | | | | | | | | | | | | | | | | | | | | |
| **26.1 Planning and implementation of control land sources of pollutants** | | | | | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | | | | | | | | |
| **27: Controlling potential polluting impacts of tourism** | | | | | | | | | | | | | | | | | | | | |
| **27.1 Planning and implementation of Control pollutants brought by tourists** | | | | | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | | | | | | | | |
| **28: Controlling oil pollution caused by boats** | | | | | | | | | | | | | | | | | | | | |
| **28.1 Planning and implementation of Control oil pollution caused by boats** | | | | | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | | | | | | | | |

**Appendix 2. The list of mangrove species in Dongzhaigang Nature Reserve**

| Scientific name |
|---|
| Bruguiera gymnorrhiza (L.) Lamk. |
| B.sexangula (Lour.) Poir. |
| B.sexangula var. rhynchopetala Ko |
| Ceriops tagal (Perr.) C.B.Rob. |
| Kandelia candel (L.) Druce |

| |
|---|
| Rhizophora stylosa Griff |
| Rhizophora apiculata Bl. |
| Lumnitzera racemosa (Jack.) Voigt |
| L. littorea (L.) Gaertn |
| Sonneratia caseolaris (L.) Engl. |
| S. hainanensis Ko |
| S. paracaseolaris |
| S. ovata Backer |
| S. alba J.Smith |
| S. apetala Buch.-Ham. |
| Aegiceras corniculatum Blanco |
| Acanthus ebrecteatus Vahl. |
| A. ilicifolius L. |
| Avicennia marina (Forsk.) Vierh. |

| |
|---|
| Nypa fruticans Wurmb. |
| Acrostichum aureum L. |
| A. speciosum Willd. |
| Excoecaria agallocha L. |
| Scyphiphora hydrophyllacea Gaertn.f. |
| Xylocarpus granatum Koenig |
| Heritiera littoralia (Dryand.) Ait. |

*Introduced Species

**The List of semi-mangrove species and mangrove associated species in Dongzhaigang Nature Reserve**

| **Scientific name** |
|---|
| Barringtonia racemosa Roxb. |
| Hibiscus tiliaceus L. |
| Thespesia populnea (L.) Solandex Correa |
| Cerbera manghas Linn. |

| |
|---|
| Dolichandrone spathacea Sch. |
| Ipomoea pes-caprae (L.) Sweet |
| Sesuvium portulacastrum L. |
| Suaeda australis (R.Br.) Moq |
| Atriplex repens Roth. |
| Casearia menbranacea Hance |
| Terminalis catappa L. |
| Calophyllum inophyllum L. |
| Caesalpinia crista L. |
| C. nuga (L.) Ait |
| Derris trifoliata Lour. |
| Pongamia pinnata (L.) Merr. |
| Canavala maritina (Aubl.) Thou |
| Dalbergia torta Crah. |

| |
|---|
| Erythrina variegata var. orientalis (L.) Merr. |
| Maytenus diversifolius (Maxim) Hou |
| Clerodendron inerme (L.) Gaertn. |
| Vitex trifolia var. simplicifolia Cham |
| Limonium sinense (Gerard) Kuntze |
| Scaevola hainanensis Hance |
| Scaevola sericea Vahl. |
| Morinda citrifolia L. |
| Pluchoa indica (L.) Less |
| Wedelia biflora (L.) Dc. |
| Launaea sarmentosa (Eilld.) Merr. |
| Caryota ochlandra Hance |
| Cocos nucifera L. |
| Pandanus tectorius Sol. |

| |
|---|
| Fimbristylis sericea (Poir.) R. Br. |
| Fimbristylis ferruginea (L.) Vahl. |
| Paspalum distichum L. |
| Paspalum var. distichum (L.) Kunth |
| Zoysia matrella (L.) Merr. |
| Ischaemum barbatum Retz. |
| Phragnites karka (Retz.) Trin |
| Spinfex littoreus (Burm.f.) Merr. |

