2024

Marine Ecological Status Report
Of Guangdong-Hong Kong-Macao Greater Bay Area

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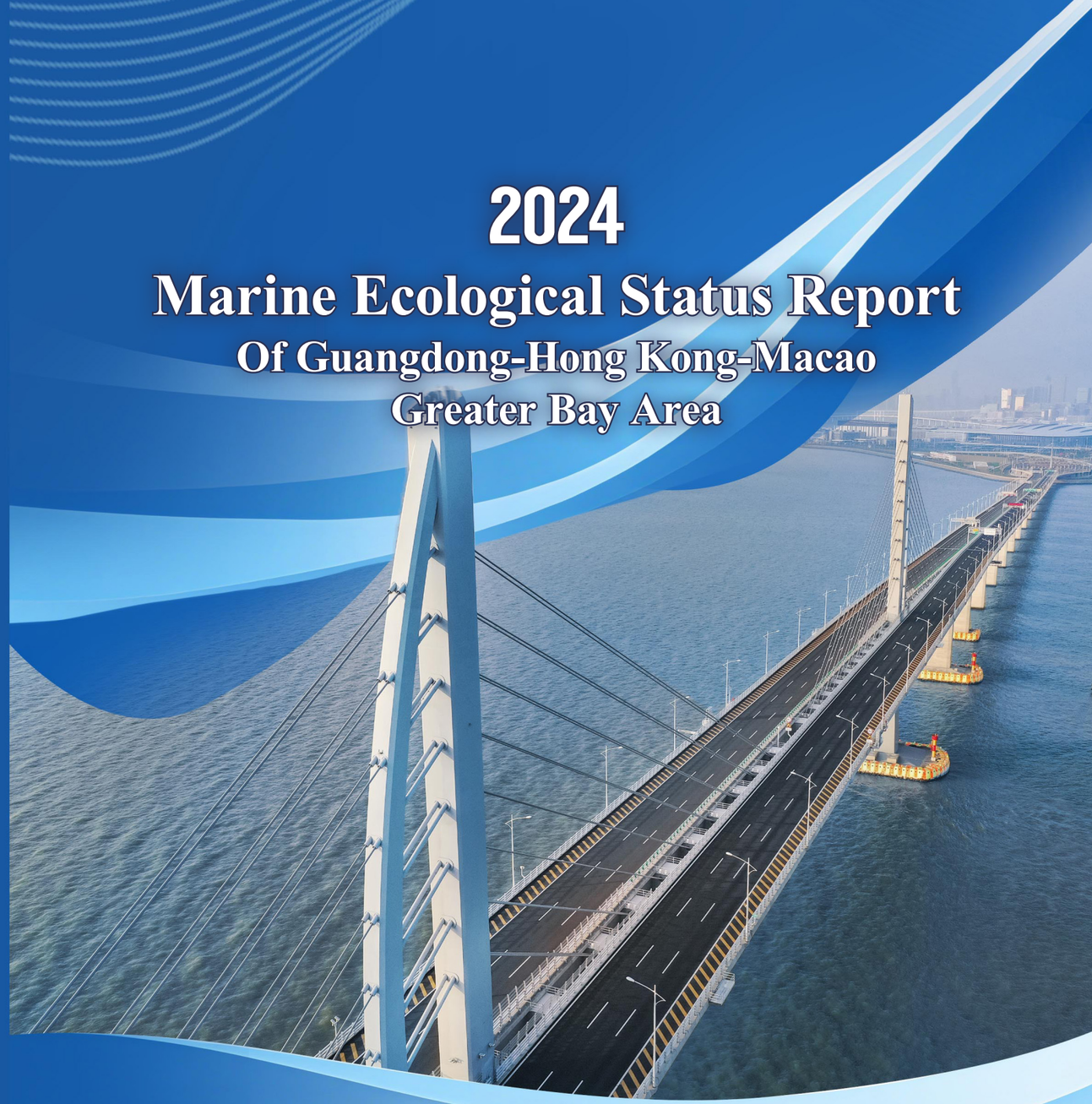

South China Sea Bureau of the Ministry of Natural Resources
Department of Natural Resources of Guangdong Province
Agriculture, Fisheries and Conservation Department, Hong Kong SAR
Environmental Protection Department, Hong Kong SAR
Environmental Protection Bureau, Macao SAR
Marine and Water Bureau, Macao SAR
Marine Development Bureau of Shenzhen

September 2025

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Preface

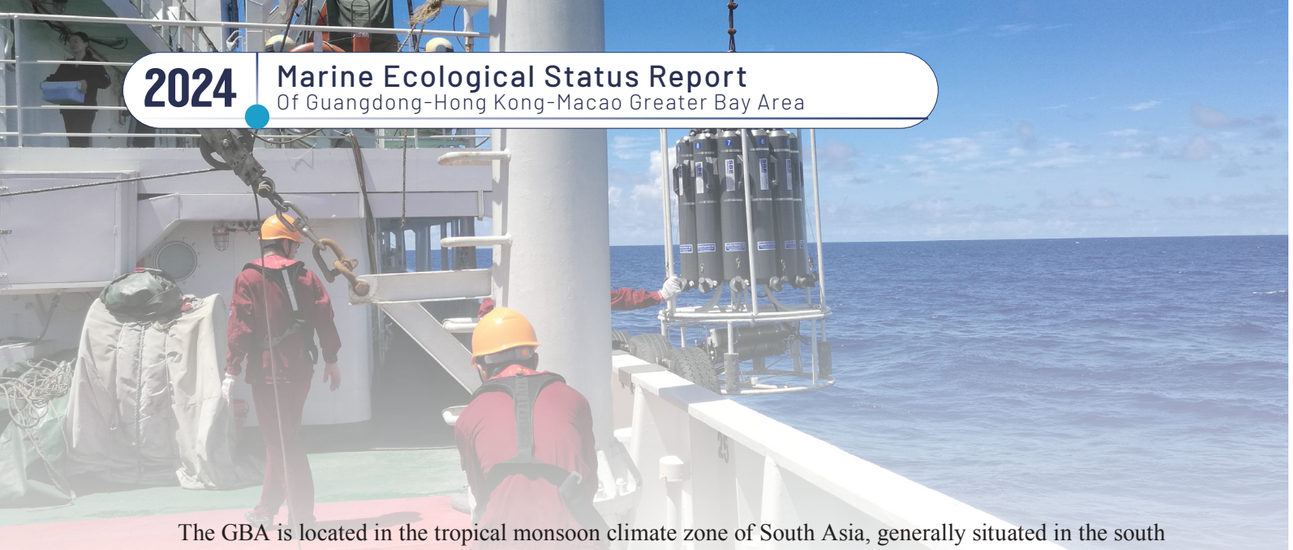
The Guangdong-Hong Kong-Macao Greater Bay Area (hereinafter referred to as GBA) is a major national strategy personally planned, directed, and promoted by President Xi Jinping. In February 2019, the CPC Central Committee and the State Council issued the *Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area*, aiming to comprehensively advance the construction of a world-class bay area and city cluster. At present, the GBA is rapidly emerging as a vivid showcase of the institutional advantages of "One Country, Two Systems," a strategic pivot for the new development pattern, a demonstration zone for high-quality development, and a pioneering ground for realizing Chinese modernization. Upholding and implementing the concept that "lucid waters and lush mountains are invaluable assets," Guangdong, Hong Kong and Macao have consistently intensified ecological conservation and restoration efforts, focused on building an ecological protection barrier and innovating green and low-carbon development models. They are committed to blazing a new path of coordinated advancement among ecological, economic, and social sectors, contributing Chinese wisdom and GBA solutions to the sustainable development of city clusters worldwide.

