

Demonstration Zone of Integrated Ecosystem-based Investigation
on Wetland of Jiaozhou Bay of Qingdao
(UNDP/GEF YSLME Phase II Project)

**Establishment of the Ecosystem-based Integrated
Monitoring System of Jiaozhou bay:
Discussion on the mode of Public Participation**

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Preface

This report is one of the outputs of the United Nations Development Program (UNDP) Yellow Sea Large Marine Ecosystem Phase II Project (YSLME II) Demonstration Zone of Integrated Ecosystem-based Investigation on Wetland of Jiaozhou Bay.

This project takes Jiaozhou Bay as a demonstration zone to conduct a series of integrated investigations on the wetland ecosystem, and to master the status of wetland ecosystem, so as to provide the municipal government with scientific information and decision making support. Therefore, Qingdao Municipal Marine Development Bureau, taking charge of the management of Jiaozhou Bay, provided strong supports for the application and implementation of this project.

This report, on the basis of the project, attempted to establish the ecosystem-based monitoring system discussed the mode of public participation, which would promote the understanding of Jiaozhou Bay ecosystem and facilitate the implementation of ecosystem-based integrated management in Jiaozhou Bay.

1 Introduction of Jiaozhou Bay

The Jiaozhou Bay, bordering on the West of the South Yellow Sea, is a semi-enclosed natural bay with total area of 370.6km² and an average water depth of 7m. There are diverse ecosystems in the Jiaozhou Bay Region, such as shallow sea, wetland, seagrass, islands and etc. Jiaozhou Bay wetland, which is the largest wetland ecosystem in the southern part of Shandong Peninsula, has been included in the key wetland protection list of China. There are multiple rivers flowing into the Bay, such as Moshui River, Baisha River, Dagu River, Yanghe River, and etc.

Jiaozhou Bay Wetland Region owns important habitats for some rare species. And the biological resources are diversified. The Jiaozhou Bay wetland is amongst the most important stopover areas for migratory birds on East Asian Australasian Flyway (EAAF) and is used by the birds for feeding and resting during the migration. Eighteen species on the "Chinese National Important Protected Wildlife List" were recorded, with 5 species of the first level and 13 species of the second level. According to the global IUCN Red List of Threatened Species (2017), 19 species of waterbirds were recorded, including 4 species of CR level, 6 species of EN level and 9 species of VU level. Furthermore, 13 Near Threatened species were recorded. Jiaozhou Bay wetland is also selected by WWF as an important bird area in its "Ecoregions 2000" program. In addition, there are some other valuable organisms in the Jiaozhou Bay Region, such as *Amphioxus* with important scientific value, and seagrass bed, an important marine habitat.

Meanwhile, Jiaozhou Bay also has various cultural tourism resources with unique characteristics and values, such as folk culture, historical

culture, festival culture, military culture, fishery culture, port culture, and etc.



Figure 1 Remote sensing image of Jiaozhou Bay, Qingdao

1.1 Resources in Jiaozhou Bay

1.1.1 Port and Shipping Resources

Jiaozhou Bay has a tortuous coastline, with bedrock coasts. There are many natural bays, with the advantages of no large river inflow, small amount of land source sand input, steep underwater slopes, and deep water, which are suitable for building deep water berth so as to form a large port group composed of port areas with various functions and

throughput. Nowadays, different kinds of ports are distributed along the coast of Jiaozhou Bay, including commercial port, industrial port, cruise home port, ferry terminal, official port, fishing port, ship building and repair yard, and etc.

Among all the ports, Qingdao Port has the greatest influence. Qingdao Port, as a natural deep-water harbor, is the sixth largest port in the world and the second largest foreign trade port in China. Qingdao Port has trade transactions with more than 700 ports from over 180 countries and regions in the world. In 2019, cargo throughput exceeded 600 million tons, ranking sixth in the world, and container throughput completed 21.83 million TEUs, ranking seventh in the world. The volume of sea-rail combined transport was 1.39 million TEUs, ranking first among coastal ports in China.

1.1.2 Tourism Resources

The administrative regions along the Jiaozhou Bay include Jiaozhou City, Huangdao District (including the original Jiaonan City), Shibei District (including the original Sifang District), Shinan District, Licang District, Chengyang District, and Hongdao. The natural and cultural tourism resources in this area have been attracting a large number of tourists because of the long history and various categories. Some scenic spots are well-known.

The tourism resources of the Jiaozhou Bay Rim include natural resources, humanism resources and cultural resources. The natural tourism resources refer to the picturesque sceneries of mountains (such as Lao Mountain, Dazhu Mountain and Xiaozhu Mountain, etc), wetlands, waters and beaches. There are also some wetland parks in this area, not only

appealing to lots of tourists, but also becoming the bird paradise. Beaches are the important tourism resource in this region, supporting different kinds of recreational activities, especially in summer.

There are many cultural tourism resources around Jiaozhou Bay, which are mainly divided into historical and cultural tourism resources and religious cultural tourism resources. The Jiaozhou Bay area has a long history. As early as more than 5000 years ago, during the Dawenkou Period, human activities occurred. After the alternation of dynasties, a large number of human civilization relics and cultural heritages have been left. Famous historical and cultural tourist attractions include Langya Terrace, Great Wall of Qi Dynasty, Han Dynasty Tomb, Sanlihe Cultural Site, etc. The Jiaozhou Bay Rim is also an important area for the spread of various religions, including Buddhism, Taoism and Christianity. Therefore, there are some famous temples and churches, which are still active nowadays.

With the characteristics of long history, wonderful landscapes, and various cultures, a number of festival brands that reflect Qingdao's urban landscape and show humanistic customs have been gradually developed in Jiaozhou Bay Rim. Some have achieved great success. For instance, Qingdao International Beer Festival, which has been held for about forty years, has raised the city's popularity and greatly promoted the development of the local economy.

1.1.3 Wetland Resources

1.1.3.1 Shoreline and Wetland

In 2019, the shoreline of Jiaozhou Bay wetland is divided into artificial

shoreline, sand (gravel) shoreline, silt and silt shoreline, bedrock shoreline, estuary shoreline and ecological shoreline. The total length of shoreline is 213.93 km, of which the total length of artificial shoreline is 164.44 km and the total length of natural shoreline is 49.49 km, and the retention rate of natural shoreline is 23.14% .

In 2019, the wetland types of Jiaozhou Bay wetland include shallow waters, sandy beaches, muddy beaches, *Phragmites communis*, *Spartina alterniflora*, intertidal brine marshes, reservoirs, aquaculture farms and 10 other types, covering a total area of 27,729.85 hectares. Among them, the area of shallow waters is 21,191.98 hectares, the area of sandy beaches is 8.84 hectares, the area of muddy beaches is 1405.86 hectares, the area of estuary waters is 727.89 hectares, the area of *Phragmites communis* is 18.37 hectares, the area of *Spartina alterniflora* is 290.01 hectares, the area of intertidal brine marshes is 10.87 hectares, the area of reservoir ponds is 355.43 hectares, the area of aquaculture farms is 3,161.43 hectares, and the area of other types is 559.16 hectares.

1.1.3.2 Birds

Jiaozhou Bay wetland is on the EAAF, which is one of the 8 migratory routes all over the world. It is also the important stopover for the waterfowl migration. From January to November 2019, 114 species of birds of 12 orders, 35 families, including 12 national protected birds and 21 threatened birds on the IUCN red list were recorded in Jiaozhou Bay wetland. There were 2 species belonging to category I in national protected birds (Chinese crested terns and Relict gull), and 10 species belonging to category II, including *Platalea minor*, *Platalea leucorodia*, Whooper swans, *Grus grus*, *Elanus caeruleus*, *Buteo japonicus*, *Pandion*

haliaetus, *Circus cyaneus*, *Falco tinnunculus* and *Falco peregrinu*. For IUCN red list, there are 2 species of CR level (*Aythya baeri* and Chinese crested tern), 4 species of EN level, including *Platalea minor*, *Numenius madagascariensis*, *Calidris tenuirostris* and *Tringa guttifer*, 3 species of VU, including *Aythya ferina*, *Larus relictus* and *Larus saundersi*, and 11 species of NT level.

