

NEASPEC-NEAMPAN

The Final Review Report on the
Selected NEAMPAN Sites in China

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Abbreviation

AGRCZ-Aquatic Germplasm Resources Conservation Zone
COD- Chemical Oxygen Demand
CY-MSPA- Changyi National Marine Ecology Special Protected Area
DIN- Dissolved Inorganic Nitrogen
DIP- Dissolved Inorganic Phosphorus
DO- Dissolved Oxygen
DOC- Dissolved Organic Carbon
MEE- Ministry of Ecology and Environment, PR. China
MEP- Ministry of Environment Protection
MNR- Marine Nature Reserve
MNR- Ministry of Natural Resources, PR. China
MPA- Marine Protected Area
MSPA- Marine Special Protected Area
NEAMPAN- North-East Asian Marine Protected Areas Network
NEASPEC- North-East Asian Subregional Programme for Environmental Cooperation
NFGA- National Forest and Grassland Administration, PR. China
NGO- Non-Government Organization
NJ-MNR- Nanji Islands National Marine Nature Reserve
NMDIC- National Marine Data and Information Center
NMEMC- National Marine Environment Monitoring Center
PA- Protected Areas
SOA- State Oceanic Administration, PR. China
SOM- Senior Officials Meeting
TSS- Total Suspended Solids

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Preface

MPA is a useful measure to protect the marine endangered species, marine biodiversity, marine ecosystem, marine natural relics, and other marine resource. China government is very concerned the marine protection by establishment of MPA. The first marine protected area in Liaoning Province in 1963. By successive efforts, there is more than 270 MPAs was setup along China coast up to the end of 2017, which covered around 4.6% of China coast area.

MPAs are established mainly according the “Marine Environment Protection Law of PR. China”, in which regulate two types of MPA, i.e. Marine Nature Reserve and Marine Special Protected Area. At the meanwhile, MPA could be divided by national level and local level in China based on the importance of protected targets. National MPA means the protected target is valued and important nationwide, and local level MPA means the protect target is only important and represented in the local scale. There are 101 national level MPAs in China, which are managed by different authorities of central government.

Because of the historic reasons, at least four agencies involved in the MPA management in China. Ministry of Environment takes responsible for 7 national marine nature reserves, Bureau of Fishery in Ministry of Agriculture takes responsible for 3 national marine nature reserve, State Forest Administration takes responsible for 10 national marine nature reserve, while State Oceanic Administration takes responsible for 14 national marine nature reserve and other 67 national marine special protected areas. However, the conflicts happened frequently among different agencies because of their overlaid obligation. In order to strengthen the MPA management, the responsibility of MPA management is transfer to National Forest and Grassland Administration from other authorities during the re-organization of central government in 2018. It should be noted that with the structural change, there may be more changes in structures and modalities in MPA management for which information is not available at the time of writing.

International cooperation is a very useful pathway to enhance the effectiveness of MPAs, because many protected targets are migrating species, and moving seawater makes a quite open environment for MPAs. A MPA network could provide a better shelter for protected marine organism. That is the purpose of launching North-East Asian Marine Protected Areas Network (NEAMPAN) in 2013, which is approved by SOM-18 for North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC). China recommend six MPAs joined the NEAMPAN based on the 5 selected criteria, i.e. national level MPA, biodiversity or endangered species type, holding an independent management agency, English communication ability, and willingness.

As a part of activities of the NEAMPAN project “Strengthening the subregional cooperation through knowledge sharing on sustainable management of MPAs”, this report is trying to review and analyze how to improve the management measures by monitoring and assessment results for six selected MPAs in China, and further to share with other NEAMPAN sites to collectively improve knowledge and practices.

DRAFT

1 Review of management plans

1.1 Basic information of the NEAMPAN sites

There are six MPAs selected as the member to join NEAMPAN in 2014 from China, in which 5 MPAs belongs to the national natural reserve and another is marine special protected area. The list is shown below as Table 1.1 and all of them will be briefed respectively. Those six MPAs were selected and recommend joining NEAMPAN as the first batch among the whole 271 MPAs in China based on five criteria, i.e.

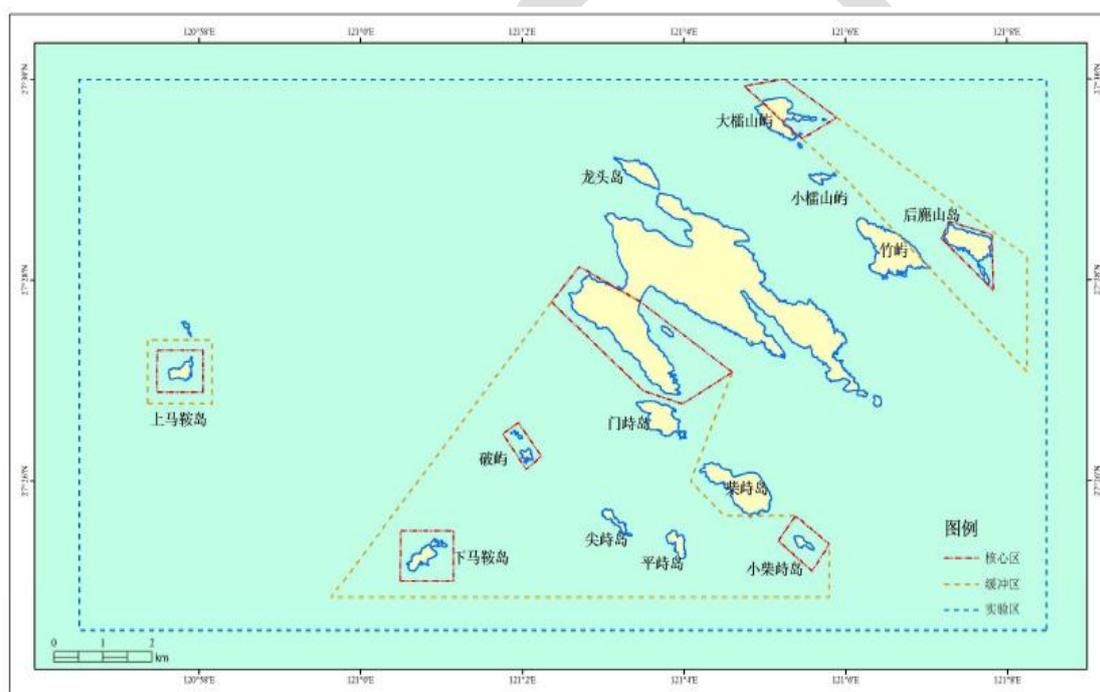
- (1) should be a national level MPA,
- (2) should have an independent management office,
- (3) with marine biodiversity, rare and endangered species as the protection targets,
- (4) enough capacity with English communication, and
- (5) willingness to join the NEAMPAN.

Table 1.1 List of MPAs of NEAMPAN sites in China

| No. | MPA's Name | Location | Area (hm ²) | Protected Targets |
|-----|--|------------------------|-------------------------|--|
| 1 | Nanji Islands National Marine Nature Reserve | Pingyang, Zhejiang | 20106 | Marine shellfish and algae as well as their habitats |
| 2 | Shankou Mangrove National Marine Nature Reserve | Hepu, Guangxi | 8000 | Mangrove ecosystem |
| 3 | Beilun Estuary National Marine Nature Reserve | Fangchenggang, Guangxi | 30000 | Mangrove ecosystem |
| 4 | National Nature Reserve of Dazhou Island Marine Ecosystems | Wanning, Hainan | 7000 | Swiftlet, its habitat and the marine ecological system |
| 5 | Sanya Coral Reef National Nature Reserve | Sanya, Hainan | 4000 | Coral reef and the marine ecological system |
| 6 | Changyi National Marine Ecology Special Protected Area | Changyi, Shandong | 2929 | <i>Tamarix chinensis</i> , marine organisms and coastal wetland ecosystems |

(1) Nanji Islands National Marine Nature Reserve

The Nanji Islands National Marine Nature Reserve belongs to the MPA types of marine ecosystems protected area, mainly protecting the shellfishes, algae, marine birds, wild daffodils and their habitats. The MPA is located in the southeast sea areas of Pingyang County, Zhejiang Province, with geographical coordinates of 120°56'30"E to 121°08'30"E and 27°24'30"N to 27°30'00"N. It is the bedrock hilly islands and consists of 52 islands, tens of bare/submerged rocks and the surrounding waters. The total area of it is 20,106 ha with 1,113 ha of land area and 18,993ha of sea area. The Nanji Islands has been listed as UNESCO's Marine Nature Reserve of World Biosphere Reserves in 1998 and selected as one of the four demonstration sites of GEF-supported project of Biodiversity Management in the Coastal Area of China's South Sea in 2002. In 2005, it was awarded by 23 new media as one of the ten most beautiful islands in China.



Key features:

Year designated: 1990

Conservation status: MNR

Area: 20106 hm², including 18993 hm² of sea waters

Range: 120°56'30"E-121°08'30"E、27°24'30"N-27°30'00"N,

Location: Pingyang, Zhejiang Province

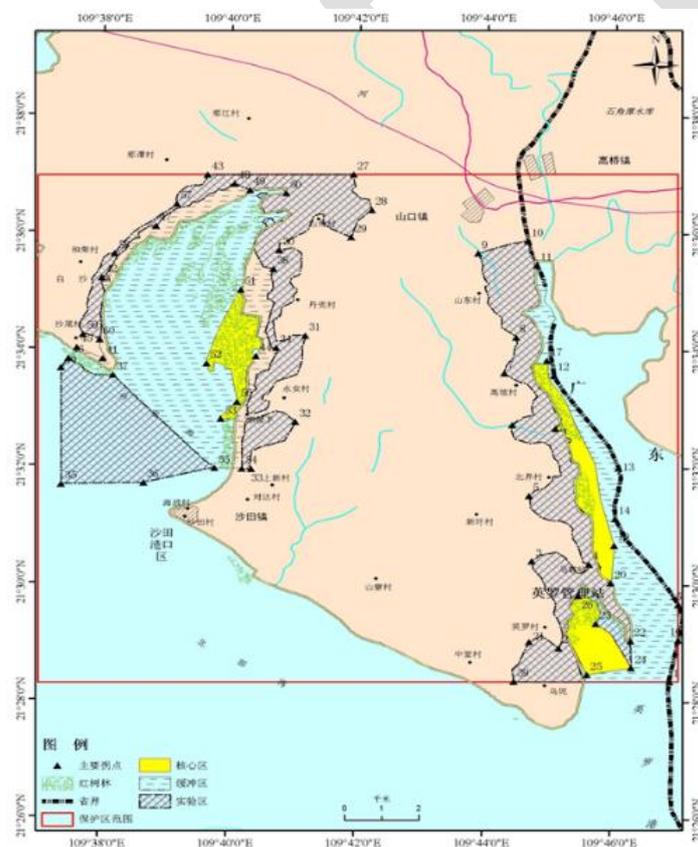
Protected Targets: marine shellfish and algae, birds and ecosystem

Management challenges: overexploitation, rapid development of tourism, infrastructure construction, mariculture, and nature environment quality degradation.

(2) Shankou Mangrove National Marine Nature Reserve

Shankou Mangrove National Marine Nature Reserve is located in Shankou Town, Beihai, Guangxi Province. The biosphere reserve includes mangroves, salt marshes and seagrass habitats, and this combination of three coastal habitats in a single location is rare along China's coast. Climate: tropical monsoon climate zone and tropical rainforest region, with thunderstorms, typhoons and strong tides frequently in spring and summer (annual average temperature: 23.4 °C; annual average precipitation: 1,700—2800 mm).

Land form: alluvial terrace - Long and narrow marine-deposition plains are formed among the terraces, shorelines and estuaries. The intertidal mudflat is wide and flat with deep silts. 16 mangrove species, 251 macro-benthos species, 5 nekton species, 36 zooplankton species, 20 plant plankton species, 118 bird species and 301 insect species are found here.



Key features:

Year designated: 1990

Conservation status: MNR

Area: 8000 hm²

Range: 109°37'00"E-109°47'00"E, 21°28'22"N-21°37'00"N

Location: Beihai, Guangxi Province

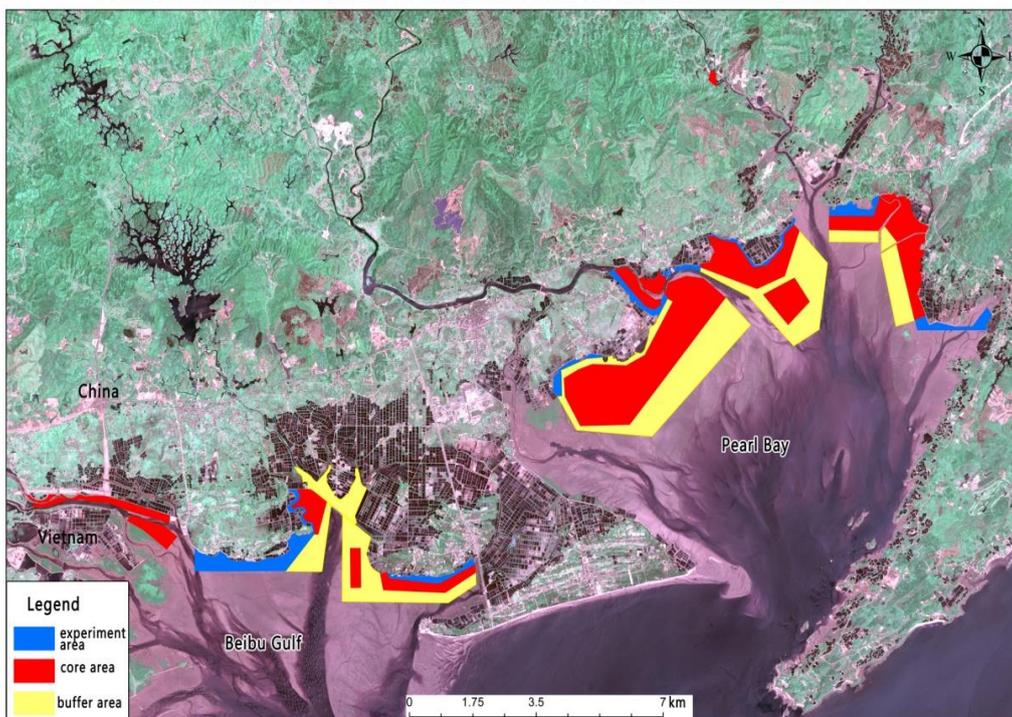
Protected Targets: Mangrove ecosystem

Management challenges: human activity, invasion species, sea surface rise, pollution.

(3) Beilun Estuary National Marine Nature Reserve

Guangxi Beilun Estuary National Nature Reserve is located in the north of Beilun River opposite Vietnam, and 180 km far southern to Nanning (the capital city of the province). It includes 105 km coastline, and covers 3 towns and 13 villages in Dongxing and the Fangcheng district of Fangchenggang. Mountains, mesa and uplands interlace with each other, and high mountains go rolling on the land side bordering upon the reserve, while the seaward side is full of estuaries and bays, as well as amplitude tidal flats. The reserve is dominated with mangroves, and it is the place where mangroves are largely distributed in China, with a relatively higher diversity of halobios and birds.