**Appendix 3. The List of Bird Species in Hainan Dongzhaigang Nature Reserve**

| English Name | Scientific Name | |
|---|---|---|
| Red-throated Diver | Gavia stellata | * |
| Little Grebe | Podiceps ruficollis | |
| Common Cormorant | Phalacrocorax carbo | |
| Grey Heron | Ardea cinerea | |

| | | |
|---|---|---|
| Purple Heron | Ardea purpurea | * |
| Little Green Heron | Butorides striatus | |
| Chinese Pond Heron | Ardeola bacchus | |
| Cattle Egret | Bubulcus ibis | |
| Large Egret | Egretta alba | * |
| Little Egret | Egretta garzetta | |
| Chinese Egret | Egretta eulophotes | |
| Intermediate Egret | Egretta intermedia | * |
| Black-Crowned Night Heron | Nycticorax nycticorax | * |
| Cinnamon Bittern | Ixobrychus cinnamomeus | |
| Little Bitten | Ixobrychus minutus | * |
| Chinese Night Heron | Gorsachius magnificus | |
| Great Bittern | Botaurus stellaris | * |

| | | |
|---|---|---|
| Spoonbill | Platalea leucorodia | * |
| Black-faced Spoonbill | Platalea minor | * |
| Bean Goose | Anser fabalis | * |
| Greylag Goose | Anser anser | |
| Common Teal | Anas crecca | * |
| Baikal Teal | Anas formosa | * |
| Falcated Teal | Anas falcata | * |
| Wigeon | Anas penelope | * |
| Garganey | Anas querquedula | * |
| Cotton Teal | Nettapus coromandelianus | |
| Black-winged Kite | Elanus caeruleus | |
| Black Kite | Milvus korschun | |
| Sparrow Hawk | Accipiter nisus | |
| Buzzard | Buteo buteo | |

| | | |
|---|---|---|
| Marsh Harrier | Circus aeruginosus | * |
| Osprey | Pandion haliaetus | |
| Peregrine Falcon | Falco peregrinus | |
| Kestrel | Falco tinnunculus | |
| Blue-breasted Banded Rail | Rallus striatus | |
| Ruddy Crake | Porzana fusca | * |
| White-breasted Waterhen | Amaurornis phoenicurus | |
| Water Cock | Gallicrex cinerea | * |
| Moorhen | Gallinula chloropus | * |
| Coot | Fulica atra | |
| Pheasant-tailed Jacana | Hydrophasianus chirurgus | |
| Painted Snipe | Rostratula benghalensis | * |
| Spur-winged Lapwing | Vanellus duvaucelii | |

| | | |
|---|---|---|
| Grey Plover | Pluvialis squatarola | * |
| Eastern Golden Plover | Pluvialis dominica | * |
| Little Ringed Plover | Charadrius dubius | |
| Ringed Plover | Charadrius hiaticula | |
| Kentish Plover | Charadrius alexandrinus | |
| Lesser Sand Plover | Charadrius mongolus | * |
| Large Sand Plover | Charadrius leschenaultii | * |
| Eurasian Curlew | Numenius arquata | * |
| Eastern Curlew | Numenius madagascariensis | * |
| Whimbrel | Numenius phaeopus | * |
| Black-tailed Godwit | Limosa limosa | * |
| Spotted Redshank | Tringa erythropus | * |
| Common Redshank | Tringa totanus | * |
| Marsh Sandpiper | Tringa stagnatilis | * |

| | | |
|---|---|---|
| Greenshank | Tringa nebularis | * |
| Green Sandpiper | Tringa ochropus | * |
| Wood Sandpiper | Tringa glareola | * |
| Common Sandpiper | Tringa hypoleucos | * |
| Grey Sandpiper | Tringa incana | * |
| Terek Sandpiper | Xenus cinerea | * |
| Turnstone | Arenaria interpres | * |
| Swinhoe’s Snipe | Capella megala | * |
| Pintail Snipe | Capella stenura | |
| Fantail Snipe | Capella gallinago | * |
| Red Knot | Calidris canutus | * |
| Red-necked Stint | Calidris ruficollis | * |
| Long-toed Stint | Calidris subminuta | * |
| Sharp-tailed Sandpiper | Calidris acuminata | * |

| | | |
|---|---|---|
| Dunlin | Calidris alpina | * |
| Curlew Sandpiper | Calidris ferrugines | * |
| Broad-billed Sandpiper | Limicola falcinellus | * |
| Sanderling | Crocethia alba | * |
| Red-necked Phalarope | Phalaropodidae | * |
| Great Stone Plover | Esacus magnirostris | |
| Common Gull | Larus canus | * |
| Herring Gull | Larus argentatus | * |
| Black –headed Gull | Larus ridibundus | * |
| Saunder's Gull | Larus saundersi | |
| Whiskered Tern | Chlidonias hybrida | |
| White-winged Black Tern | Childonias leucoptera | |
| Gull-billed Tern | Gelochelidon nilotica | |
| Caspian Tern | Hydroprogne | |