From January to November 2019, the total number of birds in the Jiaozhou Bay wetland was 201,531, with the number of Charadriiformes accounting for 85% of the total. The dominant species of birds were *Calidris alpina*, *Pluvialis squatarola*, *Numenius arquata*, *Limosa lapponica* and *Tadorna tadorna*. The largest number of birds came up in winter. The major habitats for wetland birds breeding and feeding, including coastal tidal flats, estuaries, artificial ponds, shrimp ponds, and puddles, etc. were distributed at the estuaries of Moshui River, Baisha River, Dagu River, Yuejin River and Yang River

According to standard 5 of RAMSAR, if a wetland regularly supports 20,000 or more waterfowl, its international importance should be considered. According to standard 6, a wetland should be considered as international significance if it regularly hosts 1% of a waterfowl species or subspecies. The total number of overwintering waterbirds in Jiaozhou Bay wetland exceeded 20,000, which reached the standard of wetlands of international importance. And the number of 3 species accounted for more than 1% of the total population on the migration route, including *Numenius arquata*, *Tadorna tadorna* and *Anas falcate*. And the number of two species accounted for more than 10% of the total population on the migration route, *Haematopus ostralegus* and the *Larus saundersi*. This indicates that Jiaozhou Bay wetland plays an extremely important role in

the migration route of birds from East Asia to Australia and should be included in the international wetland of importance.

1.1.3.3 Vegetation

According to the survey in 2019, there are 272 species plants belonging to 190 genera of 59 families in Jiaozhou Bay wetland, including 28 shrubs, 202 herbs, 33 trees and 9 vines. A national secondary protected plant, Wild soybean, sparsely distributed in the vicinity of the Yanghe estuary bridge, the number is less than 1000 plants, there is a green belt nearby, subject to a moderate degree of human interference. There were 53 species of invasive plants, including 44 species of invasive plants of grade 1 to 4. The main invasive species were *Spartina alterniflora* and *Spartina anglica*.

In autumn 2019, the vegetation distribution area of Jiaozhou Bay wetland was 649.31ha, the total dry biomass was 1.48×10^4 t, and the vegetation biomass per unit area was 2.27 kg/m^2 . Wetland vegetation and tidal flats are mainly distributed at the river estuaries, including Licun estuaries, Hongdao, Baisha River and Moshui River tidal flats, Dagu River Estuary, Yanghe River Estuary, and etc., in which Yanghe River Esturay and the tidal flat distributed the vegetation with largest area, and then east tidal flat of Hongdao, Nvgukou, Moshui River Esturay and Baisha River Estuary.

Spartina alterniflora、*Suaeda salsa*、*Phragmites communis* and *Spartina anglica* is the main vegetation type in . *Spartina alterniflora* had the largest area, 576.9ha, and the total biomass was 1.36×10^4 t, mainly distributed in the Yanghe River Estuary, Dagu River Estuary, Hongdao

dongtan, Nugu estuary, Moshui River Estuary and Baisha estuary. *Suaeda salsa* and *Phragmites communis* came next, with an area of 45.93ha and 42.26ha, and a total biomass of 75.8t and 960.1t, respectively. *Suaeda salsa* was mainly distributed in the mouth of Yanghe River and Moshui River Estuaries, while *Phragmites communis* was mainly distributed in the mouth of Dagu river and Moshui River Estuary. *Spartina anglica*, with an area of 11.9ha and a total biomass of 104.2t, is mainly distributed in Dagu River Estuary, Lianwan River Estuary and east tidal flat of Hongdao.

1.1.4 Marine Organisms

1.1.4.1 Phytoplankton

In 2019, 60 species of phytoplankton and 48 species of diatoms were collected in August, accounting for 80.0% of phytoplankton species. There are 12 species of phyllococcus, accounting for 20.0% of phytoplankton species. The average density was $9022.72 \times 10^4 / \text{m}^3$. The dominant species were *Chaetoceros curvisetus*, *Skeletonema costatum* and *Skeletonema sp.*. The average biodiversity index was 1.21.

1.1.4.2 Zooplankton

(1) Macro- and meso-zooplankton

In August 2019, a total of 50 species (class) (excluding fish eggs and larvae) of Macro and meso- zooplankton were detected, belonging to four phyla of Coelenterata, Arthropoda, Chaetognatha, Urochordata. There were 20 species of larvae. There were 13 species of jellyfish and 11 species of arthropod copepods, respectively accounting for 26.0% and 22.0% of zooplankton species. The average density of zooplankton was 411.38 g/m^2 . And the average biomass was 361.55 g/m^2 . The dominant

species of density is Zoea larva (Brachyura), *Sagitta crassa*, *Labidocera euchaeta*, Mysidae larva, *Paracalanus parvus*, Macrura larva, *Obelia* sp., *Acartia pacifica*. The biodiversity index was 3.49.

(2) Meso-and micro-zooplankton

In August 2019, a total of 45 species (categories) (excluding fish eggs and larvae) of meso-and micro-zooplankton were detected, belonging to 7 phyla of Protozoa, Coelenterata, Arthropoda, Chaetognatha, Urochordata and Chordata. There are 21 species of larvae. For species composition, Copepods with 11 species and jellyfish with 6 species took the dominance. The average density was 30,896.5 /m². The dominant species of density is *Oikopleura longicauda*, *Paracalanusparvus*, *Oikopleura dioica*, *Calanus sinicus*, *Noctiluca scintillans*.

1.1.4.3 Benthos

In August 2019, a total of 87 species of macrobenthic organisms were detected at 14 stations, belonging to 7 animal phyla of Platyhelminthes, Nemertea, Annelida, Mollusca, Arthropoda, Echinodermata and Chordata. There were 36 species of Polychaetes, taking the dominance, 23 species of Crustacea and 16 species of Mollusca. There average density was 604 ind./m². The average biomass was 231.10g/m². The dominant species were *Nephtysoligo branchia*, *Eriopisella sechellensis*, *Sternaspis scutata*, and *Heteromastus filiformis*. The biodiversity index was 2.91.

1.1.4.4 Intertidal organisms

In August 2019, a total of 85 species of organisms were detected belonging to 7 phyla including Chlorophyta, Coelenterata, Nemertea, Annelida, Mollusca, Arthropoda and Chordata, in which there were 28

species of Crustacea, 25 species of Polychaeta, 24 species of Mollusca, 4 species of Chordata, 2 species of Coelenterata and 1 species of Chlorophyta. The average density was 767.1 ind./ m². And the average biomass was 99.38g/m². For species composition, the dominant species was *Musculus senhousia*. The density of Mollusca accounted for 90.33% and the biomass of Mollusca accounted for 72.99%. The average biodiversity was 1.65.

1.1.4.5 Fish egg and larvae

In 2019, there were 8474 fish eggs of 7 species and 3057 larvae and juveniles of 8 species obtained in Jiaozhou Bay. For quantitative vertical trawl, the fish egg were obtained at 4 stations, with the average density of 1.34ind/m³, and larvae and juveniles were obtained at 9 stations, with the average density of 5.23/m³.

1.1.4.6 Nekton

In 2019, there were 33 species of nekton acquired in Jiaozhou Bay, with 21 species of fish, 6 species of shrimp and crab, 3 species of Cephalopoda, 2 species Bivalvia and 1 species of Echinodermata. The dominant species were *Octopus ocellatus* and *Oratosquilla oratoria*.

1.2 Marine Environment of Jiaozhou Bay

In 2019, the environmental quality of Jiaozhou Bay was generally good, with 74.8 percent of the waters meeting the quality standards for category I and II seawater, an increase of 1.1 percent over 2018. 8.3% of the sea areas were in the fourth and worst category, an increase of 0.3% over 2018. The polluted sea areas are mainly distributed in the northeast of Jiaozhou Bay and the top of Beibu bay. The main pollutants are inorganic

nitrogen, followed by active phosphate and petroleum. On the whole, in the past five years, the environmental quality of the sea water in Jiaozhou Bay has been on a continuous upward trend. The proportion of the sea areas with the water quality standards of category 1 and category II has increased, while the proportion of the sea areas with the water quality standards of category IV and category IV has decreased.