FUNCTIONAL REGIONALIZATION OF GUANGXI BEILUN ESTUARY NATIONAL NATURE RESERVE



Key features:

Year designated: 2000

Conservation status: MNR

Area: 30,000 hm²

Range: 21°31'00" - 21° 37' 30"N

108°00'30" - 108°16'30" E

Location: Fangchenggang, Guangxi Province

Protected Targets: Mangrove ecosystem, Coastal wetlands ecosystem, and Seagrass beds ecosystem

Management challenge: pollution, mangrove degradation, overfishing.

(4) National Nature Reserve of Dazhou Island Marine Ecosystems

National Nature Reserve of Dazhou Island Marine Ecosystems is located in Wanning, Hainan. Hainan Swiftlet and other swifts inhabit and breed here without seasonal migration. Dazhou MPA is abundant of wild animals and plant resources in the island. Natural plants have lush growth here and have over 95 percent coverage including four vegetation types which are groundling, grassland, brush and low forest. Abundant animals living here, such as: amphibians, reptiles, birds and mammals in the island. Dazhou MPA is rich in marine living resources with high biodiversity.



Key features:

Year designated: 1990

Conservation status: MNR

Area: 7000 hm²

Range: 110°26'50"E-110°32'06"E、18°37'06"N-18°43'54"N

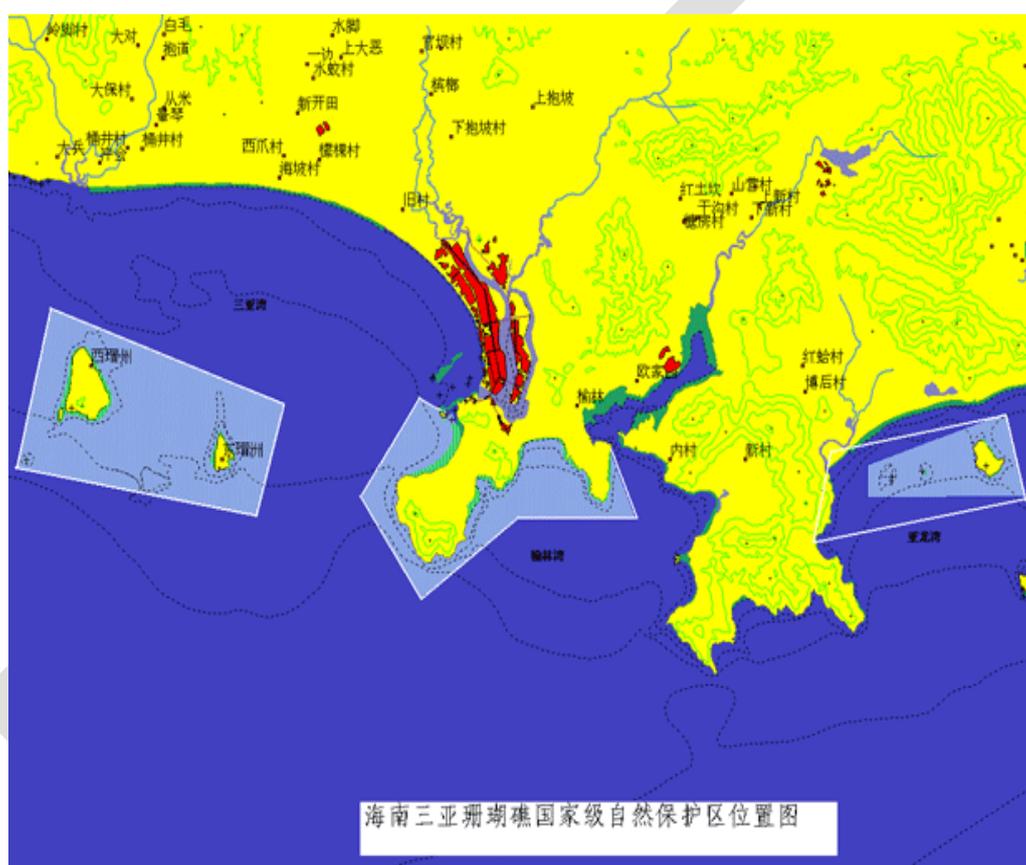
Location: Wanning, Hainan Province

Key Protected species: Swiftlet, its habitat and the marine ecological system

Management challenge: insufficient fund, illegal tourism, overfishing.

(5) Sanya Coral Reef National Nature Reserve

Sanya Coral Reef National Nature Reserve is located in Sanya, Hainan. It is the important area to protect the diversity of marine organism especially the coral reef. Differences in geomorphology are evident between the eastern, the western and the middle part: the eastern and western parts are typical island and the other is a peninsula with lots of capes and bays. In 1970-80s, coral reef were severely damaged due to human activity. Thus, in 1989, it was proposed by scientists that, this area should be protected. And in the next year, it was designated as national nature reserve to protect the coral reef and marine ecological system.



Key features:

Year designated: 1990

Conservation status: MNR

Area: 8500 hm²

Range: 109°20'50"E-109°40'30"E、18°10'30"N-18°15'30"N

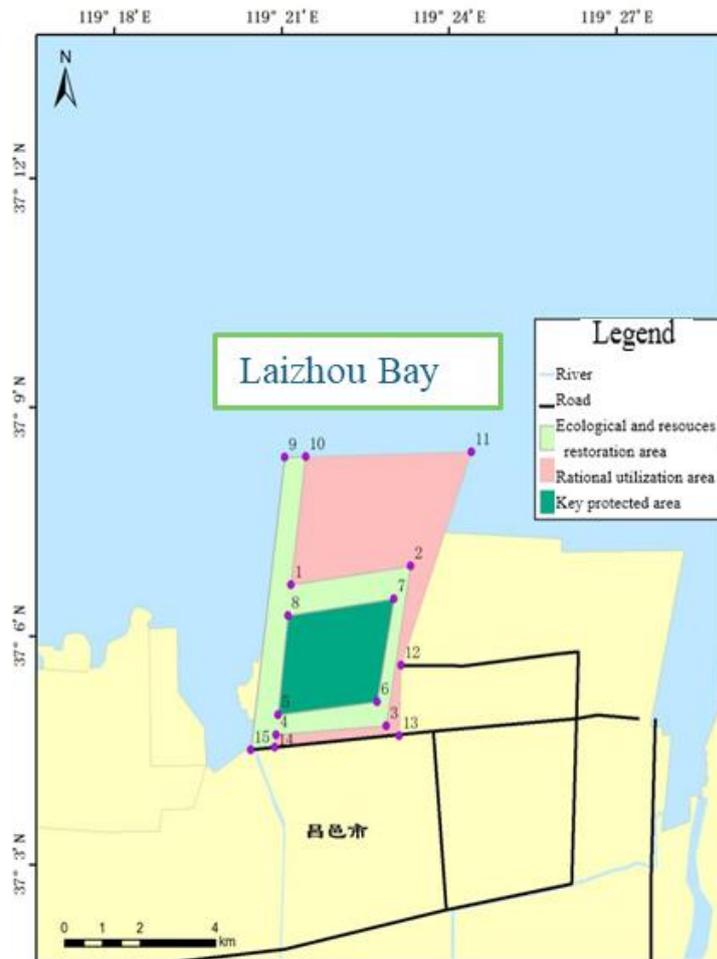
Location: Sanya, Hainan Province

Protected Targets: Coral reef and the marine ecological system

Management challenge: global climate change, environment pollution, human activity and insufficient fund.

(6) Changyi National Marine Ecology Special Protected Area

Changyi National Marine Ecology Special Protected Area is located in Changyi, Shandong Province. It's the only national MPA that protects mainly tamarisk of coastal wetland in China. Physical features: Flat topography and accumulated coastal plain, irregular and mixed semidiurnal tide, flood current of SW and ebb current of NE, low salinity of 30, five main rivers to sea including Yu river, Di river, Wei river, Pu river and Jiaolai river. Tamarisk could be used for cistanche (a Chinese herb) culture. And the coastal area has value of tourism. So Changyi was designated as MSPA for its sustainable use features.



Key features:

Year designated: 2007

Conservation status: MSPA

Area: 2929.28 hm²

Range: 119°20'09.30"E-119°24'13.21"E、37°04'25.74"N-37°08'15.47"N

Location: Changyi, Shandong Province

Protected Targets: tamarisk (*Tamarix chinensis*), marine organisms and coastal wetland ecosystems

Management challenge: insufficient fund, utilization activity, public awareness.

1.2 Background of MPA management plan

Management plan is a basic document for the daily management of MPA. It is a plan to use potential resources (human, financial and others) to carry out various activities to achieve the objectives of protection, management capacity, and resources utilization in view of challenge and threats faced at a certain time period.

Marine protected areas in China are categorized into three groups, with varying degree of restriction on human activities within the area. A brief introduction of Marine Nature Reserve (MNR), Marine Special Protected Area (MSPA) and Aquatic Germplasm Resources Conservation Zones (AGRCA) is provided as table 1.2 below.

(1) Marine Nature Reserves

Based on the “Management Measures for Marine Nature Reserves”, issued by the State Oceanic Administration (SOA) in 1995, the management plan of each national MNR should be prepared according to the *Technical regulations for the nature reserve master plan* (GB/T 20399-2006) and approved by SOA, which is authorized by the State Council as the ocean management authority in the central government. However, it is believed that obligation will be transferred to NFGA in 2019 because NFGA had been authorized with all kinds of protected areas management during the re-structure of central government.

For the management agency of respective national MNR, the obligation is very clear as bellows.

- Implementing the Law, Regulations, Guidelines and Policies of the State Concerning MNR;
- Formulating specific management measures, rules and regulations for MNR, and controlling all the activities inside the MNR;
- Drawing up the management plan of MNR;
- Installing boundary markers, landmarks and related protection facilities for MNR;
- organizing and carrying out basic investigations, regular monitoring and surveillance in MNR, as well as the documents and records management;
- Organizing the ecological restoration and scientific research in MNR;
- Carrying out publicity and public education on marine protection;

Table 1.2 Brief introduction of MNR, MSPA and ACRCZ

| | MNR | MSPA | AGRCZ |
|---------------------------------|--|---|--|
| Key legislation | <p>Marine Environment Protection Law of PRC, Article 21.</p> <p>National standard (GB/T17504-1998) Principles of type and level of classification of marine nature reserves</p> <p>National Standard (GB / T 19571-2004) Technical specifications of marine nature reserve management</p> | <p>Marine Environment Protection Law of PRC, Article 23.</p> <p>National Standard (GB / T 25054-2010) Selection technology guidelines of marine special protection areas</p> <p>Marine industry standards (HY/T118-2010) Technical guidelines for the preparation of overall planning, function zoning in marine special protection areas</p> | <p>Fisheries Law of PRC, Article 29.</p> |
| Nature of the MPAs | Typical ecosystem, | Special geographical location, Ocean park | Important habitat for protected aquatic organisms. |
| Objectives | Protection of nature | Sustainable use of resources | Protection of germplasmic resources and their habitat |
| Restriction of human activities | Human entry to core area is strictly prohibited in core area. | No construction activity in key protected area. | Human disturbance to core area is strictly prohibited. Fishing activity are allowed outside the core area. Fishing activity must obey Fisheries Law. |
| Target of management | <p>Natural relics and other resources.</p> <p>Ecosystem: mangrove, coral reef, salt marsh, estuary, bay, island, lagoon et al.</p> <p>Endangered species: amphioxus, spotted seals, dolphins, sea turtles and other rare and endangered marine species</p> <p>Others: rare marine natural heritage</p> | Marine resources | Important habitats for: national and local protected aquatic organisms, important endemic aquatic organisms, protospecies for important aquatic organisms and other organisms of high economic values and genetic breeding values. |
| Administration | National Forestry and Grassland Administration, Ministry of Natural Resources | | Ministry of Agriculture and Rural Affairs of the People's Republic of China |

(2) Marine Special Protected Area

Similarly, based on the “Management Measures for Marine Special Protected Area” issued by SOA in 2010, the management plan of each national MSPA should be prepared according to the *Technical guidelines for functional zonation and the management plan compiling of MSPA* (HY/T 118-2008) and approved by SOA, which is authorized by the State Council as the ocean management authority in the central government. However, it is believed that obligation will be transferred to NFGA in 2019 because NFGA had been authorized with all kinds of MPA management during the re-structure of central government.

For the management agency of national MSPA, the obligation is shown as bellows.

- To Implement national and local laws, regulations and policies on marine ecological protection and resources utilization;
- To formulate and implement the management system in MSPA;
- To formulate the management plan and annual work plan for MSPA and implement targeted management measures;
- To organize and construct facilities for the protection, monitoring, scientific research, tourism and public education for MSPA;
- To organize the daily patrol and management of MSPA;
- To formulate plans for ecological compensation, protection and restoration of MSPA, and implement the measures for above plans;
- To organize, implement and coordinate various activities concerning the protection, utilization, rights and interests of MSPA;
- To organize and managing ecotourism activities in MSPA;
- To organize and carry out monitoring, surveillance, evaluation and scientific research activities in MSPA;
- To organize and carry out publicity, education, training and international cooperation of MSPA;
- To establish archives of resources, environment and other information management of MSPA;
- To publish relevant information on MSPA;
- Other duties that shall be performed by the management agency of MSPA;

At the meanwhile, there is also some special requirements for MSPA, such as the management plan should be finalized within 12 months for approval after the MSPA designation, the management plan should follow the instruction of “*Technical guidelines for functional zonation and the management plan compiling of MSPA* (HY/T 118-2008)”, all the activities for protection and utilization should follow the management plans.

1.3 Objective of MPA management plan

(1) Objective of MNR management plan

Based on the guideline of “*Outline of Management Plan for National Nature Reserves*” issued by MEP in 2002, the general objective of MNR management plan is to conserve the natural status of MNR, keep human activities out of the MNR. But for a given MNR, the objective of management plan is normally specified, particularly within a limited period of 10 years. The objective of natural ecology status, protected target status, human activities/disturbance controlling, working conditions/capacity building, infrastructure building, scientific research, local community development, and public education are often set and described in the management plan. The management plan of each MPA will be rewritten every 10 years, and it will be revised every 5 years. Evaluation on the status of protected targets will be carried out every 5 years. The revision of management plan will be based on this evaluation. If the targets are undergoing significant change, the revision will be made for this change.

The principles for setting the objective of a MNR management plan are to closely focus on the protection functions of nature reserves, to meet the protection and management needs of the main protected targets, to strictly control all kinds of development and construction activities, to insist on the infrastructure construction as simple and practical as possible and integrated with the local landscape, and to insist on community participation in management and contribute to the communities sustainability. It is better to have the measurable objectives in the management plan rather than describable objectives.