The GBA consists of the Hong Kong Special Administrative Region (SAR), the Macao SAR, and the cities of Guangzhou, Shenzhen, Zhuhai, Foshan, Huizhou, Dongguan, Zhongshan, Jiangmen, and Zhaoqing in Guangdong Province. It enjoys an advantageous geographical environment, with the Pearl River Delta as its hinterland and nestling against mountains and embracing three rivers that converge here before meeting the sea. The GBA is one of the most open and economically dynamic regions in China. Thriving by the sea, the beautiful region boasts an excellent marine ecology that not only provides the foundation for safeguarding the region's sustainable development and improving its people's well-being, but also plays an important role in maintaining the routes for global migratory birds and building a treasure trove of biodiversity.

To give a strong impetus to the GBA's marine ecological progress and high-quality development of its marine economy, the South China Sea Bureau of the Ministry of Natural Resources, in conjunction with the Department of Natural Resources of Guangdong Province, the Agriculture, Fisheries and Conservation Department (AFCD) and the Environmental Protection Department of Hong Kong SAR, the Environmental Protection Bureau and the Marine and Water Bureau of Macao SAR, and the Marine Development Bureau of Shenzhen, has established a comprehensive early-warning and monitoring network integrating marine ecological stations, buoys, ships, drones, and satellite remote sensing technologies. The parties investigate and monitor 21 typical marine ecosystems under eight categories, consistently monitoring 136 biodiversity spots, 175 seawater environment spots, and 111 sedimentary environment spots. They have systematically combed through the achievements in marine ecological conservation and restoration made in Guangdong, Hong Kong, and Macao over recent years, and jointly developed the *2024 Marine Ecological Status Report of Guangdong-Hong Kong-Macao Greater Bay Area* that is open for public access.

The Report highlights a generally stable and improving marine ecology in the GBA region, with the benefits of conservation and restoration efforts becoming increasingly evident. The seawater environment, sedimentary environment, and biodiversity all remain stable; coral reef and mangrove ecosystems are mostly healthy while estuary and bay ecosystems are largely stable. However, risks of marine ecological disasters such as red tide call for attention.

Basic Marine Ecological Status 01



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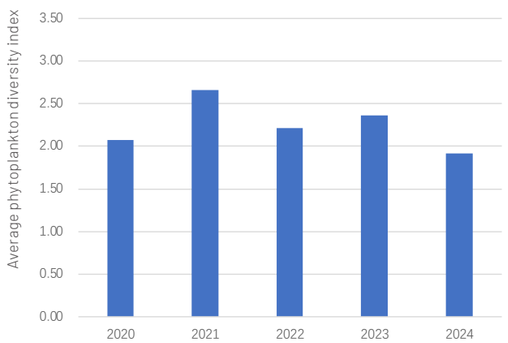
The GBA is located in the tropical monsoon climate zone of South Asia, generally situated in the south of the Tropic of Cancer and bordering China's largest marginal sea—the South China Sea. It commands a sea area of approximately 20,000 square kilometers, of which 1,640.40 square kilometers belong to Hong Kong [①] and 85 square kilometers belong to Macao [②]. The region features a winding coastline, including Guangdong's [③] 1,456km section [④], Hong Kong's 456km section (from the New Territories to the Hong Kong Island) [⑤], and Macao's 79.5km section [⑥]. The seafloor features a diverse topography, with "three shoals and two troughs" and silt-dominated sediments. The joint influence of the South China Sea circulation and the Pearl River runoff has formed unique hydrodynamic conditions and complex habitats in the GBA, resulting in rich biodiversity and diverse marine ecosystems.

(Ⅰ) Biodiversity

1. Phytoplankton

Guangdong sea areas In the summer of 2024, a total of 257 species of phytoplankton were identified through vertical net sampling, with the density ranging from 5.11×10^{4} to 2.04×10^{8} ind./m^3 and an average of 2.01×10^{7} ind./m^3. The dominant group was diatom, and dominant species included *Skeletonema costatum*, *Pseudo-nitzschia delicatissima*, and *Chaetoceros affinis*. The diversity index ranged from 0.23 to 3.88, with an average of 1.97.



Phytoplankton diversity index in Guangdong sea areas, 2020-2024 summer

Monitoring results in the past five years [⑦] indicate an average phytoplankton diversity index ranging from 1.92 to 2.66.

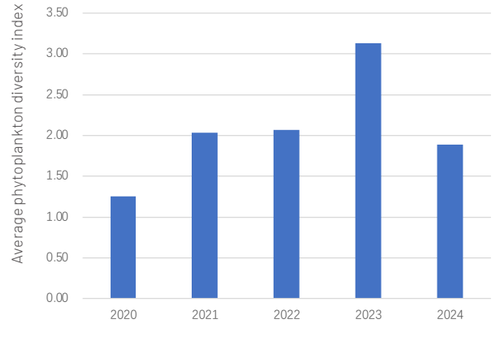
① Lands Department of Hong Kong SAR.
② Decree No.665 of the State Council of the PRC.
③ This refers to sea areas administered by Guangzhou, Shenzhen, Zhuhai, Huizhou, Dongguan, Zhongshan, and Jiangmen.
④ *Guangdong Coastal Zone and Marine Spatial Planning (2021-2035).*
⑤ Environmental Protection Department of Hong Kong SAR.
⑥ Cartography and Cadastre Bureau of Macao SAR.
⑦ From 2020 to 2024, same below.

Hong Kong sea areas In the summer of 2024, a total of 53 species of phytoplankton were identified through water sampling, with the density ranging from 9.37×10^{8} to 2.46×10^{10} ind./m^3 and an average of 6.97×10^{9} ind./m^3. The main groups were diatom and dinoflagellate, and dominant species included *Chaetoceros* sp., *Gymnodinium* sp., *and Plagioselmis prolonga.*

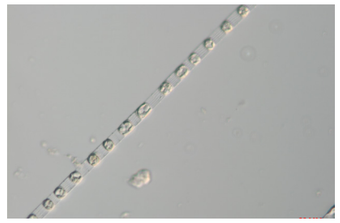
Monitoring results in the past five years indicate an average phytoplankton density ranging from 6.11×10^{9} to 2.14×10^{10} ind./m^3.

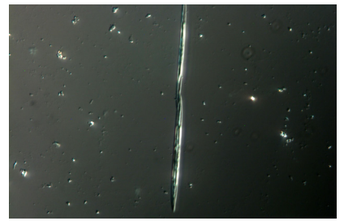
Macao sea areas In the summer of 2024, a total of 24 species of phytoplankton were identified through water sampling, with the density ranging from 6.12×10^{8} to 1.18×10^{9} ind./m^3 and an average of 8.20×10^{8} ind./m^3. The main group was diatom, and dominant species included *Skeletonema costatum* and *Thalassiosira* sp.. The diversity index ranged from 1.31 to 2.35, with an average of 1.89.

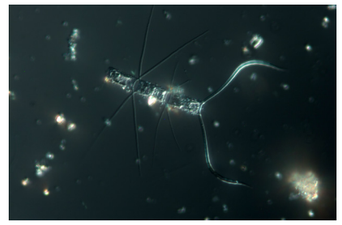
Monitoring results in the past five years indicate an average phytoplankton diversity index ranging from 1.25 to 3.13.