The sediment quality of Jiaozhou Bay is generally good. Only one petroleum station exceeds the Marine Sediment Quality Standard of category I, while all other monitoring stations meet the Marine Sediment Quality Standard of category I.

The Marine community in Jiaozhou Bay is relatively stable with little change. The species number, density, biomass and dominant species composition of Marine phytoplankton, zooplankton and benthos have not changed significantly over the years. But 2019 species of fish larvae number was lower than that in 2015, and in recent years, according to the survey, the are the main dominant of fish larvae of low-value fish, small yellow croaker, hairtail, white Chinese croaker economic fish larvae have appeared, but few in number or only in few months, showed that the shallow waters as traditional economic types of spawning, the brood place function declined.

1.3 The problems on Jiaozhou Bay ecosystem

1.3.1 Tidal prism decreased

Although *Regulation for Jiaozhou Bay Protection of Qingdao* was issued in 2014 to strictly prohibit reclamation activities in Jiaozhou Bay, the area Jiaozhou Bay has decreased greatly in the last one and a half centuries

which caused the decrease of tidal prism and hydrodynamic. And then, the ability of water exchanged was weakened and the self-purification capacity of Jiaozhou Bay declined, leading to pollution in some areas.

1.3.2 The degradation of the function of Jiaozhou Bay wetland

Jiaozhou Bay Wetland is one of the important stopovers for migratory birds on EAAF. However due to the over-exploitation of land reclamation, the construction of marine and coastal projects, etc., the area of Jiaozhou Bay's wetland continued for shrink from 1988 to 2016, and the wetland ecosystem has been destroyed with the declining biodiversity has been drastically reduced, and the function of purification and regulation has been greatly reduced.

1.3.3 Serious pollution in some areas of Jiaozhou Bay

Major pollutants in Jiaozhou Bay are inorganic nitrogen and active phosphate. The seriously polluted areas with the water quality of Grade IV or worse than Grade IV of National water quality standard are mainly distributed at the northern and eastern part of the bottom of Jiaozhou Bay.

1.3.4 Invasive species -- *Spartina alterniflora*

Spartina alterniflora, originated from the Atlantic coast of North America, is the major invasive species on the wetland of Jiaozhou Bay. The rapid expansion of *Spartina alterniflora* has attracted the attention of the government and the public.

Remote sensing monitoring results showed that *Spartina alterniflora* (including a little *Spartina anglica*) in Jiaozhou Bay had a total distribution area of 588.6ha in 2019, mainly distributed in Moshui River estuary and Baisha River estuary, Hongdao tidal bank, Dagu River

estuary, Yanghe River estuary and Lianwan River estuary. There are three areas with the largest distribution areas of *Spartina alterniflora*, including Yanghe River estuary and the south tidal flat, Nvngu River estuary and Moshui River estuary and Baisha River estuary, and the tidal flat on the east side of the Hongdao. *Spartina anglica* is mainly distributed in Dagu River estuary.

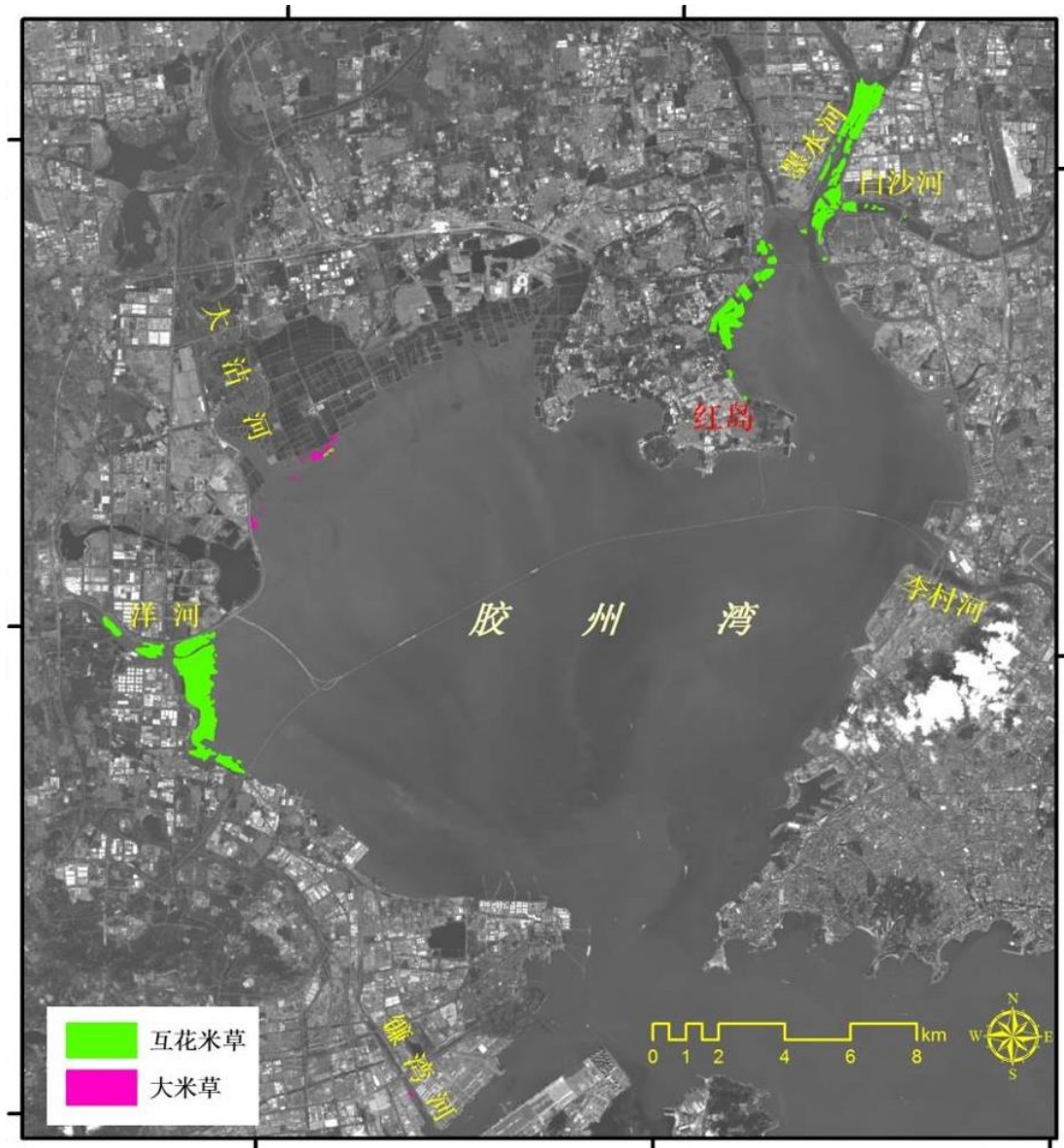


Figure 2 Distribution of *Spartina alterniflora* (including *Spartina anglica*) in Jiaozhou Bay

It was showed by the remote sensing images that from 1988 to 2019 that the distribution area of *Spartina alterniflora* increased from 16.1ha to 588.6ha, with the rapid expansion period from 2012 to 2019.