(2) Objective of MSPA management plan

For the objective of MSPA management plan, the “*Technical guidelines for functional zonation and the management plan compiling of MSPA (HY/T 118-2008)*” gives a very clear instruction. The designed MSPA should draw up a management plan according to the status quo, sensitivity, carrying capacity, and dominant ecological functions of the marine ecological environment, the structure and process characteristics of ecosystem types, the present status and trend of natural environment and socio-economic development. The MSPA should be divided into key protection zone, ecological and resource recovery zone, resources utilization zone, and reserved zone for different objective of marine protection and resource utilization. It will benefit to determine the main function, clear the direction of management activities, and form a harmonized spatial development pattern of population, economy, resources and environment. Furthermore, the MSPA management plan could formulate reasonable and feasible development goals, provide basis and policy guidance for the construction of protected areas during the planning period.

The contents of the management plan objectives should include: the status of ecological

environment, the status of the main protected targets, the human disturbance control, the social development and the economic development of neighbor community. The objective of a MSPA should be integrated with the overall protection plan of the sea area where the MSPA located, the challenge, and urgent needs of MSPA management. And the management plan could to set the general objectives, stage objectives and various construction objectives for a certain time period, such as 10-15 years.

The principles for setting the objective of a MSPA management plan should focus on sustainable development of marine resources, coordination between marine protection and economic development, coordination with marine functional zoning and other plans, implementation an inner zoning management, and comprehensive benefits for social, economic, resource and environment. In one word, the objective of management plan of MSPA is protection-oriented and moderate development for the sustainable resources development.

1.3 Key contents of the management plans

Structure of the management plan documents are basically common across all the MPAs within the same category (MNR or MSPA) as they follow the template of the respective management plan, while individual MPA management authorities would usually tailor it to reflect the local context of the respective MPAs. In principle, approval of management plan of each MPA is a precondition for the release of budget to the respective MPA management authority which, in turn, implements the management plan.

1.3.1 Contents of MNR management plan

According to the guideline of “*Outline of Management Plan for National Nature Reserves*” in 2002, a management plan should content the following aspects:

Foreword

The foreword is a concise description of the management plan of the national nature reserve, including the basic characteristics of the nature reserve, historical evolution, legal status, and the purpose and significance of the preparation and implementation of the management plan.

1. Basic Overview

The basic profile is based on the basic description and analysis of the scientific research materials and existing information of the nature reserve. The insufficient information should be supplemented and improved. The evaluation should be based on scientific evidence and make the conclusions objective and reasonable.

This part should content the information on:

- Regional natural ecology/biogeographic characteristics, and humanities and social environment characteristics;
- Location, boundary, area, land ownership and natural resources, ecological environment, and socio-economic status of nature reserves;
- The aim and evaluation of the protection function and protected targets;
- The aim and evaluation of the ecosystem services and social services;
- The aim and evaluation of the inner zoning and adaptive management measures;
- Progress and evaluation of nature reserve management;

2. The Goal of Protection for National Nature Reserve

The goal of protection is a concise description of fundamental purpose for designing the nature reserve, and the expression of the eternal value and constant pursuit of this nature reserve.

3. Major Constraints on Protection Objectives

This part will analysis the factors which will bring constraints on the protection objectives, normally includes:

- Internal natural factors: such as land desertification, decline in biodiversity index, etc.
- Internal human factors: such as over-exploitation, urbanization tendency, etc.
- External natural factors: such as regional ecosystem deterioration, islanding effect, etc.
- External human factors: such as road crossing, interception of water, poaching, etc.
- Policy, social factors: if not received enough attention, passive situation.
- Community/economic factors: If the community is resource dependent or polluted.
- Available resource factors: less management operations and lack of training for personnel.

4. Objectives of Planning Period

The objective of planning period is a specific description of the management plan objectives of the nature reserve, and it is a phased goal of the protection goal. This part should content the followings:

- Planning period: Generally can be determined as 10 years, and should have a clear starting and ending time.
- Principles for determining objectives: Determining the planning objectives should closely focus on the protection functions of nature reserves, the protection and management needs of major protection targets.
- Planning objective details: status of natural ecology/protected target, controlling objectives of human activity, improving objectives of working conditions / management facilities, working objectives of scientific research / community development.

5. Main Contents of the Management Plan

This part will give the detailed description on the following aspects:

- Management and construction infrastructure planning;
- Working conditions / patrol work planning;
- Human resources / internal management planning
- Community work / mission planning;
- Research / monitoring work planning;
- Ecological restoration planning (not planned when not necessary);
- Rational development and utilization of resources (such as ecotourism, etc.);
- Suggestions for pollution control/ecological protection around protected areas;

6. Key Projects Planning

The key projects provide supports for the implementation of the main planning content and to achieve the planning period objectives and will serve as the basis for the preparation of the feasibility study report for the nature reserve capacity building project. The infrastructure such as real estate and roads in the construction of key projects should be based on the original basis, as simple as possible, energy-saving, and multi-functional; conditional equipment should be practical and efficient; software construction should be given sufficient attention.

The key projects can be listed in a table with the project name, construction content, work/engineering volume, investment estimate and source, execution year, etc.

7. Measures for Implementing the Plan

This part will describe how to ensure the management plan implemented smoothly, it will include the requirements on Policy/Regulatory, Funding, Management organization, staffing, Department Coordination, Community Co-management, and etc.

8. Benefit Analysis

The benefit analysis is the assessment and evaluation of the environmental, economic and social benefits after the completion of the main planning matters during the planning period, such as the management and protection capabilities, the changes in the protected areas and the impact on the development of the community.

1.3.2 Contents of MSPA management plan

Based on the “*Technical guidelines for functional zonation and the management plan compiling of MSPA (HY/T 118-2008)*”, the contents of MSPA management plan should include the following 9 parts as follows.

Foreword

The foreword is a brief description of the management plan of the MSPA, including its basic characteristics, historical evolution, legal status, the purpose and significance of compiling and implementing the management plan.

1. General Information

- 1.1 Planning background
- 1.2 Necessity and significance of district construction
- 1.3 Planning basis
- 1.4 Planning scope and duration

2. General Situation of Natural Environment, Marine Resources and Social Economy

- 2.1 Basic characteristics of natural environment
- 2.2 Types and utilization Status of marine resources
- 2.3 Socio-economic situation and marine industry distribution

3. Current Situation and Existing Problems of the Construction of MSPA

- 3.1 Overview of MSPA
- 3.2 Nature and protection objectives of protected areas
- 3.3 Ecological and resource characteristics of protected Areas
- 3.4 Main constraints affecting protection objectives

4. Guidelines, Basic Principles and Development Objectives of Planning

- 4.1 Guidelines
- 4.2 Basic principles
- 4.3 Planning period objectives (Overall objectives, short-term objectives, and long-term objectives)

5 Overall Layout and Inner Zoning

- 5.1 Determination of the major function
- 5.2 Overview of inner functional zoning
- 5.3 Management objectives of each inner zones
- 5.4 Arrangement of protection and development activities and management measures in each zone

6. Key Planning Projects

- 6.1 Protection management planning
- 6.2 Infrastructure and capacity building planning
- 6.3 Planning for rational utilization of resources
- 6.4 Scientific research and monitoring planning
- 6.5 Ecological restoration planning
- 6.6 publicity and education planning
- 6.7 Community co-management planning
- 6.8 Eco-industry development planning

7. Measures Guarantee for Implementation of Planning

- 7.1 Regulation and policy guarantee
- 7.2 Organizational guarantee
- 7.3 Human resources guarantee
- 7.4 Science and technology guarantee
- 7.5 Funds guarantee

7.6 Protection and management measures

7.7 Other guarantee

8. *Comprehensive Benefit Evaluation*

8.1 Resource benefits

8.2 Eco-environmental benefits

8.3 Social benefits

8.4 Economic benefits

9. *Planning Compilation, Consultation and Approval Reference and Appendix*

1.3.3 Revision of the management plan

The MPA authorities could update or modificate their management plan every 5 years based on the evaluation on the status of protected targets and the new threat or new management demands.

The management plan of each MPA is rewritten and re-prepared every 10 years to reflect the significant changes of protected targets, the new protection activities, the new status of environment, and new developing objective of the MPA.

1.3.4 Management plans of the NEAMPAN sites

As described above, management plans of the NEAMPAN sites follow the common structure across the MPAs while there are rules and regulations specifically applicable to the respective MPAs. Reflecting the nature of the MPA, management authorities of the Marine Nature Reserve (MNR) allow no entry to the core area and prohibits any activities which harms the MPA, while the scope of measures of Marine Special Protected Area (MSPA) include sustainable use of resources within the carrying capacity of the area. Further details of the NEAMPAN site management are provided in Table 1.3.

Table 1.3 Management details of each MPA in NEAMPAN

| | Law/ regulation/ guideline, etc specific to the site. | Management measures to be taken by MPA management authority | Management Plan | Protection facilities | Monitoring | Scientific research and education |
|----------------|---|--|------------------------------------|--|---|---|
| Nanji (MNR) | Management rules of Nanji Islands National Marine Nature Reserve of Zhejiang Province(1996) | No entry in core area. No human activity in buffering area. Any activity which is harmful to the MPA is prohibited in experimental area. | Current management plan: 2014-2024 | Management station, Land mark, sign, power & water supply, disaster prevention, transportation & communication supplies. | The monitoring sites could be selected according to the historical sites. The location is mainly in the habitats of shellfish and algae, including benthic habitat and tidal flat. Monitoring sites in different cruises should be same. Monitoring time and frequency: conduct the monitoring every month if condition permits. | Training workshop for MPA staff. |
| Shangkou (MNR) | Management Measures of Shankou Mangrove National Marine Nature Reserve and Beilun Estuary National Marine Nature Reserve in Guangxi Zhuang Autonomous Region.(2018) | No entry in core area. No human activity in buffering area. Any activity which is harmful to the MPA is prohibited in experimental area. | Current management plan: 2011-2020 | Boundary marker, MPA administration building, administration site, field patrol equipment | Monitoring of the water body, fish and plant species; Environmental impact monitoring of tourism activities. | Investigation of afforestation; Structural and functional stability of mangrove systems; |
| Beilun (MNR) | Management Measures of Shankou Mangrove National Marine Nature Reserve and Beilun Estuary National Marine Nature Reserve in | No entry in core area. No human activity in buffering area. Any activity which is harmful to the MPA is prohibited in experimental area. | Current management plan: 2011-2020 | MPA administration building, administration site, boundary marker, watchtower, field patrol equipment | Mangrove monitoring | Ecological monitoring, bird observation, mangrove insect pests, plant culturing and ecological conservation in technical cooperation with Guangxi Mangrove Research Center, Breeding and recovery of rare species living in mangroves and |

| | | | | | | |
|----------------|---|---|------------------------------------|---|--|--|
| | Guangxi Zhuang Autonomous Region.(2018) | | | | | coastal wetlands, sea water chemical analysis and ecological investigation |
| Dazhou (MNR) | Announcement on reinforcing the management of national nature reserve of Dazhou Island Marine Ecosystems (1992) | No entry in core area. No human activity in buffering area. Any activity which is harmful to the MPA is prohibited in experimental area. | Current management plan: 2011-2020 | MPA administration building, boat and communication facility | Swiftlet/marine seawater monitoring | In 2008, biology resources investigation had been carried out in Dazhou Island protected area. |
| Sanya (MNR) | Management rules of Hainan Nature Reserves, 1991 | No entry in core area. No human activity in buffering area. Any activity which is harmful to the MPA is prohibited in experimental area. | No information | | Monitoring of coral reef and water quality. | Cooperate with south China Sea Institute of Oceanology, Hainan Tropical Ocean University and the Third Institute of Oceanography. Research on biodiversity of coral reef; Study on the influence to the coral reef after the enhancement of fish; Basic research on morphological characters and habits of marine animals. |
| Changyi (MSPA) | Interim management procedures of MSPA in Shandong Province.(2014) | No construction activity in key protected area. Restoration activities that is in consistent with protection objective is allowed in ecological restoration area. Sustainable use of resources within the limit of carrying capacity is allowed in proper utilization area. | Current management plan: 2016-2025 | Management office, boundary marker, fire safety sign, patrol equipment, monitoring equipment, lab equipment | Baseline study conducted every 5 years. Longterm monitoring on protected target and habitat. | The protected area has cooperated with Ocean University of China, the First Institute of Oceanography, Qingdao National Oceanography Laboratory and other scientific research institutes; It has been the demonstration zone of two marine non-profit scientific research; Scientific research institute of marine ecology and engineering in Changyi was established by the protected area and the Cold and Arid Regions Environmental and Engineering Research Institute of the Chinese Academy of Sciences. |

2 Monitoring and assessment of designated MPAs

The aim of monitoring and assessment is to know the status (mainly density, biomass, and numbers etc.), distribution area, change and main influencing factors of the protected targets in MNR/MSPA.

2.1 Monitoring parameters

2.1.1 Areas addressed by the monitoring parameters

In China, we focus on monitoring the protected targets and the influencing factors of the protected targets in all kinds of protected areas according to the *technical guidelines on marine ecology & environment monitoring protocol* (SOA, 2015) for both MNR and MSPA. The water quality must be monitored according to the requirements of functional zoning management because the MPA is high priority concerned area for management. However, there is not much attention on the socio-economic monitoring at this moment, almost no MPA take social economic data into their monitoring report.

The requirement of monitoring frequency is not less than one time per year, and the detailed monitoring time should be carried out according to the characteristics of the protected targets, especially for the MPA of marine organisms. The specific time should be determined according to the actual situation of different types of MPAs, and the more monitoring frequency the better. In the case of emergencies, it should increase the urgent monitoring for the environment and protected targets.

Table 2.1-2.5 show the requirement of standard monitoring parameters specified in the national guidelines for MPAs of various protected targets, such as endangered marine organism, high valued animals, plants, marine natural landscape, and marine ecosystem. Each MPA tailors these monitoring parameters depending on the local context. Table 2.6 summarized the specific monitoring parameters for each target MPA in reference to those standard parameters.