Phytoplankton diversity index in Macao sea areas, 2020-2024 summer


Skeletonema costatum


Pseudo-nitzschia delicatissima

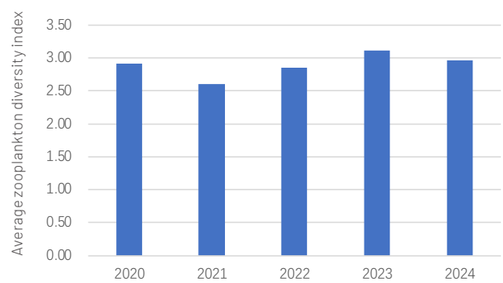

Chaetoceros affinis

Common phytoplankton in GBA sea areas

2. Zooplankton

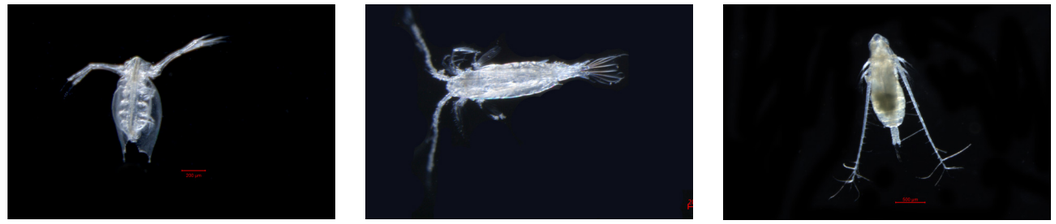
Guangdong sea areas In the summer of 2024, a total of 207 species of zooplankton were identified, with the density ranging from 8 to 2,560 ind./m^3 and an average of 581 ind./m^3. The main group was copepods, and dominant species were *Penilia avirostris*, *Acartia spinicauda*, and *Subeucalanus subcrassus*. The diversity index ranged from 1.53 to 4.83, with an average of 2.96.

Monitoring results in the past five years indicate an average zooplankton diversity index ranging from 2.60 to 3.12.



Zooplankton diversity index in Guangdong sea areas, 2020-2024 summer

Macao sea areas In the spring and summer of 2021, a total of 67 species of zooplankton were identified, with the density ranging from 7 to 158 ind./m^3 and an average of 30 ind./m^3. The main group was copepods, and dominant species included *Paracalanus parvus*, *Oikopleura* sp., and *Oithona similis*. The diversity index ranged from 1.88 to 3.56, with an average of 2.94.



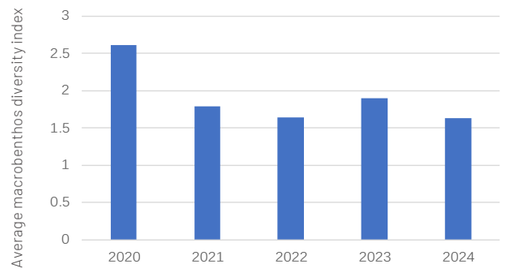
Penilia avirostris *Acartia spinicauda* *Subeucalanus subcrassus*

Common zooplankton in GBA sea areas

3. Macrobenthos

Guangdong sea areas In the summer of 2024, a total of 306 species of macrobenthos were identified, with the density ranging from 5 to 2,125 ind./m^2. The main group was annelids, and the dominant species was *Paraprionospio pinnata*. The diversity index ranged from 0.05 to 3.75, with an average of 1.63.

Monitoring results in the past five years indicate an average macrobenthos diversity index ranging from 1.63 to 2.61.



Macrobenthos diversity index in Guangdong sea areas, 2020-2024 summer

Hong Kong sea areas In the summer of 2021, a total of 277 species of macrobenthos were identified, with the density ranging from 440 to 1,672 ind./m^2. The main group was annelids, and dominant species included *Sigambra hanaokai*, *Chaetozone setosa*, and *Prionospio queenslandica*. The diversity index ranged from 1.39 to 4.03, with an average of 3.32.

Macao sea areas In the spring and summer of 2021, a total of 59 species of macrobenthos were identified, with the density ranging from 40 to 920 ind./m^2. The main groups were annelids and mollusc, and dominant species were *Potamocorbula laevis*, *Phoronis psammophila*, and *Sigambra hanaokai*. The diversit y index ranged from 0.23 to 3.46, with an average of 2.35.

Panel 1 Rare and endangered marine organisms

Chinese white dolphin

Order: Cetartiodactyla

Family: Delphinidae

Sousa chinensis, commonly known as Chinese white dolphin

Chinese white dolphin is a Level-1 protected wildlife. The Pearl River Estuary is the largest habitat for Chinese white dolphins in China, hosting the world's largest population of this species. In October 1999, the Guangdong Pearl River Estuary Chinese White Dolphin Nature Reserve was established, which was upgraded to a national nature reserve in June 2003. From 2020 to 2024, Hong Kong successively established three marine parks-Southwest Lantau, South Lantau, and North Lantau-continuously expanding the protected area of habitat for the species. According to surveys conducted from 2017 to 2021[①], there are about 1,100 Chinese white dolphins living in the reserve and its surrounding waters, with the population remaining stable.

Sea turtle

Order: Testudines

Families: Cheloniidae and Dermochelyidae

Chelonia mydas, commonly known as Green Sea Turtles

Sea turtle is a Level-1 protected wildlife. The Huidong Sea Turtle National Nature Reserve in Guangdong, the only one in the country dedicated to sea turtles, is home to several species classified as endangered by the International Union for Conservation of Nature (IUCN), including Green Sea Turtle, Loggerhead Turtle,Pacific Ridley Sea Turtle,Hawksbill Turtle, and Leatherback Turtles. Since the reserve was established, over 80,000 eggs have been laid by wild sea turtles here, hatching nearly 70,000 babies, and over 1,000 injured wild sea turtles have been helped.

Limulidae

Order: Xiphosura

Family: Limulidae

Tachypleus tridentatus, commonly known as Chinese horseshoe crab

Limulidae is a Level-2 protected wildlife mainly distributed in shallow waters of Zhejiang, Fujian, Guangdong, Guangxi, Hainan, Hong Kong, and Taiwan. Commonly known as "horseshoe crab," this species has been living in the sea for over 400 million years, hence reputed as a "living fossil." The dominant species in China are *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*, the former being listed as endangered by the IUCN. Juvenile horseshoe crabs are often found on the sandy beaches and mudflats of Deep Bay, Lantau Island, and Starling Inlet in Hong Kong.

① Guangdong Pearl River Estuary Chinese White Dolphin National Nature Reserve Administration.

(II) Seawater environment

1. Salinity

Guangdong sea areas In the summer of 2024, the surface seawater salinity ranged from less than 2.0 to 34.0.

Hong Kong sea areas In the summer of 2024, the surface seawater salinity ranged from 6.4 to 33.9.

Macao sea areas In the summer of 2024[①], the surface seawater salinity ranged from 5.5 to 18.0.

Over the past five summers, the surface seawater salinity remained generally stable in the GBA region.

2. Dissolved oxygen (DO)

Guangdong sea areas In the summer of 2024, the bottom seawater DO concentration ranged from 3.08 to 9.20 mg/L, with an average of 5.12 mg/L.

Hong Kong sea areas In the summer of 2024, the bottom seawater DO concentration ranged from 1.80 to 11.30 mg/L, with an average of 4.68 mg/L.

Macao sea areas In the summer of 2024, the surface seawater DO concentration ranged from 5.20 to 7.90 mg/L, with an average of 6.79 mg/L.

Over the past five summers, the seawater DO concentration remained generally stable in the GBA region.

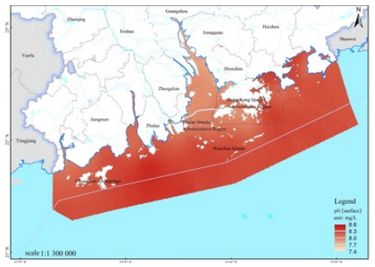
3. pH value

Guangdong sea areas In the summer of 2024, the surface seawater pH value ranged from 7.43 to 8.56, with an average of 8.16.

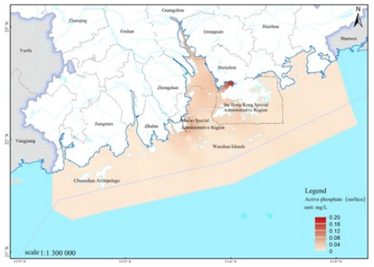
Hong Kong sea areas In the summer of 2024, the surface seawater pH value ranged from 7.50 to 8.40, with an average of 8.12.

Macao sea areas In the summer of 2024, the surface seawater pH value ranged from 7.83 to 8.12, with an average of 7.99.