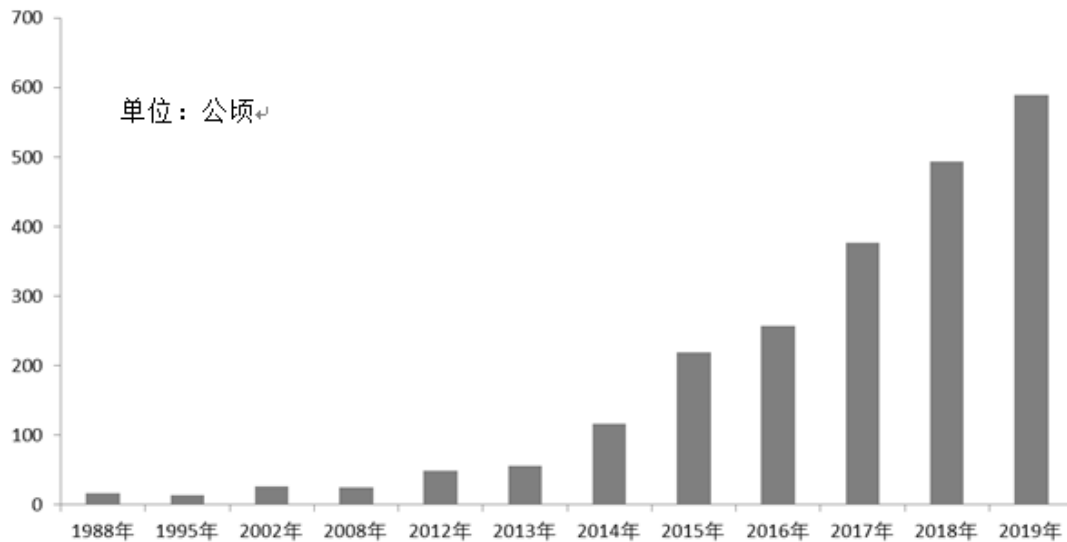


Figure 3 Statistics of *Spartina alterniflora* area in Jiaozhou Bay from 1988 to 2019

The expansion of *Spartina alterniflora* caused some ecological problems by the following means of: (1) destroying the habitat of benthic organisms by the strong root system, threatening the survival of benthic organisms and seabirds; (2) encroaching on the space and resources of indigenous species of salt marsh plants; (3) blocking the waterway and affecting the sea water exchange capacity. *Spartina alterniflora*, as the only species of coastal salt marsh plant, was in the first list of invasive species issued by Environment Protection Agency in 2003.

1.3.5 Decline of fishery resources

The data showed that the nekton has been gradually recovering in the last 3 years. However, compared with 1950s, the number of species of nekton in Jiaozhou Bay has been reduced nearly 50%, and the dominant species have also evolved from large economic fishes such as *Scomberomorus*

niphonius and *Nibea albiflora*, to the species with lower economic value such as Crustacean and Gobiidae. Thus the fishery resources need to be further restored in Jiaozhou Bay.

2 Ecosystem based Integrated Coastal Management of Jiaozhou Bay

2.1 Ecosystem based Integrated Coastal Management (ICM)

2.1.1 Integrated Coastal Management (ICM)

At the United Nations Conference on Environment and Development in 1992, Chapter 17 of Agenda 21 emphasizes on “Protection of the oceans, all kinds of seas, including enclosed and semi-enclosed seas, use and development of their living resources.”¹In this chapter, one of the program areas is “Integrated management and sustainable development of coastal and marine areas, including exclusive economic zones”, which recommends coastal countries “commit themselves to integrated management and sustainable development of coastal areas and the marine environment under their national jurisdiction.” This recommendation has been accepted by all the countries, including China².

Integrated coastal management (ICM) is recognized by the international community and by many coastal nations with the recognition of the crucial significance of their coastal zones in multi-aspects.

"Integrated coastal management (ICM) can be defined as a continuous and dynamic process by which decisions are taken for the sustainable use, development, and protection of coastal and marine areas and resources. ICM acknowledges the interrelationships that exist among coastal and

¹ Agenda 21, United Nations Conference on Environment and Development in 1992

² The UNCED Agenda 21, United Nation Conference on Environment and Development in 1992

ocean uses and the environments they potentially affect, and is designed to overcome the fragmentation inherent in the sectoral management approach. ICM is multi-purpose oriented, it analyzes and addresses implications of development, conflicting uses, and interrelationships between physical processes and human activities, and it promotes linkages and harmonization among sectoral coastal and ocean activities”³.

ICM has been taken as an appropriate policy process to balance the conservation of the valuable ecosystem with the development of economic activities dependent on these resources and areas⁴.

2.1.2 Ecosystem-based Integrated Coastal Management

Over the past few decades, ecosystem-based management (EBM), an integrated approach to management that aims to maintain an ecosystem in a healthy, productive and resilient condition while providing the services that humans want and need (McLeod et al., 2005)⁵, is critical to implement the efficient coast/marine resources management.

2.2 The management status of Jiaozhou Bay

As a semi-closed bay, with the complicated management of

³ Cicin-Sain, B. and R. W. Knecht. 1998. *Integrated Coastal and Ocean Management: Concepts and Practices*. Washington, DC: Island Press.

⁴ Indu Hewawasam. Advancing knowledge: a key element of the World Bank’s integrated coastal management strategic agenda in Sub-Saharan Africa. *Ocean & Coastal Management* 43 (2000) 361-337

⁵ McLeod, K.L., Lubchenco, J., Palumbi, S.R., Rosenberg, A.A., 2005. Scientific Consensus Statement on Marine Ecosystem-Based Management. Signed by 221 academic scientists and policy experts with relevant expertise and published by the Communication Partnership for Science and the Sea. Communication Partnership for Science and the Sea, USA 1–21.

cross-department and cross-administrative division, coastal management of Jiaozhou Bay should take the ecosystem based integrated management into account, so as to strengthen the top-level design and overall planning, intensify the coordination of different administrative districts departments, and jointly implement effective management of Jiaozhou Bay .

In view of the importance of Jiaozhou Bay in the development of City of Qingdao, the Municipal Government paid much more attention on Jiaozhou Bay management and carried out a series of measurements:

2.2.1 Strengthening organizational leadership and improving working mechanisms

The Municipal Government attached great importance to the protection of Jiaozhou Bay. In 2015, *Notice on Improving the Jiaozhou Bay Protection Management System and Mechanism* were issued to clarify the regional scope, basic principles, leadership system and division of responsibilities of Jiaozhou Bay protection management. And then, the Jiaozhou Bay Protection Committee was established, with the Mayor of Qingdao as director. In order to ensure the implementation of Jiaozhou Bay's protection responsibilities, the Office of Jiaozhou Bay Protection Committee was set up with full-time personnel responsible for Jiaozhou Bay protection management. To intensify supervision, Jiaozhou Bay Protection Social Supervision Committee was founded, composed of representatives of the National People's Congress, CPPCC members, experts and scholars, and social representatives.

In 2017, the Municipal Government pioneered to implement the Bay

Chief System, with the mayor serving as the Jiaozhou Bay Chief. This measure became a major innovation in the management and protection of bays in China. In 2018, the supporting assessment method for the Bay Chief System was formulated, and the comprehensive implementation of the Gulf Chief System was included in comprehensive assessment of Qingdao.

2.2.2 Improving local legislation and strengthening system construction

In the past ten years, the Qingdao Municipality has issued a series of regulations and policies. In 2012, the protection control line of the Bay was demarcated, which prohibited reclamation, and protected natural coastline and wetland. In 2014, *Regulation for Jiaozhou Bay Protection of Qingdao* was issued to strictly prohibit reclamation activities in Jiaozhou Bay, and implement the most stringent ultimate and permanent protection of Jiaozhou Bay. In 2016, Jiaozhou Bay Protection Committee was set up, and Jiaozhou Bay National Ocean Park was approved. In 2017, *Jiaozhou Bay Conservation and Utilization Plan* was further improved to fully integrate other plannings for city development, marine functional zoning, land use, environmental protection, and exploration and utilization. And the Qingdao Municipality pioneered to promote the Bay Chief System, in order to protect the coastal and marine resources, prevent marine pollution, improve the marine environment and promote the integrated value of the bay.

2.2.3 Strengthening protection priority and carrying out supervision and monitoring

The reclamation projects in Jiaozhou Bay were prohibited, except for

major national strategic projects. Environmental protection approval for construction projects should be strictly controlled. standards for controlling pollution were formulated. Marine ecological monitoring should be implemented and the monitoring system should be improved. The pollution control was strengthened including land-based pollution, marine pollution, rivers, sewages, industrial and agricultural pollution sources. The control of marine and coastal debris was implemented.