Table 2.1 The monitoring parameters for MPAs of endangered marine organism

| Protected Target | Monitoring Parameter | Monitoring Parameter of Affecting Factors * | | | |
|--|----------------------|--|---|--------------------------|---------------------------------------|
| | | Water Quality | Sediment Quality | Biological Quality | Others |
| Lancelet (<i>Amphioxus</i>) | Density, and biomass | pH, DO, COD, DIP, DIN, petroleum, and heavy metals | Granularity, DOC, petroleum, and heavy metals | — | Biodiversity index, and human factors |
| Songjiang Perch (<i>Trachidermus</i>) | Density, and biomass | pH, DO, COD, DIP, DIN, petroleum, and heavy metals | DOC, petroleum, | Colibacillus. Petroleum, | |

| | | | | | |
|---|--|---|---|------------------|--|
| | | | and heavy metals | and heavy metals | |
| Coral (<i>Anthozoa</i>) | Coverage of live corals, species, and death rate | pH, TSS, DO, COD, DIP, DIN, petroleum, and heavy metals | DOC, petroleum, and heavy metals | — | |
| Cowfish (<i>Neophocaena</i>) | Quantity, and frequency | — | — | — | |
| Sea turtle (<i>Chelonia mydas</i>) | | pH, DO, COD, DIP, DIN, petroleum, and heavy metals | Granularity, DOC, petroleum, and heavy metals | — | |
| Swiftlet (<i>Aerodramus</i>) | | — | — | — | |
| Chinese White Dolphin (<i>Sousa chinensis</i>) | | — | — | — | |

Table 2.2 The monitoring parameters for MPAs of high valued animals

| Protected Target | Monitoring Parameter | Monitoring Parameter of Affecting Factors * | | | |
|--|-------------------------------|--|----------------------------------|---|---------------------------------------|
| | | Water Quality | Sediment Quality | Biological Quality | Others |
| Surf Clam Shell (<i>Macra antiquata</i>) | Density, and biomass | pH, DO, COD, DIP, DIN, petroleum, and heavy metals | DOC, petroleum, and heavy metals | Colibacillus, Petroleum, and heavy metals | Biodiversity index, and human factors |
| Clam Worm (<i>Nereis succinea</i>) | | | | | |
| Sea Cucumber (<i>Stichopus japonicus</i>) | | | | | |
| Shellfish | Species, density, and biomass | | | | |
| Razor Clam | | | | | |
| Fish | | | | | |
| Birds | Species, and quantity | — | — | — | Biodiversity index, and human factors |

Table 2.3 The monitoring parameters for MPAs of plants

| Protected Target | Monitoring Parameter | Monitoring Parameter of Affecting Factors * | | | |
|---|---------------------------|---|----------------------------------|--------------------|---|
| | | Water Quality | Sediment Quality | Biological Quality | Others |
| Mangrove (<i>Rhizophora apiculata</i>) | Species, density and area | — | DOC, petroleum, and heavy metals | — | Climate factors, pests, alien invasive species, and human factors |
| Chinese Tamarisk (<i>Tamarix chinensis</i>) | Density, and area | | | | |
| Wild Daffodil (<i>Narcissus tazetta chinensis</i>) | | | | | |
| Algae (<i>Sargassum fusiforme</i>) | | | | | |

Table 2.4 The monitoring parameters for MPAs of marine natural landscape

| Protected Target | Monitoring Parameter | Monitoring Parameter of Affecting Factors * | | | |
|--------------------------|----------------------|---|------------------|--------------------|--|
| | | Water Quality | Sediment Quality | Biological Quality | Others |
| Chenier | Area, and integrity | — | — | — | Storm tide, ocean dynamic, and human factors |
| Coastal Dune | Area, and elevation | | | | |
| Oyster Reef | Area, and integrity | | | | |
| Submarine Ancient-forest | | | | | |
| Sand Beach | | | | | |
| Land-tied Island Sandbar | | | | | |
| Reef Island | | | | | |

Table 2.5 The monitoring parameters for MPAs of marine ecosystem

| Protected Target | Monitoring Parameter | Monitoring Parameter of Affecting Factors * | | | |
|------------------|---|--|----------------------------------|--------------------|---|
| | | Water Quality | Sediment Quality | Biological Quality | Others |
| Bay | Biodiversity, and typical species, density, and biomass | pH, DO, COD, DIP, DIN, petroleum, and heavy metals | DOC, petroleum, and heavy metals | — | Biodiversity index, and human factors |
| Island | | | | | |
| Estuary | | | | | |
| Coastal Wetland | | | | | |
| Seagrass bed | Species, density, coverage, and area | — | DOC, petroleum, and heavy metals | — | Climate factors, pests, alien invasive species, and human factors |

Table 2.6 The monitoring parameters for each MPA

| No. | MPA's Name | Protected Targets | Monitoring parameters |
|-----|---|--|--|
| 1 | Nanji Islands National Marine Nature Reserve | Marine shellfish and algae as well as their habitats | Density, biomass, and area plus water/sediment/ biological/other parameters in table 2.2 and 2.3 |
| 2 | Shankou Mangrove National Marine Nature Reserve | Mangrove ecosystem | Species, density and area, plus sediment/other parameters in table 2.3. |
| 3 | Beilun Estuary National Marine Nature Reserve | Mangrove ecosystem | Species, density and area, plus sediment/other parameters in table 2.3. |

| | | | |
|---|--|--|---|
| 4 | National Nature Reserve of Dazhou Island Marine Ecosystems | Swiftlet, its habitat and the marine ecological system | Quantity, and frequency, plus water/sediment/other parameters in table 2.1 |
| 5 | Sanya Coral Reef National Nature Reserve | Coral reef and the marine ecological system | Coverage of live corals, species, and death rate, plus water/sediment/other parameters in table 2.1 |
| 6 | Changyi National Marine Ecology Special Protected Area | Tamarix chinensis, marine organisms and coastal wetland ecosystems | Density, and area, plus sediment/other parameters in table 2.3 |

2.1.2 Monitoring bodies and collection of data

As requested in the “*Standardized Construction and Management of National Marine Protected Areas*” by SOA in 2014, the management agency of MPA is the responsible body for conducting the monitoring. However, because of limited staff and expertise skills, almost all the MPA’s monitoring are executed by other professional qualified agencies. Such as local marine environment monitoring center, related universities, and research institutes. MPA management agency will pay the monitoring expenditure according to the total area, amount of parameters, and monitoring frequency by services procurement. As the buyer, the MPA management agency own all the monitoring data, and has the right to decide how to use the monitoring data, for public or not. However, the MPA management agency should submit all data and assessment report to the National Marine Information Center and NFGA, the authority of central government for MPAs, for reference and decision-making.

2.2 Assessment of data

2.2.1 Assessment criteria and responsibilities

There are two purposes to evaluate the monitored data. (1) To get the ecological and environmental information. The status of protected targets could be known by evaluating the monitored data, as well as the change trend. (2) To know the pressure and threats to MPA. The intensity of the pressure and main threats will be known, as well as how to affect protected targets.

For the protected targets monitored data, such as the density, biomass, death rate, marine mammal frequency, species number, coverage area, integrity, and key species of ecosystem, there is no evaluation criteria. The biodiversity is normally evaluated by Shannon-Wiener Index. And normally,

the monitored data of affecting parameters (Table 2.1-2.5) will be evaluated with national standards, i.e. Sea Water Quality Standard (GB 3097-1997) for water quality, Marine Sediment Quality Standard (GB 18668–2002) for sediment quality, and Marine Biological Quality Standard (GB18421-2001) for the biological quality.

The evaluation process is normally done by the monitoring agency, such as local marine environment monitoring center, related universities, and research institutes. The monitoring agency will normally write and deliver the monitoring and evaluation report to the administration of MPA, and the administration will organize an expert consulting meeting to review the monitoring methodology and evaluation results. Composition of consulting and review meeting: independent consultant/experts who are familiar with this study or this area. The frequency of this is generally once a year, which depends on the budget.

The whole process of the monitoring is illustrated in Figure 2.1. When the MPA administration got the final evaluating report with the monitoring data, they should deliver all the report and data to the National Marine Information Center for backup.

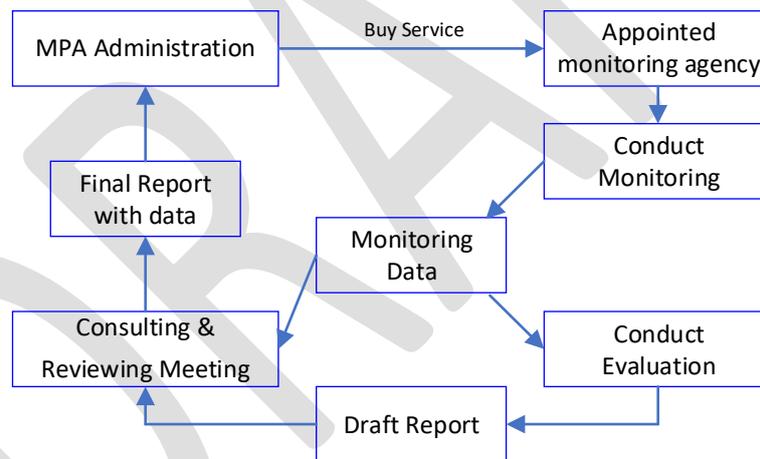


Figure 2.1 The process of the monitoring and evaluation of MPA

2.2.2 Assessment against goals and indicators

As shown in 1.4, the indicators of management plan objective usually be detailed as the status of natural ecology/protected targets, controlling objectives of human activity, improving objectives of working conditions / management facilities, working objectives of scientific research / community development. While the monitoring parameter shown in 2.1 are more focus on the protected targets, the ecology and environment, and the threats. Therefore, the assessment will against the objective indicators for the status of natural ecology and environment, the status of protected targets, the changes of human activities and other threats by the monitored data. The other objective indicators related to administration and management of MPA management office, such as the working

conditions, the capacity building of staff, and the community development, could not be monitored and evaluated.

Although there are many guidelines for the MPA's monitoring, it is a huge gap for the guidance and standards for the MPA's evaluation in China, both for the procedure and the criteria. SOA had appointed NMEMC to draft a guideline for protected targets evaluation in 2015, however it is still not finished yet.

2.3 Links between monitoring/assessment results and management

2.3.1 Use of monitoring data

The costly monitoring data are very valuable for the MPAs, especially the long-term monitoring data for the protected targets and ecology status. For the monitoring agency appointed by the MPA administration, when they get the ecological and environmental data, they will analyze with the quality standards to evaluate the states of ecosystem, compare with the historical data to assess the changes of protected targets. And then the overall evaluation report, the cause and effect chain analysis, the threats and drivers analysis are conducted. Based on above results, the annual workplan will be adjusted and some special actions will be implemented by the MPA administration. All those processes could be illustrated in Figure 2.2.

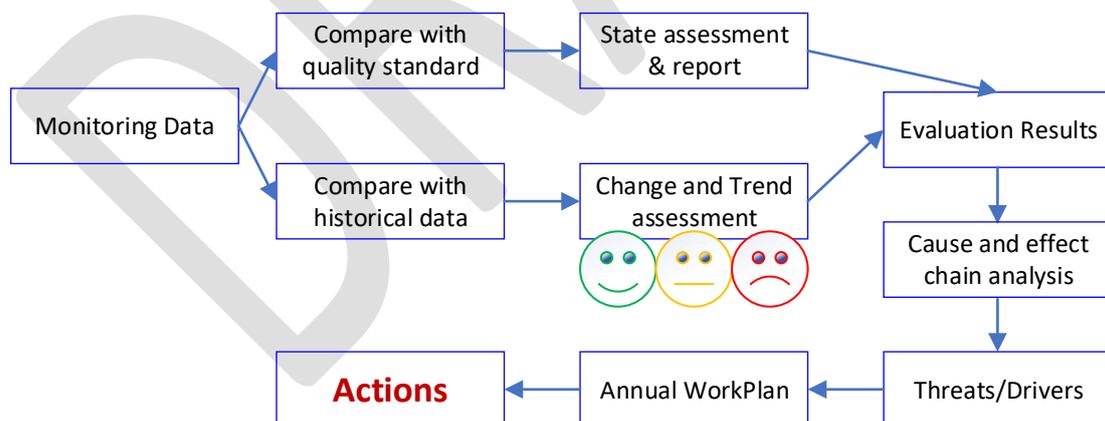


Figure 2.2 The use of monitoring data

However, it is a pity that the monitoring data are not accessible for the public and research institutions right now in China. The public does not know the states of MPA as well as the protected targets, especially useful for the neighboring community, such as fisherman. At the same time, the long-term monitoring data are very valuable for the scientific research. The scientist could have further analysis and find more useful information for the MPA's management. The scientific research

team is trying to work closely with the MPA administration to access these monitoring data for research, it is the only way up to now.

2.3.2 Institutional aspects

The institutions involved for the monitoring and evaluation are mainly shown in Figure 2. 3. The MPA administration is the core of monitoring, management plan objective setting, and the implementation of the plans and monitoring. NFGA is the MPA authority in central government, which belongs to the Ministry of Natural Resource (MNR). Ministry of Ecology and Environment (MEE) is the supervision and inspection authority for all the Pas (including MPAs), normally it will have management effectiveness evaluation every two year.

The National Marine Data and Information Center (NMDIC) is the data reservation agency for MNR, and National Marine Environment Monitoring Center (NMEMC) is the monitoring data reservation agency for the MEE. The MPA administration should deliver all the monitoring data to both agencies before the end of the year, and they two agencies should provide the data and other related information to their ministries respectively. Communication mechanism between NFGA and MEE exists, such as: meeting.

No communication mechanism between NMDIC and NMEMC. The expert committee is composed of famous experts in this field, no matter what institution.

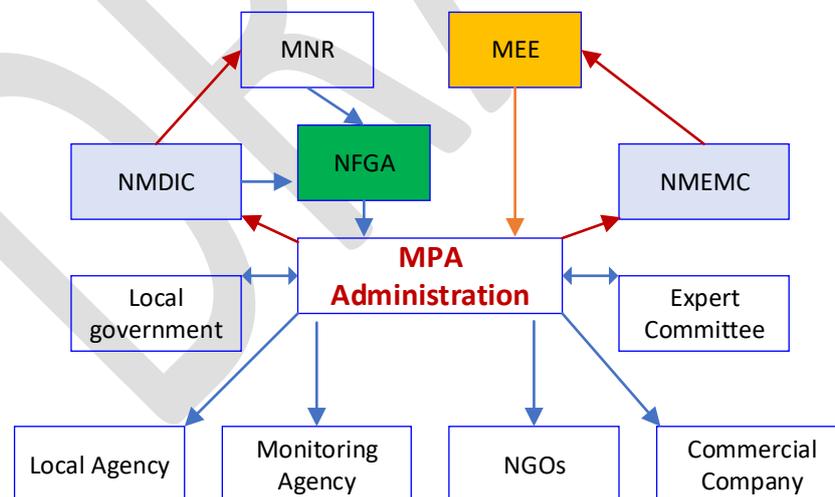


Figure 2.3 The institutions involved in monitoring and evaluation of MPA
(Blue line means normal operational connection, red line means the reporting connection, and yellow line means the supervision and inspection.)

Many objective indicators, such as the working conditions, the capacity building, and the community development in the management plan, should be coordinated with the local government. The expert committee provides the professional suggestion and technical review for the

management plan, the objectives setting, monitoring protocol, evaluation report, and other advice to MPA.

The objectives and the key projects of the management plan could be implemented by the local agency, monitoring agency, NGOs, and commercial companies based on their business scope and expertise. Normally the suppliers for goods and services are selected by public biddings in China.

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3 Feedback of assessment results to management plans and practices

The adaptive management principal is widely accepted and used in MPA management. MPA administration has responsibility and authority for monitoring and adapting the objectives of management plan of the site. Therefore, the assessment results from the monitoring could wisely be reflected in the annual workplan and/or management plan of MPA administration (Figure 3.1).