Over the past five summers, the surface seawater pH value remained generally stable in the GBA region.



Surface seawater pH value



Surface seawater active phosphate concentration

① The survey area ranges from the northeast coast to the south coast of Macao; same for other elements of seawater environment and sedimentary environment.

4.Active phosphate

Guangdong sea areas In the summer of 2024, the surface seawater active phosphate concentration ranged from undetected to 0.152 mg/L, with an average of 0.0134 mg/L.

Hong Kong sea areas In the summer of 2024, the surface seawater active phosphate concentration ranged from undetected to 0.180 mg/L, with an average of 0.0184 mg/L.

Macao sea areas In the summer of 2024, the surface seawater active phosphate concentration ranged from 0.0410 to 0.0580 mg/L, with an average of 0.0493 mg/L.

Over the past five summers, the surface seawater active phosphate concentration showed no obvious change in general.

5. Inorganic nitrogen

Guangdong sea areas In the summer of 2024, the surface seawater inorganic nitrogen concentration ranged from 0.00564 to 2.28 mg/L, with an average of 0.555 mg/L.

Hong Kong sea areas In the summer of 2024, the surface seawater inorganic nitrogen concentration ranged from 0.0300 to 1.92 mg/L, with an average of 0.422 mg/L.

Macao sea areas In the summer of 2024, the surface seawater inorganic nitrogen concentration ranged from 0.789 to 1.19 mg/L, with an average of 0.980 mg/L.

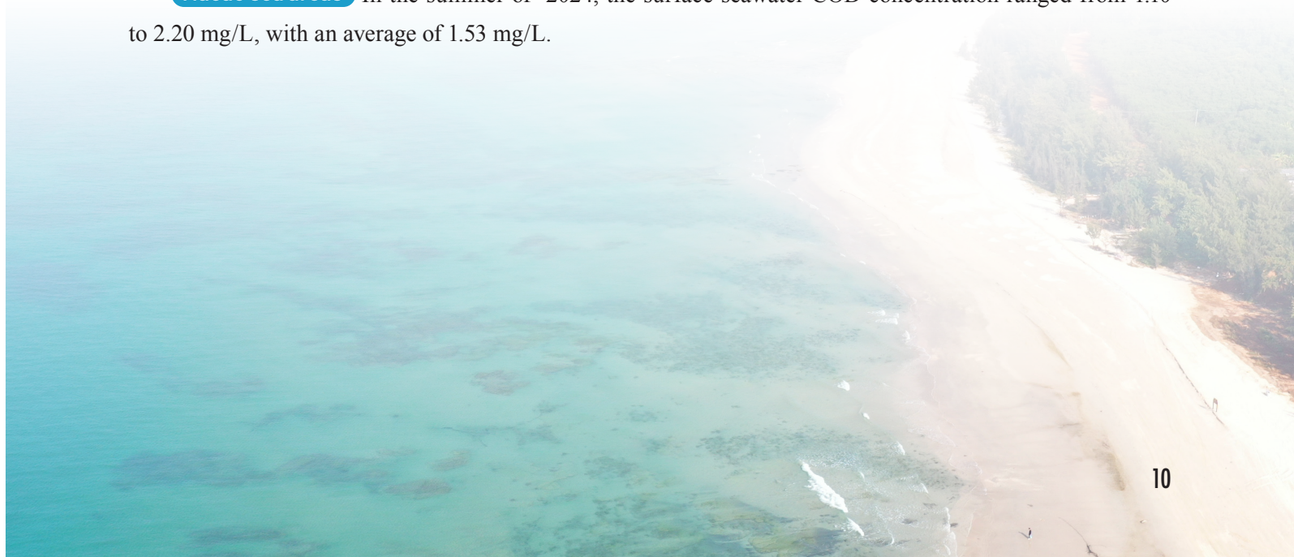
Over the past five summers, the surface seawater inorganic nitrogen concentration showed no obvious change in general.

6. Chemical oxygen demand (COD)

Guangdong sea areas In the summer of 2024, the surface seawater COD concentration ranged from 0.51 to 2.66 mg/L, with an average of 1.33 mg/L.

Hong Kong sea areas In the summer of 2024, the surface seawater COD concentration ranged from undetected to 1.14 mg/L, with an average of 0.67 mg/L.

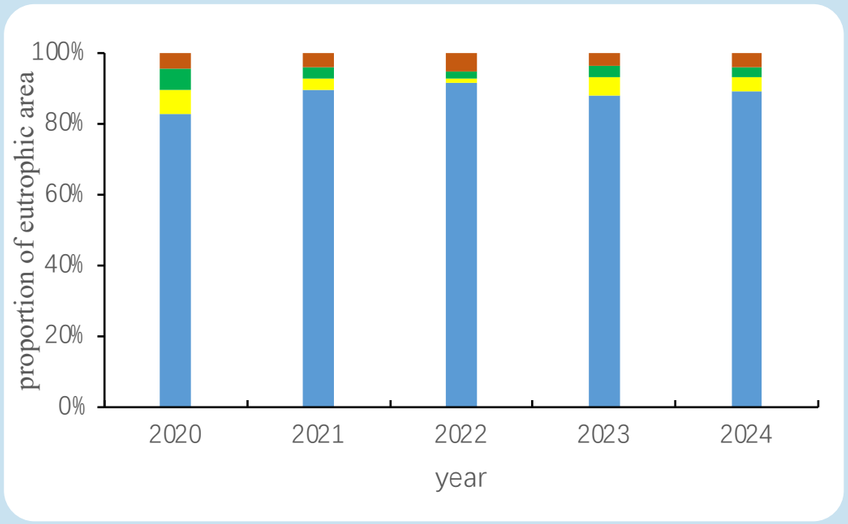
Macao sea areas In the summer of 2024, the surface seawater COD concentration ranged from 1.10 to 2.20 mg/L, with an average of 1.53 mg/L.



Panel 2 Seawater eutrophication

Seawater eutrophication refers to the phenomenon where the contents of nitrogen and phosphate in seawater exceed normal levels, leading to the abnormal growth and proliferation of certain marine organisms, which in turn causes structural and functional anomaly in marine ecosystems.

In the summer of 2024, the eutrophic seawater area in GBA was about 2,200 square kilometers, with areas of severe, moderate, and mild eutrophication[①] accounting for approximately 4%, 3%, and 4%, respectively. Severe eutrophication mainly occurred in waters around the Neilingding Island, Shenzhen Bay, off the west coast of Hong Kong, off the east coast of Hengqin Island, and in Modaomen sea areas. Compared with 2023, the proportion of eutrophic area decreased.



Proportion of eutrophic area in GBA, 2020-2024 summer

NO eutrophication
Moderate eutrophication
Mild eutrophication
Severe eutrophication

[①] The eutrophication index assessment was conducted in accordance with the *Technical Specification for Assessment of Sea Water, Marine Sediment and Marine Biological Quality* (HJ 1300-2023). The Eutrophication Index (E) is calculated as follows: $E=[(COD\times Inorganic\ Nitrogen\times Active\ Phosphate)/4500]\times10^{6}$. $E<1.0$ means no eutrophication; $1.0\leq E\leq3.0$ means mild eutrophication; $3.0<E\leq9.0$ means moderate eutrophication; and $E>9.0$ means severe eutrophication.

(III) Sedimentary environment

1. Granularity

Guangdong sea areas In 2024, silt was dominant in surface sediment with an average content of 66.5%.

Hong Kong sea areas In 2023, silt and clay were dominant in surface sediment with an average content of 71.8%.

Macao sea areas In 2024, silt was dominant in surface sediment with an average content of 86.2%.

2. Organic carbon

Guangdong sea areas In 2024, the organic carbon content in surface sediment ranged from 0.14% to 1.73% with an average of 0.90%. It remained generally stable from 2020 to 2024.