| | | |
|---|---|---|
| | tschegrava | |
| Black-naped Tern | Sterna sumatrana | * |
| Brown-winged Tern | Sterna anaethetus | * |
| Little Tern | Sterna albifrons | * |
| Short-billed Guillemot | Synthliboramphus antiquus | * |
| Rufous Turle Dove | Streptopelia orientalis | |
| Spotted Dove | Streptopelia chinensis | |
| Red Turtle Dove | Oenopopelia tranquebarica | |
| Orange-breasted Green Pigeon | Treron bicincta | |
| Indian Cuckoo | Cuculus micropterus | |
| Himalayan Cuckoo | Cuculus saturatus | * |
| Crow | Centropus sinensis | |
| Lesser Crow Pheasant | Centropus toulou | |

| | | |
|---|---|---|
| Collared Scops Owl | Otus bakkamoena | |
| Large White-rumped Swift | Apus pacificus | * |
| House Swift | Apus affinis | * |
| Pied Kingfisher | Ceryle lugubris | |
| Lesser Pied Kingfisher | Ceryle rudis | |
| Common Kingfisher | Alcedo atthis | |
| Three-toed Kingfisher | Ceyx erithacus | |
| White-breasted Kingfisher | Halcyon smyrnensis | |
| Black-capped Kingfisher | Halcyon pileata | |
| Hoopoe | Upupa epops | |
| Lesser Skylark | Alauda gulgula | |
| House Swallow | Hirundo rustica | * |
| Yellow Wagtail | Motacilla flava | * |

| | | |
|---|---|---|
| Grey Wagtail | Motacilla cinerea | |
| Pied Wagtail | Noracilla alba | * |
| Padd-field Pipit | Anthus novaeseelandiae | * |
| Oriental Tree Pipit | Anthus hodgsoni | * |
| Chinese Bulbul | Pycnonotus sinensis | |
| Black Bulbul | Hypsipetes madagascariensis | |
| Rufous-backed Shrike | Lanius schach | |
| Black Drongo | Dicrurus macrocercus | |
| Bronze Drongo | Dicrurus aeneus | |
| Grey-backed Starling | Sturnus sinensis | |
| House Myna | Acridotheres tristis | |
| Crested Myna | Acridotheres cristatellus | |
| Crackle | Ggracula religiosa | |

| | | |
|---|---|---|
| Swinhoe's Red-tailed Robin | Luscinia sibilans | * |
| Siberian Rubythroat | Luscinia calliope | * |
| Red –Flanked Bush Robin | Tarsiger cyanurus | * |
| Magpie Robin | Copsychus saularis | |
| Stonechat | Saxicola torquata | |
| Blue Rock Thrush | Monticola solitarius | |
| Grey-backed Thrush | Turdus hortulorum | * |
| Grey Thrush | Turdus cardis | * |
| Blackbird | Turdus merula | |
| Spectacled Laughing Thrush | Garrulax perspicillatus | |
| Greater Necklaced Laughing Thrush | Garrulax pectoralis | |
| Black-throated Langhing Thrush | Garrulax chinensis | |

| | | |
|---|---|---|
| Hwamei | Garrulax canorus | |
| Could’s Tit Babbler | Alcippe brunnea | |
| Pale-footed Bush Warbler | Cettia pallidipes | |
| Scaly-headed Bush Warbler | Cettia squameiceps | * |
| Singing Bush Warbler | Cettia diphone | |
| Dusky Willow Warbler | Phylloscopus fuscatus | |
| Thick-billed Willow Warbler | Phylloscopus schwarzi | |
| Yellow-browed Willow Warbler | Phylloscopus inornatus | * |
| Rufous Fantail Warbler | Cisticola juncidis | |
| Long-tailed Tailor Bird | Orthotemus sutorius | |
| Greater Brown Wren Warbler | Prinia subflava | |
| Yellow Bellied Wren Warbler | Prinia flaviventris | |

| | | |
|---|---|---|
| Brown Flycatcher | Muscicapa latirostris | * |
| Ferruginous | Muscicapa ferruginea | |
| Fork-tailed Sunbird | Aethopyga christinae | |
| Yellow-breasted Sunbird | Nectarinia jugularis | |
| Dark Green White-eye | Zosterops japonica | |
| Tree Sparrow | Passer montanus | |
| Spotted Mannikin | Lonchura punctulata | |
| Chestnut Mannikin | Lonchura malacca | |
| Yellow-breasted Bunting | Emberiza aureola | |
| Grey-headed Black-faced Bunting | Emberiza spodocephala | * |
| Gray Tree Pie | Crypsirina formasae | * |