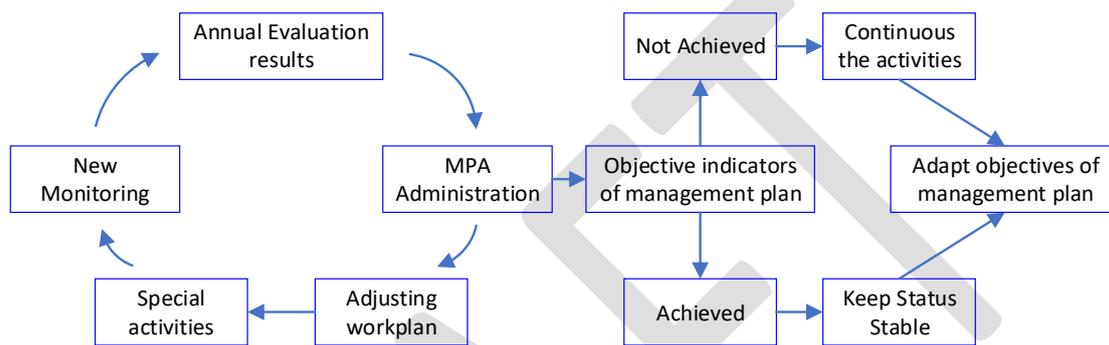


Figure 3.1 The relations of evaluation results and objective indicators of management plan

For the annual monitor and evaluation results, the MPA administration and the expert committee will more focus on the status of protected targets, the status of ecology and environment, and the threats for adjusting the annual workplan. If there are some new threats and/or degraded ecology and environment quality, some special activities will be carried on for reducing the threat and improving the environment quality. A new monitoring will be implemented for these special activities.

For the long-term evaluation results (at least 5 years), the MPA administration and the expert committee will compare with objective indicators of management plan for judging if there is a need to adapt the objective indicators of the management plan. Because the management plan is normally a 10-year plan and approved by the MPA authority, which means it is a long-term plan and should not be modified frequently. If the evaluation results showed a continuous degraded (at least 5 years) for protected targets and/or ecology, which means the threats is a lasting pressure for MPA, in this case the objective indicators of management plan will adapted. If the evaluation results shown the indicators are stable, especially the protected targets and the ecology and environment, the new objectives are usually saying “keep stable” in the new management plan. Keeping stable is the best conditions and everlasting objective for MPA to conserve the natural status and sustainable resource.

4 Case studies

4.1 Nanji Islands National Marine Nature Reserve

4.1.1 Brief introduction

Nanji Islands National Marine Nature Reserve (NJ-MNR) belongs to the marine ecosystems protected area with protected targets of shellfishes, algae, marine birds, wild daffodils and their habitats. It is located in the southeast sea areas of Pingyang County, Zhejiang Province, with geographical coordinates of 120°56'30"E to 121°08'30"E and 27°24'30"N to 27°30'00"N. The NJ-MNR consists of 52 islands, tens of bare/submerged rocks and the surrounding waters. The total area of it is 20,106 ha with 1,113 ha of land area and 18,993ha of sea area. It has been listed as UNESCO's Marine Nature Reserve of World Biosphere Reserves in 1998 and selected as one of the four demonstration sites of GEF-supported project of Biodiversity Management in the Coastal Area of China's South Sea in 2002. In 2005, it was awarded by 23 new media as one of the ten most beautiful islands in China.

The NJ-MNR is located in the transitional zone of temperate and tropical zones. Inside of the MPA, islands and rocks are everywhere with tortuous coastlines and numerous capes and bays. It has various types of beaches, including the sandy beach, mud flat, boulder beach and rocks. Because it is situated in the junction of the Taiwan Warm Current and Jiangsu/Zhejiang Longshore Current, there are unique ecological environment, diverse species and complex flora and fauna, thus providing perfect habitats for marine lives. Now the MPA has identified 427 species of shellfishes, 178 species of macro-benthic algae (The species of shellfishes and algae together account for 20% of the country's total number and 80% of Zhejiang Province), 459 species of microalgae, 397 species of fish, 257 species of crustaceans and 158 species of other marine lives. 36 shellfish species are only found in Nanji Islands, among which 22 are listed as rare species. Three algae species, *Sargassum nigrifoloides sp.nov.*, *Sargassum capitatum* and *Hincksia zhejiangensis*, are first found in the islands and reported to the world.

The algae are more than just abundant in species. They also have the features from both the temperate and tropical zones and demonstrate obvious characteristics of regional "Faults Distribution". The NJ-MNR is the natural museum and gene bank of the main marine algae in China and has been given the name of the "Shellfishes and Algae Kingdom". It is also the resource pool of the marine project "Southern species transfer to the north and northern species transfer to the south".

The scenery of NJ-MNR is praised as "Bihaixianshan", which means blue sea and fairy mountains,

for having beautiful mountains, distinctive rocks, charming beaches, green grassland, blue waters and far-reaching sky. Among different islands of the MPA, the biggest one is the Nanji Island; Dalei Island and Zhu Island are known as “the Island of Daffodil” for growing a large number of daffodils; and there are Snake Island and Bird Island. Sanpanwei scenic spot is in the Nanji Island and it is famous for the unique rocks, steep cliffs and grassy land.

As the first island ecosystem nature reserve established in China, NJ-MNR has the most important scientific and ecological value. The MPA also has stunning scenery, rich tourism resources and increasing tourists.

4.1.2 The monitoring plan

The rapid growth of population and economy in the southern coastal region have led to degradation of coastal habitats. Although measures have been implemented, such as establishment of MPAs and implementation of ICM, threats to the biodiversity still exist. To protect the biodiversity and habitats of NJ-MNR and sustain the management capacity of MPAs to the most extents, the long-term monitoring of shellfish and algae resources and their habitats are indispensable.

The objective of the monitoring plan of NJ-MNR is to provide supporting information for protecting the shellfish and algae resources and their habitats, maintain the balance of ecosystem, prevent the damage on shellfish and algae resources, promote the virtuous cycle of ecosystem, and realize the harmonious development of human and nature.

In the monitoring plan, the monitoring sites could be selected according to the historical sites. The location is mainly in the habitats of shellfish and algae, including benthic habitat and tidal flat. The main ecological types of Nanji shellfish and algae should be covered, including rock, sandy beach and muddy flat. Monitoring sites in different cruises should be same. And the Monitoring parameters are shown in table 4.1.

Table 4.1 Monitoring parameters of NJ-MNR

| Items | Parameters | Sites |
|--------------------|--------------------------------------|---|
| Habitats diversity | Sediment particle size | Sandy, muddy ecotypes |
| | Habitat | All |
| | Habitat water quality | Species with weak or no migration ability |
| | Geographic and geomorphic conditions | All |
| Biodiversity | Species diversity | All |
| | Biodiversity index | All |

| | | |
|---------------------|-------------------------------|-----|
| Community structure | Biomass and abundance | All |
| | Species composition | All |
| | Species with public attention | All |

4.1.3 Monitoring results and threats identified

There comprehensive scientific surveys were conducted in the 1970's, 1990's and 2003. Table 4.2 shows the species number of shellfish and algae in these 3 surveys. From this table we could see that species number of shellfish and algae obtained in these 3 surveys differ greatly from each other, which might be ascribed to the difference in survey time, site and transections numbers.

Table 4.2 Shellfish and algae species number in three surveys

| Year | Shellfish species number | Algae species number | Transection |
|-----------|--------------------------|----------------------|-------------|
| 1974-1976 | 122 | 94 | 4 |
| 1992-1993 | 143 | 121 | 14 |
| 2003-2004 | 105 | 85 | 10 |

(1) Shellfish abundance & biomass

As shown in Figure 4.1, in 1992-1993, the rocky transection had 103 species, while in 2003 it was 98. In sandy beach transection, the species number dropped from 17 (1992-93) to 12 (2003).

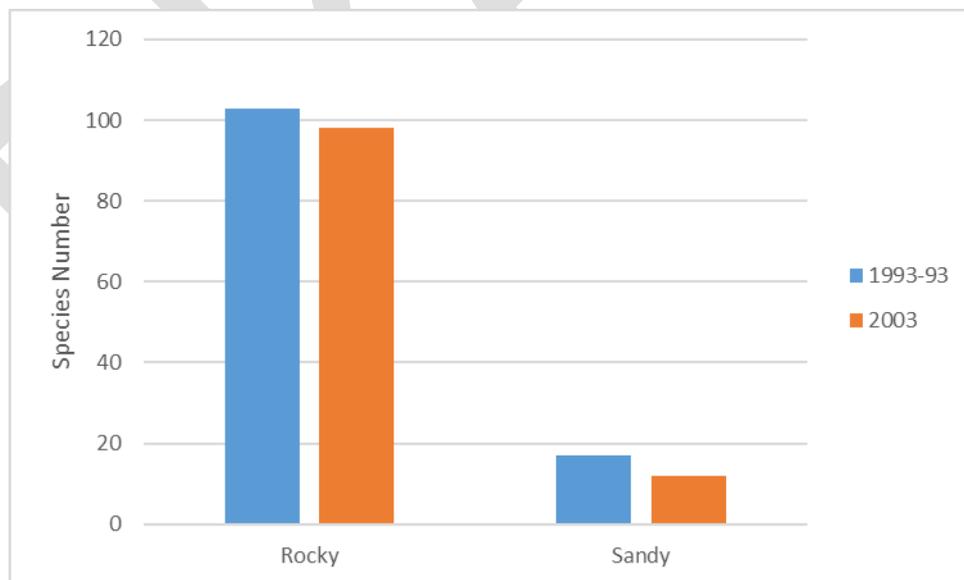


Figure 4.1 Shellfish species number between years and transections in NJ-MNR

As shown in Figure 4.2, in rocky transection, shellfish biomass and abundance in 2003 were higher than that of 1992-93. In 2003, the biomass and abundance were: 3324.29 g/m² and 3428 inds./m². While in 1992-93, they were: 970.63 g/m² and 1812 inds./m².

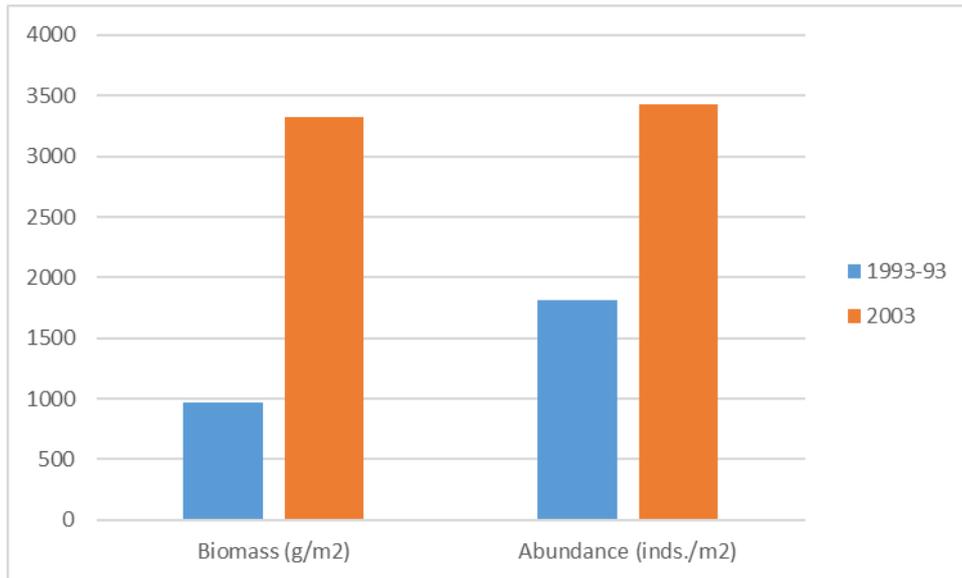


Figure 4.2 Shellfish biomass and abundance in rocky transection of NJ-MNR

As shown in Figure 4.3, in sandy transection, shellfish biomass and abundance in 2003 were lower than that of 1992-93. The biomass dropped from 162.95 g/m² to 26.78g/m². The abundance dropped from 92 inds./ m² to 17 inds./ m².

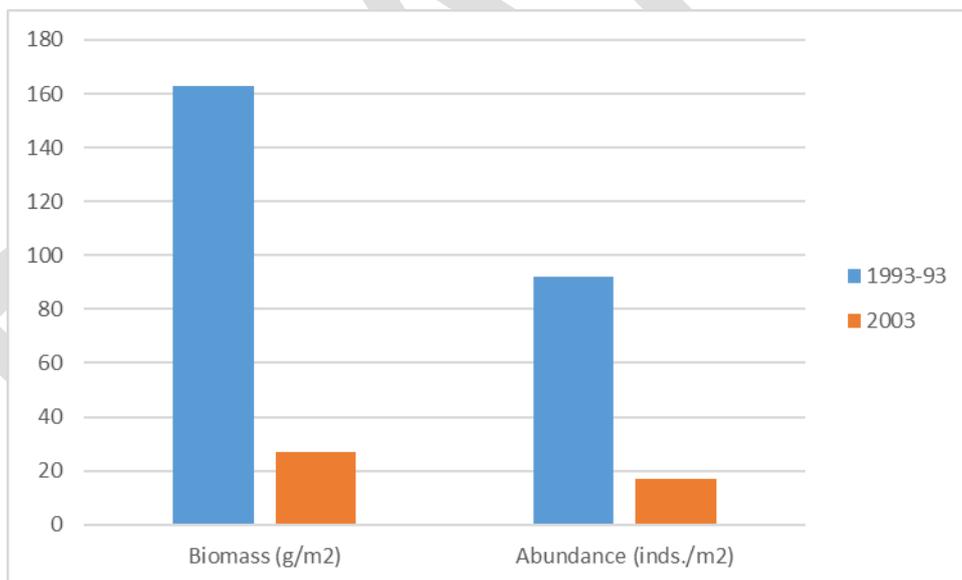


Figure 4.3 Shellfish biomass and abundance in sandy transection of NJ-MNR

(2) algae species diversity

In NJ-MNR, there is a historical monitoring site for algae, which is the south cape of Mazuao. After 40 years of monitoring, a decreasing trends in algae species diversity is found. According to table 4.3, the species number is decreasing in this site. Half of the constructive species have lost their ability to construct the community. *Ulothrix flacca* and *Pachydietyon coriaceum* are now degraded from constructive species to dominant species. *Lynghya semiplena* and *Grateloupia ramosissima* are degraded to common species.

Table 4.3 Longterm variations in species number of algae in NJ-MNR

| Year | Total species | Constructive species | | Dominant species | | Common species | |
|-----------|---------------|----------------------|------|------------------|------|----------------|------|
| | | No.of species | % | No.of species | % | No.of species | % |
| 1959-1965 | 84 | 8 | 9.5 | 14 | 16.6 | 34 | 40.7 |
| 1980-1985 | 73 | 8 | 11.0 | 12 | 16.4 | 22 | 30.1 |
| 2000-2007 | 49 | 4 | 8.2 | 4 | 8.2 | 13 | 26.5 |

(3) Threats identified

According to the previous surveys, experts and management agency investigations, several threats have been identified for the decline in biodiversity of shellfish and algae population in NJ-MNR.