Hong Kong sea areas In 2023, the organic carbon content in surface sediment ranged from 0.50% to 0.90% with an average of 0.70%. It remained generally stable from 2020 to 2023.

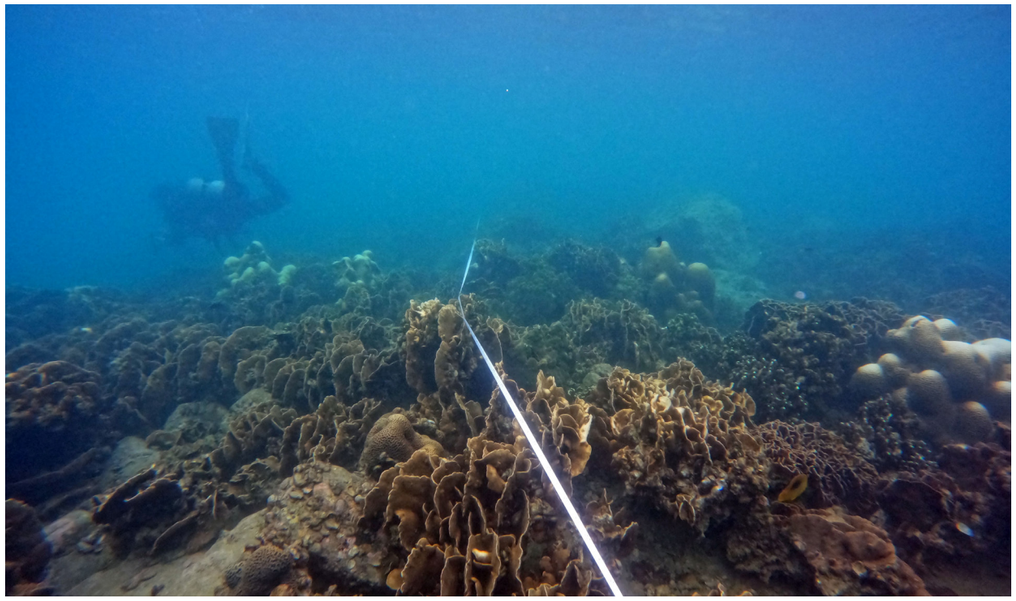
Macao sea areas In 2024, the organic carbon content in surface sediment ranged from 1.23% to 1.72% with an average of 1.44%. It showed no obvious change from 2020 to 2024.

02 Typical Marine Ecosystems

The GBA features a rich diversity of marine ecosystems, including typical types such as coral reefs, mangroves, seagrass beds, coastal salt marshes, seaweed beds, oyster reefs, estuaries, and bays.

(I) Coral reef ecosystem

The coral reef[①] ecosystem refers to a comprehensive natural system composed of coral reef habitats, formed by hermatypic corals[②], coralline algae and other corals, and the associated biotic communities. It is among the most biodiverse ecosystems in the sea, playing an important role in protecting the coastline and maintaining biodiversity, known as the "tropical rainforests" of the sea. In the GBA, coral reefs are mainly distributed at Guangdong's Daya Bay, Dapeng Bay, and Pearl River Estuary, and Hong Kong's Tung Ping Chau, Yan Chau Tong, and Hoi Ha Wan marine parks. According to the national survey of coral reef ecosystem status[③], the 2024 marine ecological early warning monitoring in Shenzhen waters, and the Hong Kong Reef check[④], a total of 106 species of hermatypic corals, under 35 genera and 17 families, have been identified in GBA waters. Dominant species are *Porites lutea*, *Plesiastrea versipora*, and *Platygyra carnosus*.



Reef check in Hong Kong

① Coral reef: A special seabed habitat formed by the accumulation of calcareous skeletons of hermatypic corals together with other calcareous organisms.
② Hermatypic coral: A general term for coral species under Scleractinia of Hexacorallia that possess symbiotic zooxanthellae, calcium carbonate skeletons, and reef-building abilities.
③ The survey was organized by the Ministry of Natural Resources and conducted by its South China Sea Ecological Center and other organizations, starting in 2019 and completed in 2020.
④ Coral reef surveys in Guangdong sea areas follow the *Technical Specification for the Monitoring, Assessment and Early Warning of Coral Reef Ecosystem (Trial)*; coral surveys in Hong Kong adopted Reef Check methodology.

Daya Bay, Guangdong Coral reef ecosystems are in moderate conditions[①]. Coral communities are in average growth, reef-dwelling biotic communities are structurally stable, and the habitat is suitable for coral growth. Benthic macroalgae, a competitive organism, is observed.

The coral reefs cover an area of approximately 1.16 square kilometers, mainly distributed in the Dalajia and Xiaolajia sea areas. Dominant hermatypic corals are *Porites solida*, *Montipora peltiformis*, and *Favites pentagona*. Living coral coverage is 8.02%, and hard coral recruitment[②] is 0.62 ind./m^2. No coral bleaching or disease is observed.

Reef fish density is 26 fish/100m^2, with dominant species being *Chromis notata* and *Neopomacentrus bankieri*. Benthic macro-invertebrate density is 22 ind./100m^2, with common groups including sea urchins, sea cucumbers, and gorgonian corals. Benthic macroalgae coverage is 3.68%. No *Acanthaster planci* or *Drupa morum*, which are harmful organisms, are observed.

Dendronepythya sp.

Entacmaea quadricolor

Phyllidia sp.

Echinoidea

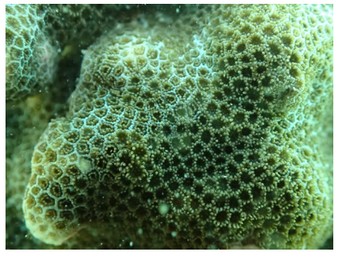
Common benthic macro-invertebrates on coral reefs in GBA

① Coral reef ecosystem status is divided into three levels-good, moderate, and poor-in the *Technical Guidelines for the Monitoring, Assessment and Early Warning of Coral Reef Ecosystem*.
Good: Coral communities are in good growth, the ecological functions of reef-dwelling biotic communities remain stable, the marine environmental quality is suitable for coral growth, and the overall ecosystem can maintain its natural attributes with a strong ability of self-recovery.
Moderate: Coral communities are in average growth, the ecological functions of reef-dwelling biotic communities remain largely stable, the marine environmental quality is largely suitable for coral growth, and the overall ecosystem can largely maintain its natural attributes with some ability of self-recovery.
Poor: Coral communities are in poor growth, the ecological functions of reef-dwelling biotic communities are to be restored, the marine environmental quality is just enough for coral growth, and the overall ecosystem can largely maintain its natural attributes but with inadequate ability of self-recovery.
② Hard coral recruitment: the number of hermatypic coral larvae within unit of area.

Dapeng Bay[①] Coral reef ecosystems are in good conditions. Coral communities are in healthy growth, reef-dwelling biotic communities are structurally stable, and the habitat is suitable for coral growth. Benthic macroalgae, a competitive organism, is present.

The coral reefs cover an area of approximately 0.38 square kilometers, mainly distributed in waters off the east coast of Dapeng Bay. Dominant hermatypic corals include *Porites lutea*, *Plesiastrea versipora*, and *Platygyra carnosus.* Living coral coverage is 31.09%, and hard coral recruitment is 3.53 ind./m^2. A very small amount of bleached (0.12%) and dead (0.40%) corals is observed, but no coral disease is observed.

Reef fish density is 35 fish/100m^2, with dominant species being *Neopomacentrus bankieri*, *Chromis notata*, and *Halichoeres nigrescens*. Benthic macro-invertebrate density is 49 ind./100m^2 , with common groups including sea urchins and snails. Benthic macroalgae coverage is 3.52%. No *Acanthaster planci* or *Drupa morum*, which are harmful organisms, are observed.