2.2.4 Strengthening the implementation of integrated measures and carrying out ecological restorations

The dismantlement of aquaculture facilities in Jiaozohu Bay was accomplished, with more than 40,000 cages and 5262 mu of rafts removed and 196 fishing boats dismantled. Nearly 450 million yuan in subsidies were issued, and more than 20 km² sea area of Jiaozhou Bay was restored. On the mudflat, over 3000 mu of repossessed aquiculture ponds were demantled.

The shoreline renovation projects and marine ecological restoration were implemented. The recovered shoreline was 20.7 km. More than 1,500 mu of saline-alkali-tolerant plants such as reeds and *Zoysia sinica*, were planted and 300 mu of demonstration areas for planting *Tamarix* and *Suaeda* were selected to rebuild the plant community of coastal wetlands. The conservation of fishery resources was intensified, releasing the economic species such as prawns, swimming crabs, flounder, *Sepia esculenta*, etc. The Jiaozhou Bay Marine Biodiversity Survey and the construction of the information database were initiated, and a total of 354 samples were obtained. Bird banding monitoring was carried out at the key ecological zone of Dagu River estuary, Yanghe estuary, and Yuejin

River estuary. Standardization construction of Jiaozhou Bay National Marine Park was carried out. And Jiaozhou Bay Wetland Park was approved as a provincial wetland park.

2.2.5 Strict law enforcement and supervision

The comprehensive law enforcement supervision system was established. Jiaozhou Bay Comprehensive Law Enforcement Bureau was set up and an effective linkage mechanism for joint law enforcement by ocean, maritime, transportation, environmental protection and other departments, administrative law enforcement, and criminal justice. The law enforcement inspection system was improved. The special law enforcement actions were conducted, such as "sea shield", "blue sea", and "fishing protection". The channels for reporting violations were open to mobilize social forces to participate in supervision, which could strengthen social supervision and public supervision of Jiaozhou Bay protection.

2.3 The challenges to management Jiaozhou Bay

With the deepening of reform and opening-up, the intensity of the development and utilization of Jiaozhou Bay has been gradually increasing, which placed the Jiaozhou Bay ecosystem under multiple stresses due to rapid development of the coastal urbanization and industrialization. More and more problems came up, such as decreasing of natural shoreline and water area, serious land-source pollution, deteriorating environments, degradation of important coastal habitat, declining of fishery resources, and more frequent ecological disasters, such as algal bloom, jellyfish bloom, and the invasion of *Spartina alterniflora*.

In terms of administrative management, Jiaozhou Bay involves many administrative districts, which may have different policies and planning on management of Jiaozhou Bay. Meanwhile, for the whole Jiaozhou Bay, the management got involved in multiple departments, such as resources, environment, shipping, fishing, aquaculture and etc. If there was no authoritative comprehensive management department, effective management regulations could not be formulated, and a scientific and reasonable management system could not be formed, which may lead to a mess, with weak coordination ability, unclear responsibilities of each department. The contradiction between the utilization and protection of Jiaozhou Bay would become more and more intensified, which could have negative effects on the effective protection and sustainable development of Jiaozhou Bay.

2.4 The mechanism of ecosystem-based integrated management in Jiaozhou Bay

2.4.1 Division of Responsibilities

The establishment of the Jiaozhou Bay Protection Committee has laid a good foundation for the implementation of ecosystem-based integrated management in Jiaozhou Bay.

Because the institutional reforms in China in 2018, the function of some administrative departments has changed. Therefore, institutional composition Jiaozhou Bay Protection Committee has changed.

The Qingdao Municipal Government is responsible for the protection and management of Jiaozhou Bay. The protection and management would be

conducted in hierarchical and sub-departmental way, with municipal management as the mainstay.

The people's governments of the districts (counties) around Jiaozhou Bay, the administrative agencies of economic function zones, and the people's governments of the districts (counties) where the river flows into the Jiaozhou Bay are responsible for the protection of Jiaozhou Bay in their jurisdiction in accordance with relevant laws and regulations.

The Jiaozhou Bay Protection Committee was established by the Municipal People's Government to organize and coordinate important work in the protection of Jiaozhou Bay, study and review important plans, systems and major project constructions related to Jiaozhou Bay, and organize comprehensive law enforcement inspections or joint law enforcement for Jiaozhou Bay protection. The organization, functions and operation mechanisms of the Jiaozhou Bay Protection Committee would be prescribed by the Municipal Government.

The municipal and district (counties) departments of natural resources and planning, ecology and environment, marine development, forestry and other departments are respectively responsible for land, planning, environmental protection, marine affairs, fishery, and wetlands within the protection scope of Jiaozhou Bay in accordance with relevant laws and the regulations.

The municipal, district (counties) departments of reform commission, housing and urban-rural development, law enforcement, safety supervision, transportation, water conservancy, municipal public utilities, agriculture and other departments shall implement the protection and

management of Jiaozhou Bay in accordance with their respective responsibilities.

Sound collaboration of all the above departments is crucial for the implementation of ecosystem-based integrated management, but it is not easy to achieve. It is necessary for Jiaozhou Bay Protection Committee to fully play the leading role in organization, conversation and coordination, and to establish a sound operating mechanism as well.

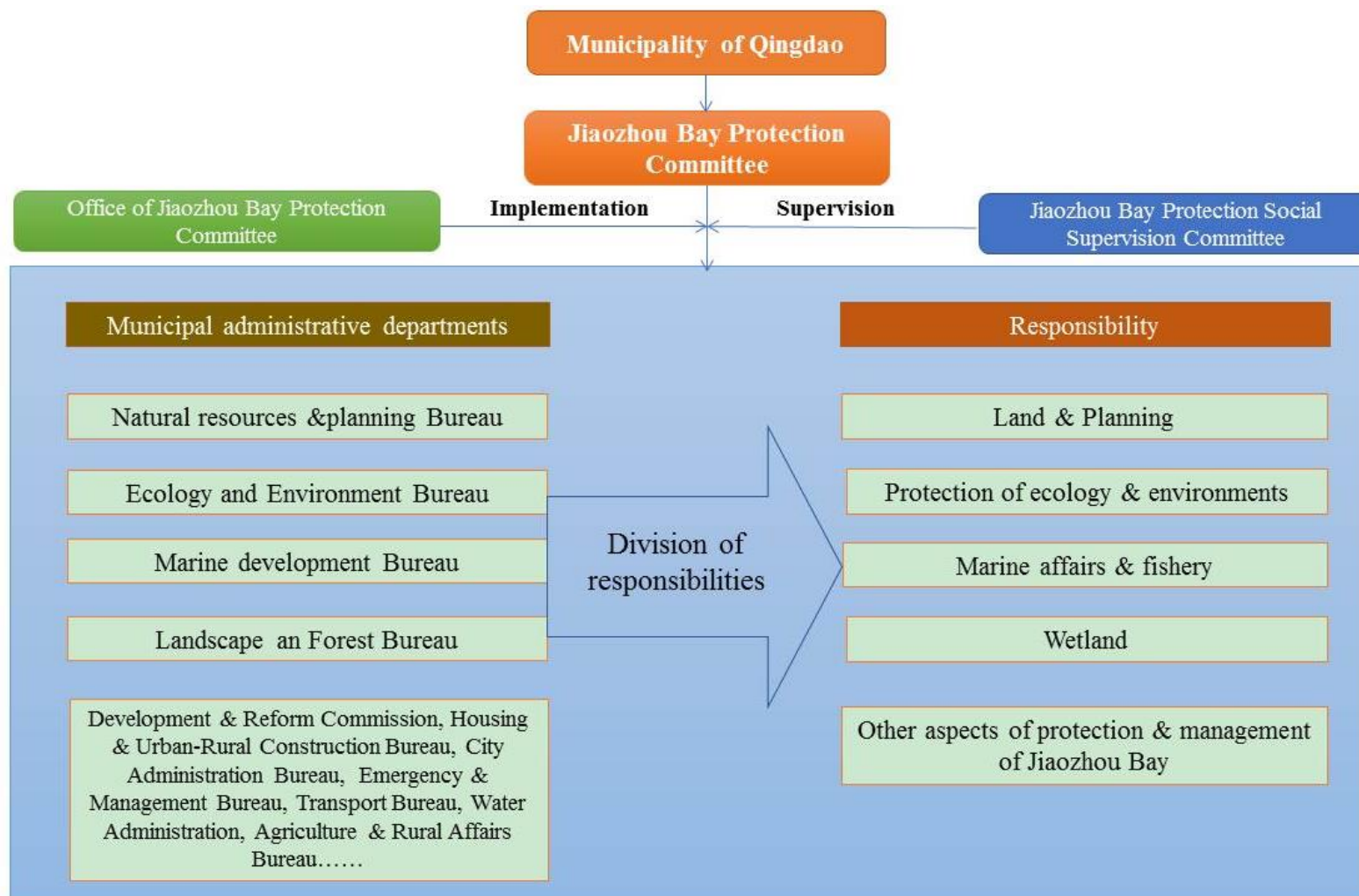


Figure 4 The structure of the management of Jiaozhou Bay

2.4.2 Mechanisms

Jiaozhou Bay Protection Committee coordinated all the departments concerned to implement protection and management of Jiaozhou Bay, by the Office of Jiaozhou Bay Protection Committee which was set up at Qingdao Municipal Marine Development Bureau.