- ◆ **Overexploitation.** NJ-MNR area is historically used by local fishermen for fishery and algae collection. Local fishermen make money out of these fishing activities, the main part of local fishermen's income is from fishery. Among all kinds of fishery activities, fish resources are the most important part, along with the aquatic production process. Generally, fishermen here catch fish from coastal waters directly, aquatic culture accounts for smaller parts of fishery resources acquisition. The production, lifestyle and culture here are relatively less developed compared with other coastal parts of China. The less developed fishery style here poses pressure on the environmental protection of MPA. For example: due to the over sampling of *Sargassum fusiforme*, the population of this species has degraded.
- ◆ **Rapid development of tourism.** There is conflict between tourism development and MPA management. Since the establishment of MPA, the tourism has developed rapidly. More and more tourists come to NJ-MNR. The most tourist number could be more than 1000 people/day. In the year 2007, the tourists' number was as high as 60,000 people/year. Tourists prefer to eat economic shellfish, which will increase the strength of overexploitation of shellfish resources. The decrease of shellfish species diversity, number and size in Dashao beach is an example of this. The need of shellfish promotes the formation of harvesting-selling chain, which is a big threat to the shellfish diversity conservation. At the same time, the increased tourists will also bring pressure to water& electricity supply and water/solid waste disposal. Without proper management on those pressures, the environmental pollution could be aggravated.
- ◆ **Infrastructure construction.** Although NJ-MNR is far from mainland, there are some coastal engineering activities for existing villages and islands, such as around-island road construction, dock construction. Tons of detritus, sand and mud are generated during the

constructions, which will influence the local biological resources and environment. Especially, the artificial coastal lines influence the surrounding fishery grounds and habitats. For example, due to the Nanji Islands around-island road construction, large amount of soil and stones sink into the sea, leading to the degradation of Mazuao habitats. *Sargassum horneri* bed is largely degraded in this area. Generally, this algae species lives from low-tide line to 3-4 meter shallow water area, the road construction damage not only its habitats, but also bring negative effects to its growth by changing pH of sea water and increasing turbidity of sea water. So, anthropogenic development activities in NJ-MNR could bring influence to biodiversity of MPA to some extents.

- ◆ Mariculture. In recent years, cage farming is developing rapidly in and around NJ-MNR. Introduction of non-native species might lead to species invasion. Mariculture may result in environmental pollution as well. In NJ-MNR, about 4ha sea area is used for deep-water cage farming, which poses threats on shellfish and algae biodiversity inside the MPA. Large amount of residual feeds, faeces, and death of cultured organisms will influence the water environment. Medicines applied during the culture will also suppress the growth of plankton. Residual of medicine will accumulate within low trophic organisms and gradually being transferred to high trophic level organisms and may finally influence the human health.
- ◆ Natural environment quality degradation. NJ-MNR area is rich of nutrients. According to Redfield ratio: N/P=16, the ratio here is much higher than this value. According to survey in 1992, the N/P=36.94. In the survey of year 2003, the ratio was 31.68 in spring, and 28.33 in summer. The ecosystem here is sensitive to the variation of nutrients, the possibility of harmful algae bloom do exist.

4.1.4 Improved management measures

Based on the identified threats, the management agency of NJ-MNR drafted the special management plans for reducing the threats to MPA and applied the extra-funding for the activities. There is mainly two pathway to conduct the measures for reducing the threats, (1) the activities could be implemented by the agency directly, such as the ecological restoration and real time monitoring network building; (2) activities should be cooperative with local government, such as extending the fishing-off period, control the tourists arrival, and developing the eco-mariculture. The detail measures are briefing below.

(1) Extended fishing-off period in MPA

China fully implemented summer fishing-off policy since 1995. After more than 20 years' improvement, the fishing-off time is keeping extending. From the earliest 2.5 months, to 3.5 month, and the fishing-off time is 4.5 month per year now in NJ-MNR, from the beginning of May to the

middle of Sep. This fishing-off policy can help fishing resources to recover from catching pressure and protect the fish larva from being caught by controlling the fishing gear. Summer fishing-off policy is an important measure to sustain the health development of marine organism and improve ecological environment. It has ecological, social and economic benefits. Abundance and size of fish larva are increasing. Marine biological community composition is improved. At the same time, the bottom trawling is fully forbidden for reducing the threats to the benthic habitat in NJ-MNR.

(2) Tourists control and updated management facilities

The development of tourism can bring considerable incomes to local fishermen. But as stated before, over development of tourism can also bring pressure to the ecosystem. To promote the healthy development of tourism, reduce the cost of management, the tourism carrying capacity was calculated and the number of tourists could be controlled by this. The “one-ticket system” was proposed from 2007 to control tourist quantity. At the same time, the boundary and area of management were clarified, bright warning signs and fences were set up to prevent tourists entering the core area of the MPA. The old facilities were updated, such as communication devices, cars, law enforcement boats.

(3) Ecological restoration

Sargassum horneri can be the shelter, spawning and feeding habitats for many marine organisms. But the *S. horneri* bed was degraded due to many reasons, such as construction. At the same time, these macroalgae can absorb nutrients for ambient sea water to prevent eutrophication. So the restoration of *S. horneri* population is an important job for NJ-MNR. The restoration of *S. horneri* can be simply described as following: 1) study on the life circle of *S. horneri*, 2) artificial breeding in lab, and 3) cultivation of seedling. Good effect has been observed after restoration. Two seaweed fields with an area of 100 hm² have been formulated after recent restoration.

(4) Marine ranching and eco-mariculture

Select proper sea area, such as the out circle of NJ-MNR, set up artificial fish reef to create a suitable habitats and environment for marine organism growth. This activity will promote the production outputs of NJ-MNR and reduce the fishing pressure. Reasonable development of mariculture is encouraged, but the development of mariculture must consider the protection of marine environment and biodiversity. Several measures were carried out to ensure the sustainable development of mariculture, such as reasonable design of mariculture area, promotion of eco-mariculture mode, control on pollution, control on alien species culture, and control on culture scale based on the environment carrying capacity.

(5) Real time monitoring network

A comprehensive monitoring system is set up, including satellite, unmanned aerial vehicle, shore-based radar and law enforcement boat to better manage the dynamic of environment and protected

organisms. Long-term monitoring sites are set up to obtain continuous monitoring data. Water quality is monitored by conducting supervision, control, and management on wastewater discharge and pollution status in mariculture area. The ecosystem assessment indicator system is set up, including environmental indicators, biological indicators, biodiversity indicators and environmental quality indicators. Better analysis and prediction of NJ-MNR biological resources and ecological environmental quality could be achieved by such comprehensive monitoring system.

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4.2 Changyi National Marine Ecology Special Protected Area

4.2.1 Brief introduction

With the coastal wetland ecosystem and the tamarisk (*Tamarix austromongolica* and *Tamarix chinensis*), Changyi National Marine Ecology Special Protected Area (CY-MSPA) is the only MPA for Chinese tamarisk as the protected target in China and also the first National level MSPA in Shandong Province. It was designed and approved by the SOA in October of 2007, and located in the mud flat area on the eastern coastline of Changyi with geographical coordinates of 119°20'19"E to 119°23'49"E and 37°3'7"N to 37°7'12"N.

CY-MSPA maintains various ecotypes, ranging from the shallow waters and mud flat to the saltmarsh and tamarisk wetland. Inside of the MPA, there are diverse plants and animals, including plant species of the Chinese tamarisk, reed (*Phragmites communis*), seepweed (*Suaeda heteroptera*), silvergrass (*Miscanthus sacchariflorus*) and *Limonium bicolor*, bird species of the white swan, wild goose, wild duck, and pheasant, mammal species of the hare, badger, fox, yellow weasel, and palm civet, and macro-benthic communities in the intertidal zone of the *Mactra veneriformis*, *Moerella irideseens*, *Solen gouldi* and *Bullacta exarata*. The natural tamarisk forests cover an area of 2,070 ha, accounting for 71% of the total MPA. The scale and density of the forests is rarely seen in the coast of China, which makes it extremely valuable in the scientific research and tourism development. Together with the mangrove planting, marine scientists give it the name of “Southern Mangrove and Northern Tamarisk”. The tamarisk will bloom three times from every May to September, creating a scene of flower sea in the MPA.





Figure 4.4 The protected targets of CY-MSPA

The CY-MSPA is divided into three zones due to different functions, which are the key protected zone, the ecological and resource restoration zone and the moderate utilization zone. The key protected zone is in the central part of the MPA. It has the most intensive tamarisk forests, most diverse animal/plant species, and most natural resources for scientific, economic and social value. The ecological and resource restoration zone surrounds the key protected zone, having sparse tamarisk now. The moderate utilization zone is outside of the ecological and resource restoration zone and has sufficient sources of marine multiplication and cultivation and saline chemical industries.

The establishment of the CY-MSPA will greatly contribute to the conservation of the coastal wetland ecosystem and biodiversity, to the provision of ecosystem goods and services for purification of air, wind sheltering, sand fixation, and erosion prevention.

4.2.2 Monitoring plan

The objective of the monitoring is providing the information for the MPA effective management and increasing the knowledge of protected targets. Particular objectives of monitoring are shown as below:

- (1) The basic situation of CY-MSPA and its surrounding areas, the growth of Tamarisk, the living habits and wildlife, the natural environment condition, and the relationship among various systems are comprehensively understood by the monitoring.
- (2) In order to protect the coastal wetland ecosystem and marine living resources dominated by *Tamarix chinensis*, the natural law of evolution of wetland will be better understood on the basis of monitoring and scientific research.
- (3) To provide scientific basis for the ecological restoration of *Tamarix chinensis* and wildlife by the monitoring and research, as well as to provide the information on the rational utilization, such as ecotourism and vegetation resources in CY-MSPA.

The monitoring focus on the protected targets, i.e. Tamarisk and wetland, and habitat quality. The

monitoring parameters are shown in Table 4.4, and it was conducted once every year.

Table 4.4 Monitoring parameters of CY-MSPA

| Items | Parameters | Sites |
|-------------------|--|------------|
| Protected targets | Coverage of Tamarisk, biomass | intertidal |
| Habitat quality | Oil concentration in soil | intertidal |
| | Organic carbon in soil | intertidal |
| | Sulfide in soil | intertidal |
| | COD in seawater | intertidal |
| | Phosphate in seawater | intertidal |
| | Dissolved inorganic nitrogen in seawater | intertidal |
| | Oil concentration in seawater | intertidal |

4.2.3 Monitoring results and threats identified

(1) Seawater quality

The monitoring results of sea water quality are summarized in Table 4.5. The COD was stable in the sea water from 2011-2015, the Phosphate was various at the first 2 years and stabilized from 2012-2015, the oil concentration was changed in a similar variation. However, the DIN showed a very high concentration in the first 4 years and dropped in recent 2 years. Comparing with seawater standard, only DIN was exceeding the criteria (0.3 mg/L), and all other monitoring parameters are within the limits of criteria.

Table 4.5 Monitoring results of sea water quality in CY-MSPA

| | COD (mg/L) | PO ₄ -P (mg/L) | DIN (mg/L) | Oil (mg/L) |
|-----------------|--------------|---------------------------|---------------|------------------|
| 2010 | 1.65 ~ 2.88 | 0.00744 ~ 0.0174 | 0.503 ~ 0.811 | 0.0240 ~ 0.0379 |
| 2011 | 1.83 ~ 3.00 | 0.0360 ~ 1.01 | 0.146 ~ 0.280 | 0.0285 ~ 0.0490 |
| 2012 | 1.37 ~ 1.90 | 0.002 ~ 0.003 | 0.698 ~ 0.772 | 0.0196 ~ 0.0258 |
| 2013 | 0.760 ~ 1.37 | 0.00500 ~ 0.0220 | 0.696 ~ 1.76 | 0.00406 ~ 0.287 |
| 2014 | 1.14 ~ 2.21 | 0.00500 ~ 0.0390 | 0.371 ~ 1.12 | 0.00911 ~ 0.0236 |
| 2015 | 1.37 ~ 2.21 | 0.00200 ~ 0.00500 | 0.345 ~ 1.32 | 0.0193 ~ 0.0388 |
| Criteria | 3.0 | 0.030 | 0.3 | 0.05 |

(2) Sediment quality

For the sediment quality monitoring, the results show a very good situation in soil. All the monitoring sites were much lower than the criteria (Table 4.6).

Table 4.6 Monitoring results of sediment quality in CY-MSPA

| | Oil (mg/kg) | Organic carbon | Sulfide (mg/kg) |
|------|-------------|-----------------|-----------------|
| 2010 | 28.0 ~ 67.3 | 0.0672 ~ 0.0398 | 0.00 ~ 6.63 |
| 2011 | 32.3 ~ 38.6 | 0.0523 ~ 0.0945 | 0.672 ~ 1.56 |

| | | | |
|-----------------|--------------|----------------|--------------|
| 2012 | ---- | 0.015 ~ 0.027 | 0.00 ~ 0.384 |
| 2013 | 0.00 ~ 7.40 | 0.0852 ~ 0.10 | 0.469 ~ 4.07 |
| 2014 | 0.00 ~ 58.4 | 0.0578 ~ 0.282 | 1.10 ~ 5.08 |
| 2015 | 7.12 ~ 17.70 | 0.0281 ~ 0.392 | 6.80 ~ 48.10 |
| Criteria | 500 | 2.0 | 300 |

(3) Protected targets

The tamarisk forest consists of various age trees, the density is 450 ~ 4000 /ha with crown width of 0.6*0.6m ~ 4*4m. The height and diameter of tamarisk are shown in Table 4.7 in the fixed monitoring sites of CY-MSPA.

Table 4.7 Monitoring results of tamarisk in CY-MSPA

| | Height (cm) | Diameter (cm) |
|------|-------------|---------------|
| 2013 | 290-310 | 3.9-4.8 |
| 2014 | 340-380 | 4.2-4.9 |
| 2015 | 350-390 | 4.3-5.0 |

The coverage of tamarisk is monitored by the satellite image, which is shown in Figure 4.5 for the year 2013 and Figure 4.6 for the year 2015. There are big changes for the tamarisk coverage and other botany coverage as shown in Table 4.8 and Figure 4.7. There are 470.65 ha tamarisk forest transformed into grassland (332.23 ha), water pond for aquaculture (102.07 ha), and land (40.05 ha).