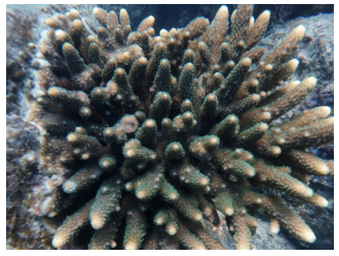
Porites lutea

Galaxea fascicularis

Platygyra carnosa

Plesiastrea versipora

Pavona decussata



Acropora tumida

Common species of reef-building corals in GBA

Zhuhai, Guangdong Coral reef ecosystems are in good conditions. Coral communities are in healthy growth, reef-dwelling biotic communities are structurally stable, and the habitat is suitable for coral growth. Benthic macroalgae, a competitive organism, is present.

The coral reefs cover an area of approximately 13.36 square kilometers, mainly distributed in waters around the Wanshan Archipelago. Dominant hermatypic corals include *Porites lutea*, *Plesiastrea versipora*, and *Platygyra carnosus*. Living coral coverage is 17.30%, and hard coral recruitment is 0.61 ind./m^2. A very small amount of bleached (0.08%) and dead (0.03%) corals is observed, but no coral disease is observed.

[①] Data from the Shenzhen Marine Development Research and Promotion Center; survey area is Guangdong sea areas.

Reef fish density is 51 fish/100m^2, with dominant species being *Neopomacentrus cyanomos*, *Neopomacentrus bankieri*, and *Siganus canaliculatus*. Benthic macro-invertebrate density is 3,464 ind./100m^2, with common groups including snails, crustaceans, and sea urchins. Benthic macroalgae coverage is 0.12%. No *Acanthaster planci* or *Drupa morum*, which are harmful organisms, are observed.

Hong Kong Coral reef ecosystems are in good conditions. Coral communities are generally healthy, reef-dwelling biotic communities are structurally stable, and the habitat is suitable for coral growth.

Coral communities are mainly distributed in Tung Ping Chau, Yan Chau Tong, and Hoi Ha Wan marine parks. Dominant hermatypic corals are *Porites lutea*, *Platygyra carnosus*, and *Pavona decussata*. The AFCD has carried out public reef checks continuously for many years.The average living coral coverage of the 33 sites surveyed in 2024 was 42.1%, and was 50% at 1/3 of the sites. Coral bleaching was observed in 2024, and most of the bleached coral colonies recovered in winter.

Dominant Reef fishes include Labridae, Chaetodontidae, Serranidae, and Lutjanidae. Benthic macro-invertebrates such as sea cucumbers, sea urchins, and snails are observed. Potential coral predators like *Acanthaster planci* or *Drupa morum* are not observed.

Chaetodon wiebeli

Pterois volitans

Chelonodontops patoca

Cirrhilabrus melanomarginatus

Common reef fishes in GBA

(II) Mangrove ecosystem

The mangrove ecosystem is primarily composed of mangrove plants, alongside other flora, fauna, and microorganisms, and interacts with the environment. It plays an important role in wind and wave protection, seawater purification, biodiversity preservation, and carbon sequestration and storage, being known as "guardians of the sea."

The GBA is home to approximately 40 square kilometers of mangroves[①], primarily distributed in Guangdong's Shenzhen, Zhuhai, and Jiangmen, Hong Kong's Mai Po, Tai Po Ting Kok, Sai Kung, and Lantau Island, and Macao's Taipa Island, Cotai, and Coloane Island. There are 24 species of mangrove plants in the region, including 15 true mangroves. Dominant species include *Kandelia obovata*, *Aegiceras corniculatum*, and *Bruguiera gymnorhiza*.

Mangroves in Futian, Shenzhen, Guangdong

Futian of Shenzhen, Guangdong Mangrove ecosystems are in good conditions, so are the mangrove plant communities. The level of macrobenthos diversity is quite high, and the habitat is suitable for mangrove growth.

The mangroves cover an area of approximately 1.48 square kilometers, including eight true mangrove plants such as *Kandelia obovata*, *Bruguiera gymnorhiza*, and *Aegiceras corniculatum*.

Nine species of macrobenthos are identified, with a diversity index of 1.52. Dominant species are *Pontodrilus litoralis* and *Ellobium chinense*.

Silt makes up 63% of sediment and organic carbon 5.29%.

① Remote sensing monitoring results in 2024.

Qi'ao Island of Zhuhai, Guangdong Mangrove ecosystems are in good conditions, so are the mangrove plant communities. The level of macrobenthos diversity is quite low, and the habitat is suitable for mangrove growth.

The mangroves cover an area of approximately 5.49 square kilometers, including 15 true mangrove plants such as *Sonneratia apetala*, *Acanthus ilicifolius*, and *Avicennia marina*.

Eleven species of macrobenthos are identified, with a diversity index of 0.91. Dominant species are *Sinosesarma tangi* and *Ilyoplax tansuiensis*.

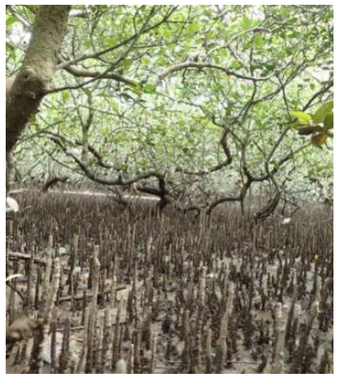
Zhenhai Bay in Jiangmen, Guangdong Mangrove ecosystems are in good conditions, so are the mangrove plant communities. The level of macrobenthos diversity is quite high, and the habitat is suitable for mangrove growth.

The mangroves cover an area of approximately 1.18 square kilometers, including six true mangrove plants such as *Aegiceras corniculatum*, *Avicennia marina*, and *Kandelia candel*.

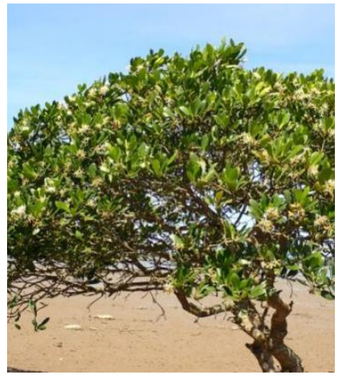
Fifteen species of macrobenthos are identified, with an average density of 44 ind./m^2, a richness index of 1.68, and a diversity index of 1.68.

Aegiceras corniculatum

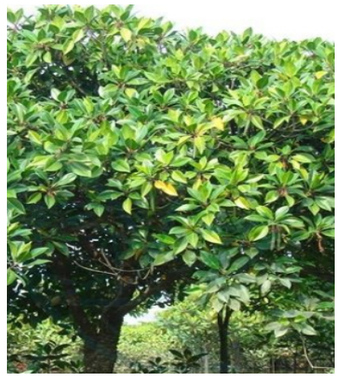
Acanthus ilicifolius



Avicennia marina



Kandelia obovata



Bruguiera gymnorrhiza

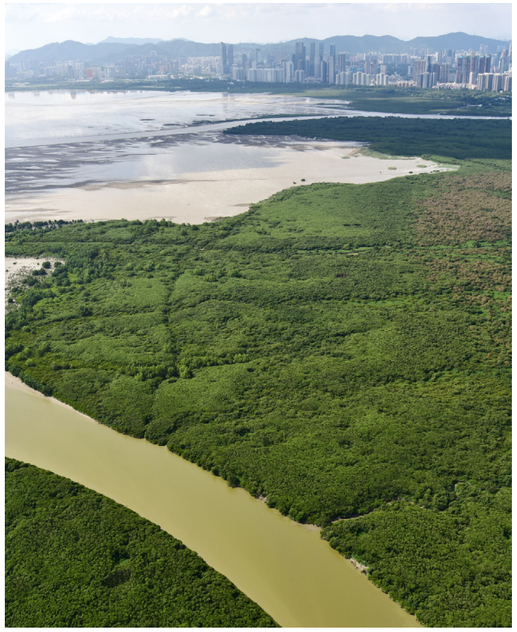
Acrostichum aureum

Main mangrove plants in GBA

Hong Kong Mangrove ecosystems are in good conditions, so are the mangrove plant communities. The level of macrobenthos diversity is quite high, and the habitat is suitable for mangrove growth.