(Protect level)

* (Listed in the China-Japan and China-Australia Migratory Bird Protection Agreement)

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**Appendix 4. The List of fish Species in Dongzhaigang Nature Reserve**

| Scientific name | Scientific name |
|---|---|
| Triakidae | Nibea albifora (Richardson) |
| Mustelus griscus (Pietschmann) | Leiognathidae |
| Elopidae | Leiognathus equulus(Forskal) |
| Elope saurus Linnaeus | Leiognathus bindus (Cuvier et Valenciennes) |
| Megalopidae | Gerridae |
| Megalops cyprinoides(Broussonet) | Gerreomorpha decacantha(Bleeker) |
| Cluperdae | Lutjanidae |
| Harengula ovalis(Bennett) | Lujtanus russelli Bleeker |
| Clupannodon punctatus(Schlegel) | Sparidae |
| Llisha indica(Swainson) | Taius tumifrons (Temminck et Schlegel) |
| Engraulidae | Sparus latus Houttuyn |
| Anchoviella tri(Bleeker) | Pomadasyidae |
| Ophichthyidae | Parapristipoma trilineatum(Thunberg) |

| | |
|---|---|
| Trachinocephalus myops(Bl) | Theraponidae |
| Muaenesocidae | Theraapon jarbua(Forskal) |
| Muraenesox talabonoides(Blecker) | Mullidae |
| Ophichthyidae | Upeneus Luzonius Jordan et Scale |
| Cirrhimuraena chinensis | Ephippidae |
| Pisoodonophis boro(Hamilton Buchanan) | Ephippus orbis (Bloch) |
| Pisoodonophis csnerivorous(Richardson) | Drepanidae |
| Ophichthys apicalis(Bennett) | Drepane punctata(Linnacus) |
| Muraenidae | Congrogadidae |
| Thyrsoidea macrurus(Beeker) | Congrogadus Subducens (Richardson) |
| Belonidae | Ammodytidae |
| Tylosurus strongylurus(van haaaselt) | Bleekeria anguillivirdis(Fowler) |
| Hemirhamphidae | Siganidae |
| Hemihamphus dussumieri Cuvier et Valenciennes | Siganus fuscescens(Houttuyn) |

| | |
|---|---|
| Sphyraenidae | Trichiuridae |
| Sphyraena jello Cuvier et Valenciennes | Trichiurus haumela(Forskal) |
| Mugilidae | Eleotridae |
| Mugil carinatus Cuvier et Valenciennes | Butis butis(Hamilton) |
| Mugil offinis Gunther | Gobiidae |
| Polynemidae | Oxyurichthys microlepis |
| Eleutheronema tetradactylus(Shaw) | Acentrogobius viridipunctaatus (Cuvier et Valenciennes) |
| Serranidae | Acentrogobius caninus (Cuvier et Valenciennes) |
| Epomepjelis mapabarcrs (Bloch et Schncider) | Ctenogobius criniger (Cuvier et Valenciennes) |
| Lates calcarfer(Bloch) | Scorpaenidae |
| Carangidae | Sebastcus marmoratus (Cuvier et Valenciennes) |
| Caxanx equula Temminck et Schlegel | Triglidae |
| Caranx Sexfasciatus Quoy et Gaimard | Lepidotrigla kanagashira Kamohara |

| | |
|---|---|
| Caranx ignobills(Forskal) | Soleidae |
| Caranx kalla(Cuvier et Valenciennes) | Brachirus orientalis |
| Caranx mate(Cuvier et Valenciennes) | Pardachirus pavoninus |
| Caranx malam(Bleeker) | Cynoglossidae |
| Seriola dumerili(Richardson) | Paraplagusia bilineata |
| Sciaenidae | Periophthalmiddae |
| Otilithes argenteus Cuvier | Scartelaos viridis |
| Sciaena russelli(Cuvier et Valenciennes) | |