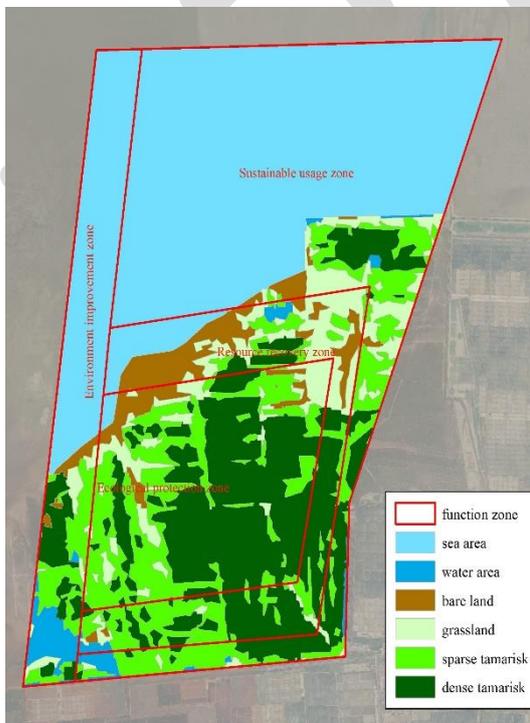


Figure 4.5 The coverage of CY-MSPA in 2013

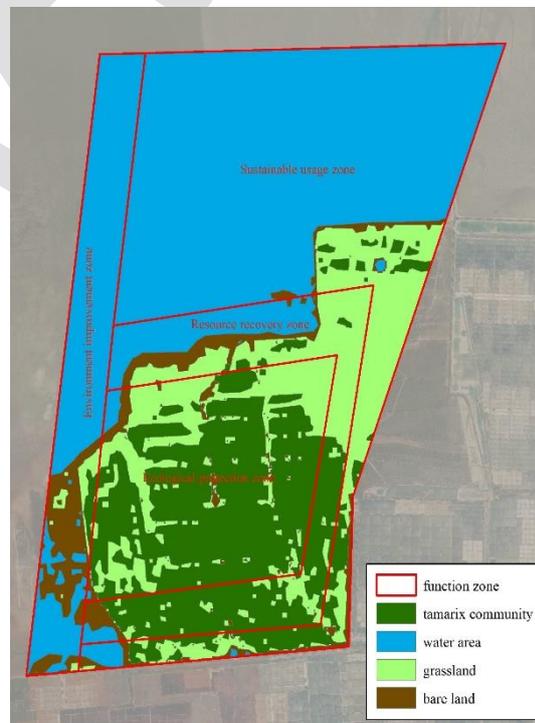


Figure 4.6 The coverage of CY-MSPA in 2015

Table 4.8 Monitoring results of land coverage in CY-MSPA

| | 2013 | | 2015 | |
|-----------|---------|-----------|---------|-----------|
| | Patches | Area (ha) | Patches | Area (ha) |
| Grassland | 60 | 131 | 236.82 | 569.05 |
| Tamarisk | 100 | 25 | 1156.36 | 685.71 |
| Land | 16 | 107 | 137.07 | 177.12 |
| Water | 15 | 16 | 1395.88 | 1497.95 |

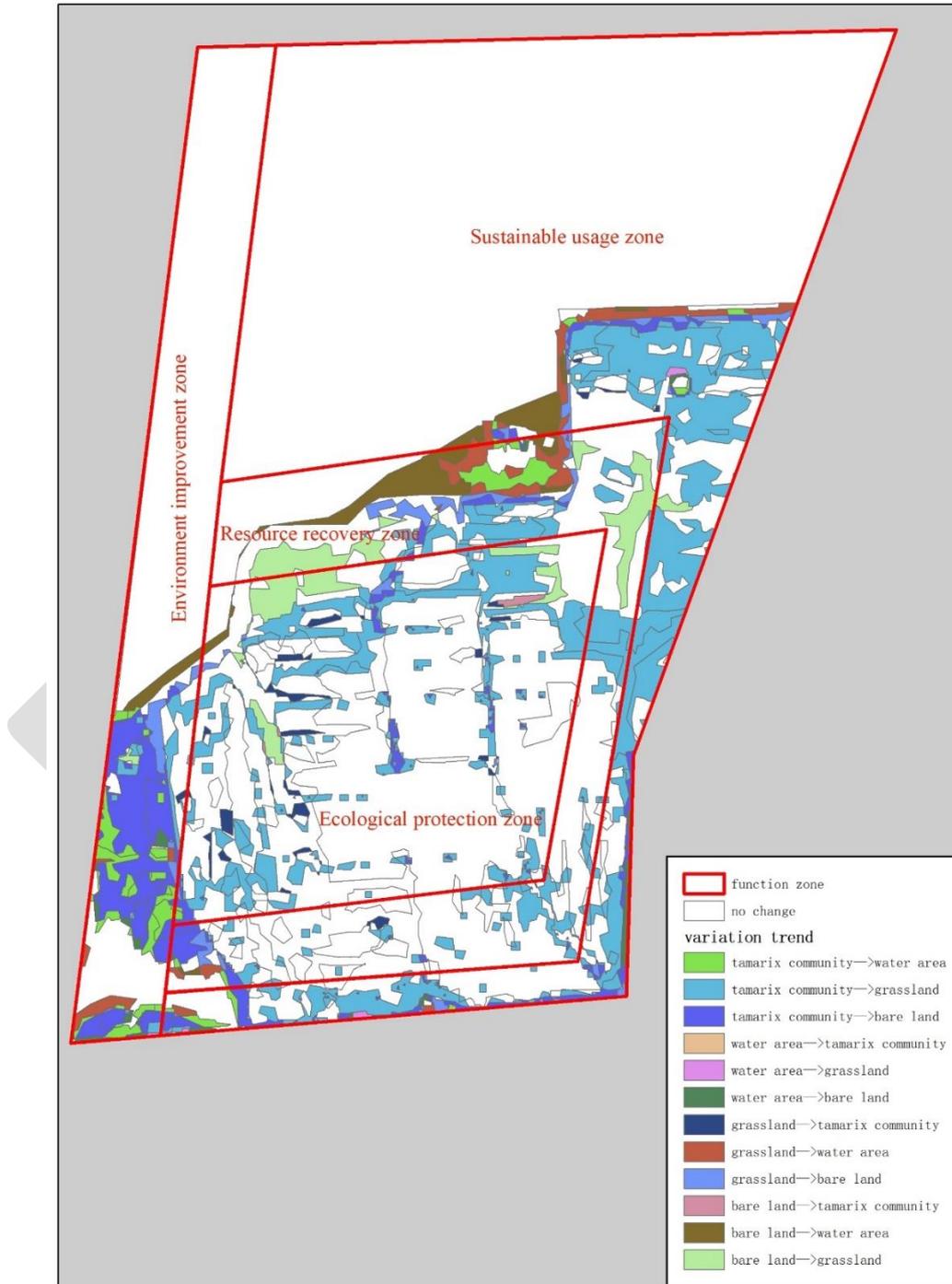


Figure 4.7 The change of land coverage of CY-MSPA from 2013 to 2015



Figure 4.8 The change of botany coverage of CY-MSPA

(4) Threats identified

Based on the monitoring results and habitat analysis, especially the tamarisk habitat transferred to grassland, water pond, and bare land. The major threats were identified as below for the CY-MSPA.

- ◆ Natural ecosystem degradation. When the dam outside the CY-MSPA was completed in 2011, the character of the habitat changed from coastal wetland to dry land with less sea water soaking period. The ecological succession is going fast from saline species to freshwater species, from tamarisk to grassland, although the dominant species is still the tamarisk. Under the background of global climate change, the CY-MSPA will show more and more characters of freshwater wetland with the rainfall increased if the dam was still separate CY-MSPA from the salt water.
- ◆ Aquaculture. There are more than 500 thousand people living around the CY-MSPA, and most of them lived on the aquaculture industry. Therefore, the aquaculture is a very important threats to the MPA, both the habitat occupation and wastewater discharged. The monitoring shows a huge transformation on the habitat around the CY-MSPA, the tamarisk forest had been transferred the aquaculture pond. And DIN pollution is mainly from aquaculture wastewater discharge.
- ◆ Tourism. With the coastal tourism developing fast in China, more and more tourists visit the CY-MSPA, which makes some vegetation habitat damaged to the bare land by trampling and walking. CY-MSPA does not have a tourism management plan and free access for all the people at this moment. More tourists will bring more trashes discharged into MPA, as well as the risk of forest fire.

4.2.4 Management improved

Based on the monitoring results, the management agency of CY-MSPA conducted several special activities for the recovery the coastal wetland ecosystem dominant by tamarisk forest, as well as reducing the influence of more tourists.

(1) Ecological marine aquaculture

The DIN was exceeded the criteria of seawater inside CY-MSPA, which were most from the discharged water of neighbor marine aquaculture pond. To reduce the impact of DIN on the habitat of CY-MSPA, a special law enforcement action was conducted, and an online monitoring system are planned to build on the outlets of aquaculture pond. At the same time, upgrading the traditional aquaculture into the ecological aquaculture to prevent DIN pollution from neighboring marine aquaculture pond.

(2) Ecological restoration.

From the monitoring, there are many original tamarisk forests was transformed and/or degraded into grassland, marine aquaculture pond, and land. To recovery the coverage of tamarisk forest, a restoration project was funded by both central and local government. There is 70 ha tamarisk forest was recovered in 2017, and there will be more grassland and land will be rehabilitated by the tamarisk trees.

(3) Ecotourism planning.

With more and more tourist came into the MPA, which will bring high threats of waste discharge, vegetation damage, risk of fire, and ecosystem degradation. The management agency realizes all those threats and start the ecotourism planning, which make a reasonable tourist visit routine in MPA, reducing the risks of ecosystem degradation, and building an emergency response system for the fireproofing, accidents, and rescues for the tourist. It will provide more ecological goods and services for the people in future.

4.3 Conclusion & Recommendation

By two case studies were analyzed in this chapter, some important information and conclusion we could summarized as a reference for other NEAMPAN MPA sites, as well as the recommendation for the future improvement in other China MPAs.

(1) The MPAs are in good status although facing some threats.

From the monitoring results and evaluation of the above two MPAs, the protected targets are stable with a very fair ecological environment status. However, there are some threats around/within the

MPA, and most of them are from human activities.

Threats from human activities could be well controlled if the MPA agency put efforts on it, although the harmony of the protection and development is a long-term conflict for all the MPAs in China. Because the coastal area is a very developed area along China coast, very intensive human activities and disturbances will bring the pressure to MPAs located along the coast as well. With the progress of eco-civilization implementation, the new policy and regulation will be announced and put into force for the human activities controlling in MPAs in China.

Threats from natural environment and large scale, such as the climate change and global plastic pollution, are very difficult to removed or reduced by a single MPA, which should be have more cooperation world widely. The international coordinating actions are always important for the protected targets and MPAs, not only China but world widely.

(2) The MPAs should develop a tailor-made monitoring plan for protected target.

Although there are some national guidelines for MPA/PA monitoring in China, the protected targets are special in each habitat or ecosystem with various ecological environment and facing various threats in each MPA. It is very important to develop a tailor-made monitoring plan to reflect the changes of protected targets, the status of the ecological environment, and the pressure of the threats (especially the human activities).

For the MPA management agency, the monitoring could start within the framework of the national guideline for 2-3 years. When some monitoring data collected and evaluation had been conducted, the MPA had a better understanding of the status of MPA and protected targets, the tailor-made monitoring plan should be developed for the particular concerns in a long term. For example, the tourist number becomes a monitoring indicator when the tourism is identified as one of the threats in NJ-MNR.

(3) The monitoring data could be used by MPA agencies to improve the management, but not good enough.

The monitoring will normally produce many data, information, and results. However, it is a big issue for the MPA how to use the monitoring data wisely in China. One reason is that the managers of MPAs normally are lack of expertise background on the protected targets, there is none of college education on the MPA in China, which leads to the lack of expertise knowledge widely exist in all the MPAs in China. The managers don't know how to apply those monitoring data into the management actions and further improving the management effectiveness. Another reason is that the lack of a very clear guidance or directives on how to apply the monitoring data into the management actions, which makes most MPAs are not good enough to use those monitoring data.

Right now, the MPA manager is mostly depend on the suggestion from experts or scientists who conducting the monitoring survey or scientific research, but the experts or scientists are obviously lack of practical management experience.

(4) Adaptive management should be more emphasized in MPA monitoring.

As one of the most important and basic principals in MPA, the adaptive management is not well realized to solve the uncertain and complex issues which the MPA faced. Although China published the *Technical Specification for the Management of MPAs* (GB/T 19571-2004), the adaptive management is not recommended. As we know, the marine ecosystem is a complex system affected by many factors, and the policies or actions for controlling the influence of human activities on MPA are also an uncertain impact. Then we need a adaptive path to modify our management actions based on scientific results of the monitoring in MPA, which is critical for MPA's effectiveness.

DRAFT

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Annex 1. Sea Water and Marine Sediment Quality Criteria

Sea Water Quality Criteria of China and other institutions

| Agent (mg/l) | Sea water quality standard of P.R. of China (Class 2) | ASEAN (Proposed Marine water quality criteria) | U.S. EPA Quality Criteria for seawater for regulatory purposes | |
|--|---|--|--|-----------------------|
| | | | Acute criteria | Chronic criteria |
| Nitrate | 0.30 | 0.06 | | |
| Phosphate | 0.030 | 0.015-0.045 (coastal-estuaries) | | |
| DO | >5 | 4 | | |
| COD | 3 | | | |
| Fecal coliform (individual/l) | 2,000 | | | |
| TSS | Man-caused increment ≤ 10 | 50(Malaysia) | | |
| Copper | 0.010 | 8.0 $\mu\text{g/l}$ | 2.9 $\mu\text{g/l}$ | 2.9 $\mu\text{g/l}$ |
| Mercury | 0.0002 | 0.16 $\mu\text{g/l}$ | 2.1 $\mu\text{g/l}$ | 0.025 $\mu\text{g/l}$ |
| Lead | 0.005 | 8.5 $\mu\text{g/l}$ | 140 $\mu\text{g/l}$ | 5.6 $\mu\text{g/l}$ |
| Cadmium | 0.005 | 10 $\mu\text{g/l}$ | 43 $\mu\text{g/l}$ | 9.3 $\mu\text{g/l}$ |
| DDT (dichloro-diphenyl-trichloro ethane) | 0.0001 | | 0.13 $\mu\text{g/l}$ | 0.001 $\mu\text{g/l}$ |
| 666 (benzene hexachloride) | 0.002 | | | |
| Oil/grease | 0.05 | 0.14(Water soluble fraction) | 0.09 | 0.004 |
| PAH | | | 300 | |

Marine Sediment Quality Criteria of P.R. of China (Class 1, GB 18668-2002)

| Agent | Sediment quality standard ($\times 10^{-6}$ dry weight) |
|--|--|
| Mercury | 0.2 |
| Copper | 35 |
| Lead | 60 |
| Cadmium | 0.5 |
| Arsenic | 20 |
| DDT (Dichloro-diphenyl-trichloro ethane) | 0.02 |
| Oil/grease | 500 |
| 666 | 0.50 |
| Organic carbon | 2.0 |
| Sulfide | 300 |