The supervision and assessment mechanism involving social participation was established to intensify the social supervision. Jiaozhou Bay Protection Social Supervision Committee, composed of representatives of the National People's Congress, CPPCC members, experts and scholars, and social representatives, would take charge of supervision.

The mechanism of "multi-plan integration" was established to coordinate urban planning, marine functional zoning, land use planning, environmental protection planning, development and utilization planning, etc., so as to achieve the overall planning of land and marine development in Jiaozhou Bay.

In addition, Jiaozhou Bay Protection Committee of the Municipal People's Government would organize relevant municipal administrative departments, relevant district (counties) governments to establish a Jiaozhou Bay protection information sharing mechanism to realize the sharing of the information of investigation, surveillance, monitoring, and supervision and management information of Jiaozhou Bay. And the information releasing mechanism should be established to publish the information regularly as well.

Meanwhile, other mechanisms such as the coordination and cooperation mechanism for the investigation and punishment of violations would be established to guarantee the effective implementation of the management.

3 Establishment of Ecosystem-based Integrated Monitoring System of Jiaozhou Bay

3.1 The requirements of ecosystem-based integrated monitoring in Jiaozhou Bay

It is essential to understand the status and trends of the ecosystem for the implementation of ecosystem-base integrated management in Jiaozhou Bay. For Jiaozhou Bay ecosystem, there are diverse components, including biological and physical elements as well as human elements. The complication of the ecosystem not only comes from the complexity of each component of the ecosystem, but also the inexplicit interactions existing between/among different parts. It is no doubt that to make a better understanding of Jiaozhou Bay ecosystem could not be realized without the ecosystem-based monitoring to get the first-hand data. Therefore, monitoring is the first step toward the management actions and decision-making.

3.2 Ecosystem-based Integrated Monitoring System

3.2.1 Improvement of the operation and management mechanism of the ecosystem-based integrated monitoring system

It is essential to clearly divide the authorities of the administrative departments responsible for the integrated management of Jiaozhou Bay and establish and improve the overall coordination mechanism. The administrative departments take charge of supervision on the monitoring agencies.

3.2.2 Strengthening the construction of monitoring institutions and talent teams

The construction of monitoring institutions should be promoted according to the division of responsibilities. The construction of professional talent team could not be ignored as well. It is necessary to optimize the policy for talent development, increase the number of monitoring personnel, and optimize the allocation of professional and technical personnel. In addition, the training is also important to improve professional competence of the monitoring team. And the construction of multimedia training platform could play an active role in the development of remote training.

3.2.3 Optimization the ecosystem-based monitoring plan

Ecosystem-based management, the effective approach for Jiaozhou Bay resource management, aims to achieve conservation, sustainable use and the fair allocation of benefits from natural resources, thereby striking a balance between short-term needs and sustainability⁶ (Cowan et al 2012). Monitoring in this context requires whole ecosystem indicators, including information on the status/trends of species, habitats and environmental conditions in the biophysical, and related human system⁷.

Based on this consideration, a set of essential indicators is identified to serve for ecosystem-based integrated management of Jiaozhou bay, which

⁶ Cowan, J.H., Rice, J.C., Walters, C.j., Hilborn, R., Essington, T.E., Day, J.W. & Boswell, k.M.(2012) Challenges for implementing an ecosystem approach to fisheries management. *Marine and Coastal Fisheries*. 4, 496-510.

⁷ Heenan, A. , Gorospe, K. , Williams, I. D. , Levine, A. , Maurin, P. , & Nadon, M. , et al. (2016). Ecosystem monitoring for ecosystem-based management: using a polycentric approach to balance information trade-offs. *Journal of Applied Ecology*.

could be classified into the following aspects of shoreline, wetland, marine ecosystem, and human activities.

3.2.3.1 Shoreline

Monitoring is carried out to obtain the data on the length, type and changes, so as to understand the status and trend of the shoreline.

3.2.3.2 Wetland

Monitoring on wetland ecosystem includes the status of wetland, vegetation, bird and the invasive species of *Spartina alterniflora*.

Bird observation could be carried out at the estuaries, beaches, ponds, etc., with the indicators of species, especially the rare species, numbers and distributions of the breeding birds, migratory birds and wintering birds

Monitoring on vegetation could be carried out by means of remote sensing and field investigation to obtain the data on the coverage rate, distribution and the protective species. Invasive species of *Spartina alterniflora*, as the major ecological problem of Jiaozhou Bay, would be focus on the changes and the trend.

3.2.3.3 Marine ecosystem

The monitoring would be implemented to master the status of marine ecosystem of Jiaozhou Bay, including water, sediment, marine organism, intertidal organisms and fishery resources, etc.

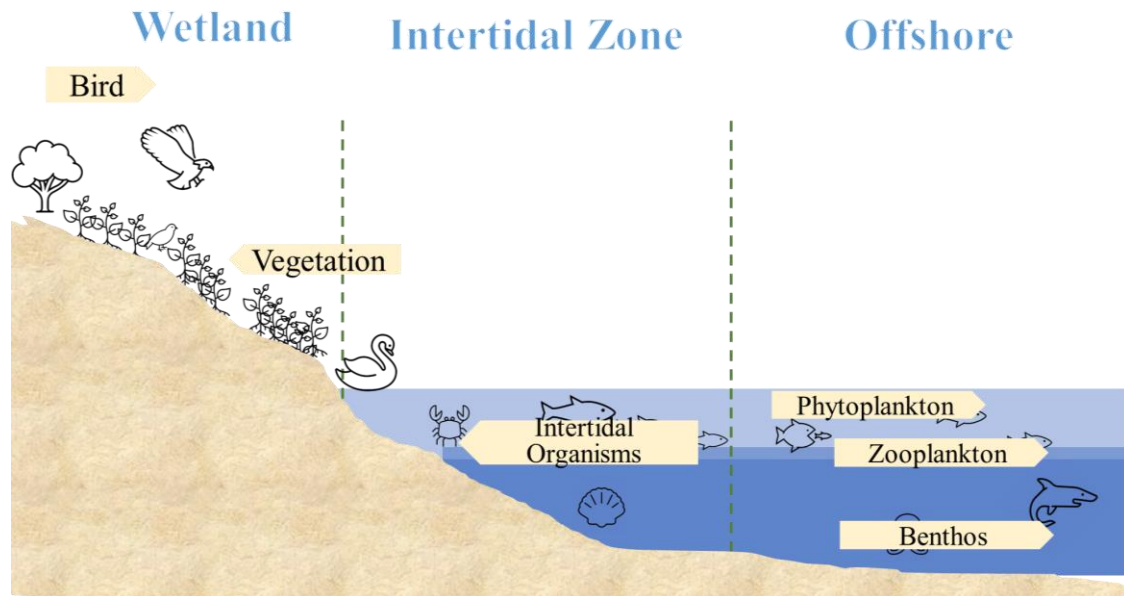


Figure 5 The monitoring indicators of Jiaozhou Bay ecosystem

3.2.3.4 Human Activities

Human activities, as a significant element of ecosystem-based management, could not be ignored. The monitoring in this context would be carried out mainly on the basis of the supervision on the ecological red-line zone to obtain the data on development activities, utilization of natural shoreline, water quality and land-based pollutants, etc.