The mangroves cover an area of approximately 6.24 square kilometers, including eleven true mangrove plants such as *Kandeltia candel*, *Avicennia marina*, and *Aegiceras corniculatum*.

At Mai Po Inner Deep Bay Ramsar Site, a total of 70 species of macrobenthos are identified throughout the year, with a diversity index of 0.81-2.39. Dominant groups are Malacostraca, Polychaeta, and Oligochaeta. Twenty-seven species of macrobenthos are identified in other areas, with a diversity index of 1.93. Dominant species are *Heteromastus filiformis*, *Anomalifrons lightana*, and *Discapseudes mackiei*.



Mangroves in Mai Po, Hong Kong

Paracleistostoma crassipilum

Periophthalmus modestus

Geloina erosa

Ellobium aurismidae

Common macrobenthos in the mangrove ecosystems of GBA

Macao Macao is home to approximately 0.7 square kilometers of mangroves, mainly distributed along the west coastline of the Taipa Island-Cotai-Coloane Island route, including about 0.13 square kilometers in the Cotai Ecological Reserve[①]. Eight true mangrove plants[②] have been observed, with *Acanthus ilicifolius* and *Aegiceras corniculatum* being dominant.

A total of 40 species of macrobenthos are observed in the Cotai Ecological Reserve throughout the year. Dominant species include *Ellobium aurismidae*, *Sermyla riqueti*, and *Dendronereis pinnaticirris*.

Panel 3 International Mangrove Center established

In November 2022, President Xi Jinping announced the decision to establish an International Mangrove Center (IMC) in Shenzhen at the opening ceremony of the 14th Meeting of the Conference of the Contracting Parties to the *Ramsar Convention on Wetlands* (COP14). In September 2023, the Standing Committee of *Ramsar Convention on Wetlands* passed the regional motion to develop the IMC in Shenzhen. In November 2024, representatives from the first group of 18 member states signed the *Agreement on the Establishment of the International Mangrove Center* in Shenzhen, pledging to establish an open and inclusive international cooperation mechanism aimed at win-win cooperation and shared development regarding mangroves and coastal blue carbon ecosystems.

The establishment of the International Mangrove Center marks an important milestone in building a modernization defined by the harmonious coexistence between man and nature. It stands as a shining emblem of Shenzhen's commitment to ecological civilization, and also represents a new starting point in China's efforts to join hands with the world in restoring the blue planet's lifeline and safeguarding the shared future of humanity.

Signing ceremony for the establishment of the IMC

① The area of mangroves in the Cotai Ecological Reserve was estimated based on aerial photos and maps of 2024.
② He Ruirong, "Mangroves and Their Protection in Macao," Jinan University, 2009.

(III) Seagrass bed ecosystem

The seagrass bed[①] ecosystem refers to a natural system dominated by seagrass and formed through the interactions between biotic communities and their surrounding environment. Known as the "undersea grassland," it plays an important role in purifying water, stabilizing sediments, maintaining biodiversity, and enhancing carbon sequestration. In the GBA, approximately 0.4 square kilometers of seagrass beds have been observed, mainly distributed in Guangdong's Daya Bay, Zhuhai's Tangjia Bay and Hengqin, and Hong Kong's Sheung Pak Nai, Mai Po, and San Tau. Five species of seagrass are identified, namely *Halophila beccarii*, *Halophila ovalis*, *Halophila minor*, *Ruppia maritima*, and *Zostera japonica*.

Seagrass bed in San Tau, Hong Kong

Tangjia Bay in Zhuhai, Guangdong The seagrass beds cover an area of approximately 0.05 square kilometers with a coverage of 33.4%. The dominant seagrass is *Halophila beccarii*, and the seagrass shoot density is 1,098 shoots/m^2.

Seventeen species of macrobenthos are identified, with a density of 43 ind./m^2 and a biomass of 13.6 g/m^2. Dominant species are *Glauconome chinensis* and *Dendronereis pinnaticirris*. *Ulva compressa*, a competitive macroalgae, is identified with a coverage of 0.34%.

Seawater salinity is 8.7, transparency 0.7 m, DO 6.31 mg/L, inorganic nitrogen concentration 1.27 mg/L, and active phosphate concentration 0.0420 mg/L.

① Seagrass refers to monocotyledonous angiosperms that can live entirely in seawater or saline water at estuaries. A seagrass community occupying a certain area is called a seagrass bed.

Hong Kong[①] Seagrass beds are mainly distributed at Deep Bay and San Tau of Lantau Island both in the western waters. They usually co-exist with mangroves, occurring in a small scale and showing an obvious trend of decline. Five species of seagrass are identified, namely *Halophila beccarii*, *Halophila ovalis*, *Halophila minor*, *Ruppia maritima*, and *Zostera japonica*.

Zostera japonica *Halophila ovalis* *Halophila beccarii*

Main species of seagrass in GBA

④ Data from the surveys conducted during 2020-2024 by the Wetland Specialist Working Group of AFCD, Hong Kong SAR.

(IV) Coastal salt marsh ecosystem

The coastal salt marsh [①] ecosystem refers to a comprehensive natural system composed of salt marsh plants along with their habitats and biotic communities. It serves a variety of ecological functions, including wildlife habitat, wave attenuation and bank protection, and carbon sequestration and storage. The GBA is home to about nine square kilometers of coastal salt marshes, mainly distributed in Guangdong's Guangzhou, Zhuhai and Jiangmen, with some found in the Mai Po Nature Reserve in Hong Kong. Dominant plants are native reed, *Phragmite saustralis*, *Cyperus malaccensis* var. *brevifolius*, *Cyperus malaccensis*, and the alien invasive species *Spartina alterniflora*.

Salt marsh at Jiaomen waterway in Guangzhou, Guangdong

Jiaomen waterway in Guangzhou, Guangdong The salt marshes cover an area of approximately 0.16 square kilometers. Dominant salt marsh plants are *Cyperus malaccensis* var. *brevifolius* and *Phragmites australis*, with a coverage of 86% and a density of 394 plants/m^2.

Eleven species of macrobenthos are identified, with a density of 73 ind./m^2, a biomass of 8.7 g/m^2, and a diversity index of 0.44. The dominant species is Ilyoplax tansuiensis.

Surface sediment features a pH value of 7.2, silt content of 81%, and organic carbon content of 2.3%.

Modaomen waterway in Guangzhou, Guangdong The salt marshes cover an area of approximately 1.97 square kilometers. Dominant salt marsh plants are *Cyperus malaccensis* var. *brevifolius* and *Phragmites australis*, with a coverage of 56% and a density of 149 plants/m^2.

Eighteen species of macrobenthos are identified, with a density of 79 ind./m^2, a biomass of 11.7 g/m^2, and a diversity index of 1.48. Dominant species include *Ilyoplax ningpoensis, Namalycastis abiuma*, and *Dendronereis pinnaticirris*.

[①] Salt-tolerant herbaceous plants or low shrubs (excluding mangrove plants and seagrass) growing in the upper and middle parts of intertidal zones that are periodically or intermittently submerged by tides.

Surface sediment features a pH value of 7.0, silt content of 65%, and organic carbon content of 2.7%.

Salt marsh at Modaomen waterway in Zhuhai, Guangdong

Jitimen waterway in Zhuhai, Guangdong The salt marshes cover an area of approximately 0.81 square kilometers. Dominant salt marsh plants are *Phragmites australis* and *Cyperus malaccensis*, with a coverage of 52% and a density of 247 plants/m^2.

Fourteen species of macrobenthos are identified, with a density of 121 ind./m^2, a biomass of 110.6 g/m^2, and a diversity index of 2.14. Dominant species include *Tarebia granifera*, *Dendronereis pinnaticirris*, and *Deiratonotus cristatum*.