Annex 2. Introduction of 6 MPAs in Reference 1-6 (in Chinese)

(1) 浙江南麂列岛国家级自然保护区 (National Nature Reserve in Nanji Islands, Zhejiang)
以海洋贝藻类、海洋性鸟类、野生水仙花及其生态环境为主要保护对象的国家级自然保护区，属于海洋生态系统保护区类型。保护区位于浙江省平阳县东南海域，列岛为基岩丘陵岛屿，由 52 个岛屿、数十个明、暗礁及周围海域所组成，地理坐标为 120°56'30"E 至 121°08'30"E、27°24'30"N 至 27°30'00"N，总面积为 20106 ha，其中岛屿陆域面积 1113 ha，海域面积 18993 ha。保护区于 1990 年建立，1998 年加入联合国教科文组织“世界生物圈保护区网络”，2002 年被列为由全球环境基金(GEF)资助的“中国南部海域生物多样性管理国别项目”四个示范区之一，是我国首批 5 个国家级海洋自然保护区之一。

保护区地处温带和热带的过渡带，气候适宜，区内岛礁星罗棋布，岸线逶迤曲折，岬角丛生，海湾众多，有沙滩、泥滩、砾石滩与岩礁等多种岸滩类型；由于地处台湾暖流和江浙沿岸流的交汇处，生态环境独特，生物种类多样，生物区系复杂，为海洋生物栖息生长提供了良好的场所。现已知贝类 427 种，大型底栖藻类 178 种（两者约占全国的 20%、浙江省的 80%），微小型藻类 459 种，鱼类 397 种，甲壳类 257 种，其他海洋生物 158 种。有 36 种贝类在国内仅出现在南麂列岛，黑叶马尾藻、头状马尾藻和浙江褐茸藻属世界新种，22 种藻类被列为稀有种。保护区的海洋贝藻类不仅物种繁多，而且还具有温带、热带两种区系特征，同时表现出明显的地域上的“断裂分布”现象，素有“贝藻王国”之美誉，是我国主要海洋贝藻的天然博物馆和基因库，是海洋生物“南种北移，北种南移”的资源库。

南麂列岛自然景观独特，山秀、石奇、滩美、草绿、海蓝、空远，被誉为“碧海仙山”。保护区内岛屿众多，各具特色。最大岛为南麂岛；大擂岛和竹岛因长有大量的水仙花，被称为“水仙花岛”；还有蛇岛、鸟岛等。南麂岛的三盘尾则怪石众多，岩壁耸秀，草坪如茵，旅游资源丰富多彩。

保护区是我国建立的第一个海岛海域生态系自然保护区，具有重要的科学和生态价值。保护区海洋风光秀丽，旅游资源丰富，游客规模也逐渐增加。保护区不仅是教学科研基地，也是海洋生态旅游的胜地。

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南麂列岛国家级自然保护区 <http://www.njld.org/>

(2) 广西山口红树林国家级自然保护区 (National Nature Reserve for Mangrove in Shankou, Guangxi) 以红树林生态系统为主要保护对象的国家级自然保护区。位于广西合浦县沙田半岛东西两侧，南临大海，是北部湾东侧沙田半岛的沿海滩涂，地理坐标为 109°37'00"E 至 109°47'00"E，21°28'22"N 至 21°37'00"N，总面积 8000 ha。1990 年经国务院批准建立，是中国首批五个国家级海洋类型保护区之一，是中国第二个国家级的红树林自然保护区。1993 年加入中国人与生物圈组织，1994 年被列为中国重要湿地，1997 年与美国佛罗里达州鲁克利湾国家河口研究保护区建立姐妹保护区关系，2000 年加入联合国教科文组织世界生物圈，2002 年被列入国际重要湿地名录。

保护区地处亚热带，海岸线总长 50 km，由沙田半岛东侧和西侧的海域、陆域及全部滩涂组成。东侧是火山灰发育的土壤，滩涂淤泥肥沃，红树林生长特别茂盛。西岸滩涂全为淤泥质，适宜红树林生长。保护区所处地理位置光热条件较好，冬季低温影响小，海湾侵入内陆，封闭性好，风浪、潮汐和余流的作用较弱，岸滩比较稳定，水质洁净，是红树林大面积分布和生存的理想区域，构成良好的生态系统。山口红树林保护区是广西沿海“三最”（海水盐度最高、降雨量最少、地表温度最高）的地方，这里的红树林包括 6 个群系：红海榄群系、秋莉群系、白骨壤群系、海漆群系、桐花树群系、木榄群系。

保护区是著名的动物栖息地，包括多种海洋生物和鸟类，具有重要的科学价值。鸟类有国家 II 级保护动物白琵鹭、凤头鹰、松鹊鹰、雀鹰、黑脸鳶鹰、燕华、红脚华、红华、小鸦鹃、斑头鹃等 13 种，还有白鹭、大白鹭、池鹭等鹭科鸟类，青脚鹏、白腰构鹏、叭鹏、红颈滨鹏等适合观鸟爱好者观察的鸟类；还有黑脸琵鹭，是中国继朱鹮之后的最濒危的鸟类，是世界上濒于灭绝的动物之一。保护区不时还有儒艮出现，海草是其主要食物。此外还有昆虫 167 种，鱼类 95 种。保护区红树林底栖动物和鱼类多为广温性亚热带、热带种类。

保护区集中分布有红树林、盐沼草和海草生态系统，具典型的大陆红树林海岸生态系统特征，是中国大陆海岸发育较好、连片较大、结构典型、保存较好的天然红树林分布区。保护区的建立，不仅有利于红树林养护，而且能改善保护区生态系统，带动当地社会经济的发展。

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- 中国红树林保育联盟 <http://www.china-mangrove.org/point/26>
- 湿地馆 http://amuseum.cdstm.cn/AMuseum/marsh/page/shidiminglu_010201_143.html

(3) 广西北仑河口国家级自然保护区 (National Nature Reserve in Beilun Estuary, Guangxi)

以红树林生态系统为主要保护对象的国家级自然保护区。位于广西壮族自治区防城港市防城区和东兴市境内的沿海地带，南濒北部湾，西与越南交界，海岸线全长 87 km，地理坐标为 108°00'30"E 至 108°16'30"E，21°31'00"N 至 21°37'30"N，总面积 3000 ha。1985 年建立县级红树林保护区，1990 年晋升为省级海洋自然保护区，2000 年晋升为国家级自然保护区。2001 年加入中国人与生物圈组织，2004 年加入中国生物多样性保护基金会自然保护区委员会，2008 年被列为国际重要湿地。

保护区拥有河口海岸、开阔海岸和海域海岸等地貌类型，并有红树林生态系统、滨海过渡带生态系统、海草床生态系统。由于位于海湾、河口及其邻近滩涂，潮汐相对缓和，有利于海潮和入海河流中泥沙、碎屑等物质的沉积，形成了适宜红树林生长的环境。珍珠湾内生长着我国大陆海岸连片面积最大的红树林和木榄纯林，是典型的海湾红树林和罕见的平均海平面以下大面积的红树林，在我国大陆沿海红树林中具有不可替代的重要性。红树林面积约 1065.8 ha，红树植物 14 种（其中真红树 9 种、半红树 5 种），包括白骨壤、桐花树、秋茄、木榄、红海榄、海漆、老鼠勒、榄李、卤蕨、水黄皮、黄槿、杨叶肖槿、海芒果和银叶树；红树植物群落分为海岸红树植物群落和海岛红树植物群落两大生态类群，主要群落类型有卤蕨群落、白骨壤群落、桐花树群落、秋茄群落、木榄群落、海漆群落、老鼠勒群落和银叶树群落等 12 种。

红树林内还有大量的鸟类和海洋生物资源，也是候鸟迁徙的重要中继站。保护区有鸟类 187 种，其中黄嘴白鹭、白琵鹭、凤头鹰、雀鹰、松雀鹰、灰脸鵟鹰、燕隼、红脚隼、红隼、小鸦鹃、红角鸮和鹰鸮等种类属于国家 II 级保护动物。海洋生物主要有大型底栖动物 155 种，鱼类 27 种，其中一些海洋动物为古老的子遗种类，如被称为“活化石”的鲎是 II 级保护动物，鸭嘴海豆芽是我国优先级保护动物。

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- 中国园林网 <http://jingguan.yuanlin.com/10829.html>

(4) 海南万宁大洲岛海洋生态国家级自然保护区 (National Nature Reserve for Marine Ecology in Dazhou Island, Wanning, Hainan) 以海岛及周围海域重要海洋生态系统和金丝燕及其生存环境为主要保护对象的国家级自然保护区。位于海南省万宁市东南部, 地理坐标为 110°26'50"E 至 110°32'06"E, 18°37'06"至 18°43'54"N, 总面积 7000 ha。1988 年建立大洲岛省级保护区, 1990 年升级为国家级自然保护区, 是中国首批建立的 5 个海洋类型国家级自然保护区之一。

大洲岛由南岭、北岭两岛构成, 南岭面积 2.7km², 海拔 289m; 北岭面积 1.5 km², 海拔 136m, 地势较平坦, 沿海一带有较长的沙滩。大洲岛是海南沿海离岸最大的岛屿, 具有典型的海岛生态系统。岛上植被郁郁葱葱, 乔木、灌木、藤类和草本植物纵横交错, 植物种类繁多, 有名贵的中草药金不换、金银花等。动物资源丰富, 有蜥蜴、蛇、猴、穿山甲、狐狸、野兔、四脚蛇等野生动物自由穿行、栖息和繁衍, 有鹧鸪、老鹰、海燕、鹭、金丝燕等鸟类在空中翱翔, 这些生物群落及其环境构成了大洲岛特殊的海岛海洋生态系统。海岛附近太阳河等入海河流带来大量有机物和饵料, 形成了著名的大洲渔场, 盛产马鲛鱼、鱿鱼、龙虾、鲍鱼等名贵海珍品; 还有澄黄滨珊瑚、二异角孔珊瑚等珊瑚礁资源, 泰莱草、海神草等海草资源。

大洲岛是金丝燕在中国唯一的长年栖息地, 花岗岩构造的岛岸, 经海水长年剥蚀而成形状各异的陡峭岩洞, 为金丝燕提供了良好的栖息场所。金丝燕是濒危保护物种, 是中国目前所知唯一可以营造白色可食燕窝的珍稀鸟类, 所产燕窝是十分名贵的食品和药品, 素有“东方珍品”和“稀世名药”的盛誉。

保护区原始状态的热带海岛海洋生态系统在中国极为稀少, 具有很高的保护价值。

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(5) 海南三亚珊瑚礁国家级自然保护区 (National Nature Reserve for Coral Reef in Sanya, Hainan) 以造礁珊瑚、非造礁珊瑚、珊瑚礁及其生态系统、生物多样性为主要保护对象的国家级自然保护区。位于海南省三亚市南部近岸及海岛四周海域，地理坐标为 109°20'50"E 至 109°40'30"E， 18°10'30"E 至 18°15'30"N，总面积 8500 ha。1990 年经国务院批准建立，是我国首批的 5 个海洋类型国家级自然保护区之一。

保护区由 3 块区域组成，即亚龙湾片区、鹿回头半岛-榆林角沿岸片区、东西瑁岛片区。亚龙湾片区主要包括西排、东排与野薯岛及其之间的海域；鹿回头半岛-榆林角片区主要包括鹿回头湾、鹿回头岭、小东海、大东海等区域。东、西部属典型的海岛地貌，中部岬角、海湾多，属半岛陆域地貌。

本区地处低纬度，属热带海洋性季风气候，水文条件适宜珊瑚群落的生长发育，是珊瑚礁发育的理想场所。造礁珊瑚的建造者为珊瑚虫，珊瑚虫属热带海洋腔肠动物。区内珊瑚种类繁多，目前已查明有 117 种（包括 5 个亚种）造礁珊瑚，分别属于 13 科 33 属和 2 亚属，10 种最常见的造礁石珊瑚是从生盔形珊瑚、澄黄滨珊瑚、秘密角蜂巢珊瑚、中华扁脑珊瑚、多孔鹿角珊瑚、梳状菊花珊瑚、同双星珊瑚、疣状杯形珊瑚、标准蜂巢珊瑚、繁锦蔷薇珊瑚。在成礁建造中有积极意义的珊瑚有苍珊瑚、笙珊瑚、多孔媳，还有多种非造礁珊瑚—软珊瑚、柳珊瑚。在珊瑚礁生态系统中，有多种密切依赖珊瑚礁的共栖海洋生物，包括底栖生物海葵，102 种珊瑚礁鱼类等。

保护区海域与三亚市几处主要著名旅游海湾—亚龙湾、大东海海湾、三亚湾及天涯海角相邻，构成了三亚滨海景区的生态内涵。

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海南三亚珊瑚礁国家级自然保护区管理处 <http://www.sycoral.com.cn/>

(6) 山东昌邑国家级海洋生态特别保护区 (National Marine Ecology Special Protected Area of Changyi, Shandong) 以柽柳为主的滨海湿地生态系统, 是中国唯一以柽柳为主要保护对象的国家级海洋生态特别保护区。保护区位于山东省昌义市北部堤河以东、海岸线以下的滩涂上, 地理位置为 119°20'19"E 至 119°23'49"E、37°3'7"N 至 37°7'12"N, 总面积 2929 ha。于 2007 年 10 月获国家海洋局批准建立。

山东昌邑海洋生态特别保护区, 生态类型多样, 主要有浅水海域、滩涂、盐沼、柽柳湿地等天然湿地类型。保护区内植被茂盛, 生物种类繁多。除柽柳外, 还有芦苇、翅碱蓬、荻、二色补血草及其他多种植物; 有白天鹅、大雁、野鸭、野鸡等多种鸟类; 有野兔、獾、狐狸、黄鼬、狸猫等野生哺乳动物; 潮间带大型底栖动物群落物种丰富, 有四角蛤蜊、彩虹明樱蛤、长竹蛏、泥螺等。保护区内天然柽柳林达 2070 ha, 约占保护区总面积的 71%, 其规模和密度在全国滨海盐碱地区罕见, 被海洋专家们誉为“南有红树林, 北有柽柳林”, 具有极高的科学研究和旅游开发价值。每年 5 月柽柳开始抽生新的花序, 一直到 9 月的几个月内, 区内一片花海, 花谢花开, 三起三落。

按功能, 将保护区划分为 3 个区, 即重点保护区、生态与资源恢复区、适度利用区。重点保护区位于保护区中心地带, 为柽柳最密集、动植物最具多样性和保护对象科研价值、经济价值、社会价值最集中的区域; 生态与资源恢复区位于重点保护区周边区域, 现有稀疏柽柳分布; 适度利用区位于生态与资源恢复区外侧, 周边水产增养殖和盐化工产业十分密集。

山东昌邑海洋生态特别保护区的设立, 对维护海洋及海岸生态系统, 保护海洋生物多样性, 净化空气、防风固沙、防止海岸侵蚀, 改善莱州湾生态环境, 都起到了非常重要的作用。

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