Investigation on social economy of Jiaozhou Bay is quite helpful to obtain the information on discharge of industrial and domestic sewage, the area of reclamation and marine economic output value, etc.

In addition, some information on inappropriate or illegal activities, such as bird setting, and etc. could be obtained by human activity monitoring.

Here is the table of the details of ecosystem-based integrated monitoring index.

Table 1 Index system of Ecosystem-based Integrated monitoring of JiaozhouBay

Items	Elements	Index
Shoreline	Basic status	Length, type, erosion, etc.
	Development and utilization	Distribution, type and area
Wetland	Basic status	Area and type
	Wetland birds	Species, quantity, rare species
	Wetland vegetation	Area, distribution, dominant species
	Invasive species of <i>Spartina alterniflora</i>	Distribution, area
Marine ecosystem	Sea water	Salinity
		Temperature
		Suspended substance
		COD
		DO
		Oil
		pH
		Ammonium salt
		Nitrite
		Nitrate
	Sediment	Active phophate
		Petroleum
		Sulfide
	Biological quality	Organic carbon
	Organisms	Heavy metal (Cu, Zn, Cr, Hg, Cd, Pb, As), petroleum hydrocarbon
		phytoplankton
		zooplankton
		diatom
		Intertidal organisms
		Egg and spawn
nekton		

Items	Elements	Index
Human Activity	Supervision on ecological red-line zone	Distribution, Area, type of human activities in ecological red-line zone
	Land-based pollutant	Effects on marine ecosystem and functional zone
	Sea utilization of Port Industry	Impacts on marine ecosystem
	Social economic status	Industrial and domestic sewage discharge, area of reclamation, marine/coastal engineering projects, marine economic output value, etc.
	Others	Unappropriate/illegal activities, such as bird setting, etc

3.3.4 Intensifying the construction of the total quality management (TQM) system

Monitoring quality notification mechanism and responsibility accountability mechanism would be established to intensify the monitoring quality inspections, and strictly investigate and deal with violations. Quality supervision team was established to conduct omnidirection quality supervision.

The application of laboratory information management system should be promoted. And quality awareness of monitoring personnel should be raised. All kinds of monitoring skill competition activities are encouraged to improve the monitoring capacity of the monitoring personnel.

3.3.5 Improving the efficiency of ecosystem-based integrated management

3.3.5.1 Normalization of information disclosure

It is necessary to establish and improve the normalization of information disclosure mechanism for the general public and regularly disclose relevant information. During the period with high-frequency of ecological disaster, such as red (green) tide or jellyfish bloom, or tourism season, the early warning and monitoring information would be issued in real-time, relying on various forms such as radio, television, the Internet, and WeChat. It would be quite helpful to increase the types of information products, expand coverage, and enrich information forms.

3.3.5.2 Specialization of integrated management service

The comprehensive analysis and application of the ecosystem-based integrated monitoring data of Jiaozhou Bay would provide decision-making basis for Jiaozhou Bay development planning, resource management and control, marine pollution prevention and control, and ecological restoration planning, etc. The information on the hot spots of Jiaozhou Bay would be issued to the local communities. Correlation analysis of marine resources, environment, ecosystem and social economy and other data could support the integrated monitoring and prewarning on resources and environment carrying capability of Jiaozhou Bay. The information platform on emergency monitoring, assessment and prewarning of Jiaozhou Bay ecosystem would be established to provide the professional information for emergency decision-making, command, and joint handling of ecological disasters.

3.3.5.3 Integration of monitoring and law enforcement

It is important to promote the integration of Jiaozhou Bay ecosystem monitoring and evaluation system and emergency command and dispatch platform. The real-time prewarning information would be reported to the maritime law enforcement agencies.

4 Public Participation of Ecosystem-based Monitoring

Most scholars consider that the public participation system in environmental law means that in the field of environmental protection, citizens have the right to participate in all decision-making activities related to environmental interests through certain procedures and channels, making this decision in line with the immediate interests of the people⁸.

Nowadays, the public awareness of coastal/marine ecosystem is still in the initial stage. The complexity of coastal/marine ecosystem has caused many difficulties. Public participation is the important supplement of coastal/marine monitoring capacity. It should be emphasized that the “public” covers not only citizens as individuals, but also various enterprises, agencies, voluntary groups, non-profit organizations (NGOs), and etc. In other words, the public can be understood as a collection of citizens, enterprises and social organizations⁹.

In decades, there were also different kinds of public participation of Ecosystem –based monitoring, such as community-based monitoring, citizen scientist, and volunteer. Community-based ecosystem monitoring refers to a range of observation and measurement activities involving participation by community members and designed to learn about ecological and social factors affecting a community¹⁰. It is apparent that

⁸ 倪强.浅论我国环境法中公众参与制度.中国环境管理, 1999,(5):7 ~ 9.

⁹ 吕建华, 柏琳.我国海洋环境管理公众参与机制构建刍议.中国海洋大学学报(社会科学版). 2017,2:32-38

¹⁰ Bliss, J, Aplet, G, Hartzell, C, Harwood, P, Jahng, P, Kittredge, D, Lewandowski, S, Soscia, M.L. 2001. Community-Based Ecosystem Monitoring. Journal of Sustainable Forestr. Vol 12. Iss3-4, 143-169

“community-based” means that the participants are local people, who know the status of the ecosystem quite well, and are willing to keep it in a good state.

Public participation in support of ecosystem-based monitoring should correspond to the characteristics of ecosystem-based monitoring.

4.1 Requirements of public participation

As we discussed that the ecosystem-based integrated monitoring, as the interdisciplinary monitoring, covers the indicators not only of the whole ecosystem with variety of scientific areas, but also of human society. Therefore, sometimes the monitoring programme could be decomposed into many single purpose plans for the convenience of implementation. So it is common that different monitoring agencies or units cooperate to fulfill the ecosystem based integrated monitoring.

Under the circumstances of shortage of monitoring teams, promoting the socialized supply of monitoring services and increasing public participation could play an active role in ecosystem based integrated monitoring. Guiding and regulating diversified social forces to participate in ecosystem-based integrated monitoring, and promoting the establishment of societies, organizations or social groups related to the construction of marine ecological civilization can effectively make up for the lack of government monitoring capabilities.

4.2 Practice of public participation of ecosystem-based integrated monitoring in Jiaozhou Bay

In 2019, NCSEMC applied the project on *Demonstration Zone of*

Integrated Ecosystem- based Investigation on Wetland of Jiaozhou Bay, supported by UNDP Yellow Sea Large Marine Ecosystem Phase II Project (YSLME II). This project aimed to make a better understanding of the wetland ecosystem, with the monitored indicators including birds, vegetation, rare species and the habitat, water quality, sediment quality, marine organisms, intertidal organisms, and etc.

This project was carried out by organizing the different monitoring agency and the social association to take part in the monitoring in Jiaozhou Bay. The proponent was NCSEMC, with 5 collaborating partners, including Ocean University of China (OUC), Qingdao Agricultural University, First Institute of Oceanography (FIO), MNR, Qingdao Birdwatching Association and Qingdao Shipowner’s Association. All participants exerted their own strengths, to carry out the ecosystem-based investigation of Jizoshou Bay wetland.