**Appendix 5. The list of benthons in Dongzhaigang Nature Reserve**

| **Scientific name** | **Scientific name** |
|---|---|
| PLATYHELMINTHES | Tellina virgata |
| Parap1anocera.sp | Tellinides timorensis |
| ANNELIDA | Merisca diaphana |
| Nectoneanthes oxypoda | Cyclotellina remies |

| | |
|---|---|
| Perinereis aibuhitensis | Macoma(Psammacoma) candida |
| G1ycera chirori | Sinonovacula constricta |
| Tylonereis bogoyawlesky | Pharella acutidens |
| Nama1ycastis aibiuma | Pitar?Pitarinum?striaum |
| Notomastus latericeus | Dosinia?Phacosoma?cumingii |
| Limnodriloides sp | Gafrarium tumidum Roding |
| Pontodrilus sp? | Circe stutzeri |
| SIPUNCULA | Meretrix lusoria |
| Phascolosoma escu1enta | Meretrix lusoria |
| MOLLUSCA | Anomalodiscus squamosus |
| Tegil1arca granosa | Clausinella calopblla |
| Arcopsis sculptilis | Clausinella isabellina |
| Arcopsis interplicata | Cyclina sinensis |
| Modiolus?Fulgida? f1avidu | Marcia hiantina |

| | |
|---|---|
| Placuna?P1acuna?placenta | Tapes dorsalus |
| Hyotissa hyotis | Cryptonema producta |
| Ostrea mordax | Sepia aculeata |
| Crassostrea rivu1aris | ARTHR0P0DA |
| Vignadu1a artata | Metapenaeus intermedius |
| potamocorbu1a rubromuscula | Penaeus?Penaeus?monodon |
| Venerilae | Penaeus merguiensis |
| Pectinidae | Palaemon serrifer |
| Ilommya mutabilis | Alpheus distinguendus |
| Laternu1a (Exo1aternu1a?truncat | Philyra carinat |
| Clithom oualaniensisa | Scylla serrata |
| Bithynia fuchsiana | Sesarma picta |
| Turritel1a bacillum | Sesarma plicatu |
| Cerithidea cingu1ata | Portunus pelagicus |

| | |
|---|---|
| Batil1aria zonalis | portunus sanguinolentus |
| Cerithidea rhizophorum | Portunus trituberculatus |
| Terebralia sulcta | Mictyris longicarpus |
| Umbonium uestiarium | Uca?Thalassuca?borealis |
| Chicoreus ramosus | Uca arcuata |
| Naticidae | Uca lactea |
| Turridae | Macrophthalmus(Mareotis) erato |
| Neritina violaea | Leipocten trigranulum |
| Neritina achatina | Ilyoplax serra |
| Littorinopsis scabra | Macrophthalmus(Mareotis?pacificus |
| Littorinopsis intermedia | Metaplax sheni |
| Batil1aria cumingi | Anchisquilla fasciata |
| Nassarius(Reticunassa)festivus | Cloridopsis scorpio |
| Nassarius(Zeuxis) siquijorensis | Oratosquilla oratoria |

| | |
|---|---|
| Nassarius thesites | Oratosquilla kempi |
| Loligo duvaucelii | Tachypleus tudentatus |
| Littorinopsis melanostom | |

**Appendix 6. The List of Butterfly in the Dongzhaigang Nature Reserve**

| Scientific name |
|---|
| Papille demolkeus |
| Papille polytes |
| Papille memnon |
| Graphium agamemnon |
| Graphium sarpedon |
| Dellas aglaja |
| Eurema hecabe |
| Ixias pyrene |
| Salatura agenutia |

| |
|---|
| Euploae core |
| Euploea mulciber |
| Melanitis leada |
| Nymphalidea |
| Precis atlites |
| Precis almana |
| Precis lemonias |
| Precis iphita |
| Precis orithya |
| Phalanta phalantha |
| Cupha erymanthis |
| Hypolimnsa bolina |
| Neptis hylas |
| Rohana parisatis |

| |
|---|
| Vagrans egista |
| Lampides boeticus |
| Pseudozeerla maha |
| Hasora chromus |

**Appendix. 7. The list of mammals in the Dongzhaigang Nature Reserve**

| **Scientific Name** |
|---|
| Paguma Laryate |
| Tupaia glis modesta |
| Hystrix hodgson |
| Lutra lutra hainana Xu et Liu |
| Rousettus leschenaulti |
| Cynopterus sphinx |
| Ratufa bicolor |
| Callosciurus erythraeus |

**Appendix 8. Amphibians and Reptiles in Dongzhaigang Nature Reserve**

| Scientific name |
| --- |
| Rhacophorus leucomystax |
| Calotes versicolor |
| Rana limnocharis Boie |
| Bungarus fasciatus |
| Bungarus multicinctus |
| Naja naja |
| Python molurus |

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