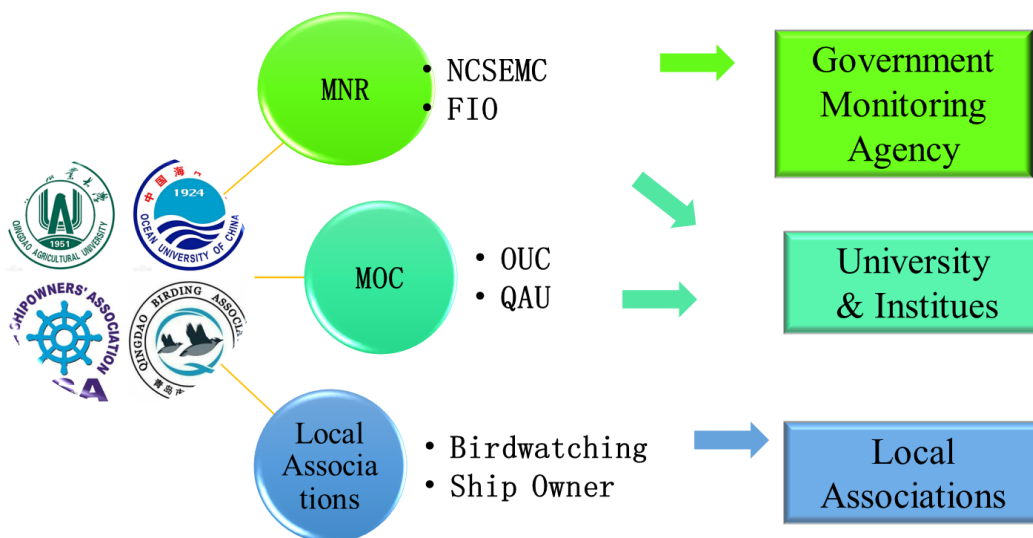


Figure 6 Partners of the project

In the project, as proponent, NCSEMC developed the monitoring plan and organized all the partners to implement the project, and carried out

the remote sensing monitoring on the wetland and the environment monitoring, and intertidal and offshore organisms as well. FIO took charge of the remote sensing on wetland vegetation and mainly focused on the invasion of *Spartina alterniflora*. QAU carried out the field investigation on wetland vegetation. OUC carried out the investigation on seagrass. Birdwatching Association was responsible for the bird observation. And Ship Owner Association provided the vessels.

In this cooperation, NCSEMC, as the government agency, clearly knew the requirements of the management, and then, developed the plan to meet the requirements as much as possible. The other partners could choose the monitoring items according to their interests and advantages. For example, Birdwatching Association, established in 2016, is a social group approved by the Qingdao Civil Affairs Bureau. The business unit is Qingdao Forestry Bureau. Although it is a social group, the members are composed of the experts, the university students, the enthusiasts, with the reservoirs of knowledge and observational skills on birds. Therefore, the association has the ability to implement the bird observation, which is a wonderful complement for wetland integrated monitoring. Interdisciplinary cooperation could help the implementation of overall monitoring program. And the interdisciplinary conversations could help all the partners make better understanding of the major drivers and status of ecosystem change, and then make the prediction of the trend, so as to support the management.

4.3 Challenges of public participation

Public participation in support of ecosystem-based monitoring still presents some challenges. (1) Regarding the public participation system, the existing laws and regulations only have provisions in principle, and

seldom have the specific regulations on the implementation, legal responsibilities, and rules on how to implement the public participation system. (2) from the cognitive perspective, not only the weak public awareness of participation of the monitoring, but also lack of professional knowledge, limit the willingness and the degrees of public participation of ecosystem-based monitoring; (3) furthermore, most of the modes of public participation in China are mostly guided by the government to organize public participation, while the public participates passively, which would affects the systematicness and continuity of public participation; (4) The credibility of the data or results obtained by public participation is also a problem that could not be ignored. Therefore, it is critical to conduct specialized training of participants in order to get reliable data and results.

4.4 Suggestion of public participation

To promote the public participation of ecosystem-based integrated monitoring, the first thing is to clarify the legal status of public participation. The relevant laws and regulations should be continuously improved to make it clear that the public is the main body of rights to participate in the ecosystem management, and the law and methods of participation, corresponding rights and responsibilities and possible disputes should be clearly determined by law.

The improvement of public awareness is the foundation of public participation of ecosystem-based monitoring. Promote the knowledge of marine ecosystems by various means, so that the protection of marine ecosystems is deeply rooted, so as to enhance the enthusiasm of public participation, and then ensure the continuity of public participation.

It is critical to incorporate the social monitoring forces into the quality management system. And training could not be ignored to to improve capacity of public participation. The handbook would benefit all the participants to carry out the monitoring.

5 Conclusion

Jiaozhou Bay, as a semi-enclosed bay, has its own unique characteristics. The Jiaozhou Bay ecosystem consists of about 370 km² of sea area and the largest wetland of Shandong Peninsula, which has a variety of resources. Jiaozhou Bay provides the wonderful habitats for many important species and the biodiversity is high. Jiaozhou Bay wetland is amongst the most important stopover areas for migratory birds on East Asian Australasian Flyway (EAAF) and provides the habitats for some rare birds, eg. Chinese crested tern. On the other hand, many industries such as marine scientific research, high-tech industries, and ports, etc. were gathered around Jiaozhou Bay. It is a multi-functional bay integrating port, tourism, fishery, and marine culture. The significant locational advantage makes the Jiaozhou Bay not only the core area for the development of City of Qingdao, but also the forefront of the development of Shandong Province. The "*Planning for Coastal Town zones in Shandong Province (2018-2035)*" issued in 2018, proposes to build the Jiaozhou Bay Area as the world-class bay area.

In view of the importance of Jiaozhou Bay, the management of Jiaozhou Bay has also attracted much attention. As there are many administrative regions and many types of industries involved, how to coordinate the contradictions between/among different districts and different departments, and how keep the balance of protection and development of Jiaozhou Bay are crucial to the sustainable development of Jiaozhou Bay. In this context, the ecosystem-based integrated management is the appropriate mode to solve the problems. As the Qingdao Municipal Government attaches great importance to the Jiaozhou Bay, the Jiaozhou Bay Protection Management Committee was established in 2014, led by

the municipal government, with multi-departmental participation. Subsequently, the Jiaozhou Bay Protection Social Supervision Committee was established. And then a series of mechanisms was set up, with constant adjustment and improvement in the process of operation. All these measures provided a sound foundation for the implementation of ecosystem-based integrated management in Jiaozhou Bay.

The integrated management based on the ecosystem needs the support of corresponding monitoring to provide the information/data to satisfy the objective of the management. Therefore, ecosystem-based monitoring is the preferred approach in Jiaozhou Bay to meet this requirement. According to the management objectives, the goal of monitoring is to grasp the status and changes of the ecosystem, the status of ecological resources, and the interaction between human activities and the ecosystem of Jiaozhou Bay, so as to analyze the ecological problems in Jiaozhou Bay and provide a basis for the ecosystem-based integrated management.

In terms of the organization of monitoring, the Jiaozhou Bay Protection Management Committee is responsible for organizing the preparation of the overall monitoring plan, and then organizing the relevant monitoring agencies of different departments or partners to implement the monitoring according to the division of responsibilities. Ecosystem-based monitoring mainly includes two aspects: ecosystem and human activity. The ecosystem monitoring consists of shoreline, wetland (including wetland type and distribution, bird, vegetation), and water bodies (including water, sediment, marine organisms and fishery resources). Human activity monitoring consists of utilization, human activities in ecological red-line area, land-based pollution, sea utilization of port industry, social

economy and others factors (including unappropriate/ illegal activities).

In terms of the implementation of monitoring, to ensure the implementation and the effective function of the ecosystem-based monitoring, it is essential to strengthen the construction of the total quality management system and to improve the efficiency of the support of monitoring to management by normalization of information disclosure, professional support for management and integration of monitoring and law enforcement.

In addition, public participation is an effective supplement for ecosystem-based monitoring. This mode was adapted in the project of *Demonstration Zone of Integrated Ecosystem-based Investigation on Wetland of Jiaozhou Bay*, sponsored by YSLME II. This project was led by the government agency with the partners of scientific institution, universities and social associations. With the sound collaboration, the research team obtained the comprehensive and systematic data of Jiaozhou Bay wetland, analyzed the problems of the ecosystem and proposed some suggestion for the management. The further efforts should made to improve the mechanism, to raise the awareness of public participation of monitoring, to intensify the professional training and to ensure the quality of the monitoring, and then ultimately to promote broader and deeper public participation.