Surface sediment features a pH value of 7.7, silt content of 78%, and organic carbon content of 1.6%.

Phragmites australis

Cyperus malaccensis var. *brevifolius*

Cyperus malaccensis

Main native species of salt marsh plants in GBA

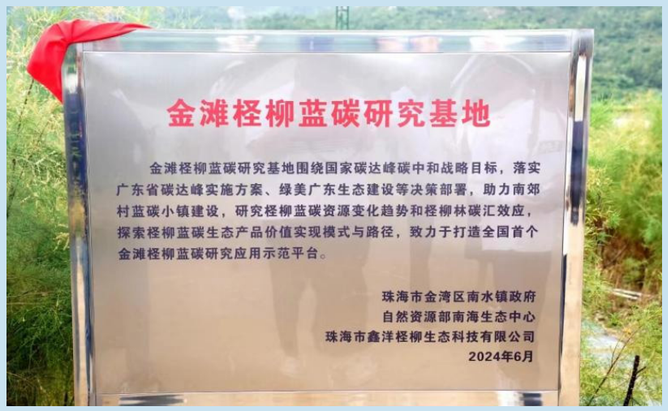
Panel 4 Blue carbon survey and assessment support "dual carbon" strategy

Blue carbon, also known as "blue carbon sink" or "marine carbon sink", specifically refers to the processes, activities, and mechanisms through which marine activities and marine organisms absorb carbon dioxide from the atmosphere and fix and store it within marine ecosystems. Mangrove, seagrass bed, and coastal salt marsh ecosystems are internationally recognized as three major types of coastal blue carbon ecosystems. Enhancing their carbon sink capabilities is an important way for China to achieve carbon neutrality.

To deliver the "dual carbon" (carbon peaking and carbon neutrality) goals set forth by President Xi Jinping, the South China Sea Bureau of the Ministry of Natural Resources, along with natural resources (marine) regulators of Guangdong and Shenzhen, has conducted a series of surveys, assessments, and scientific research on the coastal blue carbon ecosystems in the GBA region, understanding their baseline carbon sink and potential for enhanced carbon sequestration. The parties led the development of the *Technical Specification for the Survey and Assessment of Carbon Stocks in Mangrove Ecosystems,* and participated in the formulation of the *Technical Specification for the Survey and Assessment of Carbon Stocks in Coastal Salt Marsh Ecosystems* and the *Technical Specification for the Survey and Assessment of Carbon Stocks in Seagrass Bed Ecosystems*. These documents provide the technical guidelines and references for further research on blue carbon mechanisms and carbon-sink-enhancing measures.

The South China Sea Ecological Center under the Ministry of Natural Resources, in conjunction with the Nanshui Town Government of Jinwan District, Zhuhai and other parties, established a *Tamarix austromongolica 'Jintan'* blue carbon research base. The base focuses on researching the models and pathways of realizing the value of *Tamarix austromongolica 'Jintan'*, a blue carbon ecological product. It will help achieve a new situation of ecological restoration-both mangroves and *Tamarix austromongolica 'Jintan'* will grow along China's southern coastline.

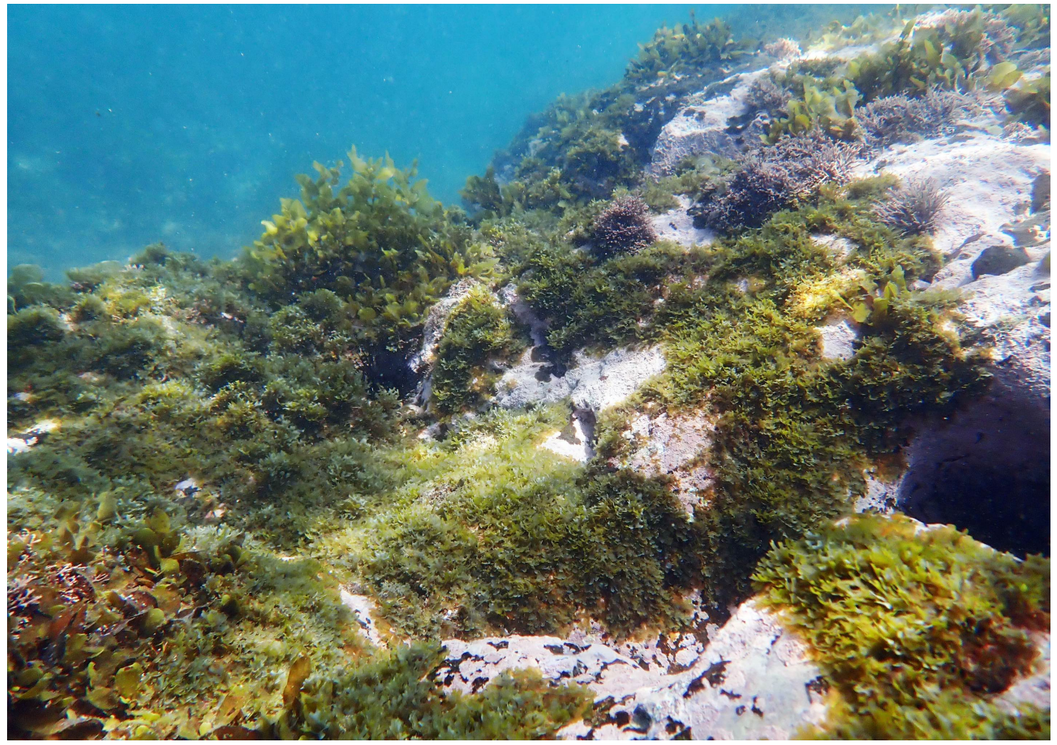
Tamarix austromongolica 'Jintan'



Tamarix austromongolica 'Jintan' blue carbon research base

(V) Seaweed bed ecosystem

The seaweed bed ecosystem refers to a nearshore ecosystem with self-regulating mechanisms in which biotic communities supported by macroalgae and the abiotic environment interact with each other. It plays an important role in maintaining the diversity of species, protecting coastlines, and enhancing carbon sequestration. In the GBA, seaweed beds are sporadically distributed in the nearshore waters of Dongchong-Xichong and Xiaomeisha of Shenzhen, Guangdong, and in Hong Kong's Tung Ping Chau Marine Park and Cape D'Aguilar Marine Reserve. Common macroalgae species include *Sargassum hemiphyllum, Colpomenia sinuosa, Padina arborescens, Corallina pilulifera, Asparagopsis taxiformis*, and *Plocamium telfairiae*.



Seaweed bed on the coast of Shenzhen, Guangdong

Dongchong-Xichong of Shenzhen, Guangdong The seaweed beds cover an area of approximately 0.14 square kilometers. Fourteen species of macroalgae are identified, and the dominant species is *Sargassum hemiphyllum*, with a biomass of 241.1 g/m^2.

Forty-four species of phytoplankton, 46 species of zooplankton, eight species of ichthyoplankton, five species of nekton, and 25 species of intertidal macrobenthos are identified.

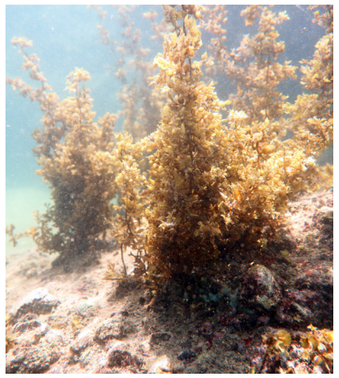
The seawater features a salinity of 33.22, pH value of 8.14, DO concentration of 10.06 mg/L, and chlorophyll a concentration of 1.74 μg/L.

Xiaomeisha of Shenzhen, Guangdong The seaweed beds cover an area of approximately 0.04 square kilometers. Twelve species of macroalgae are identified. The dominant species is *Sargassum hemiphyllum*, with a biomass of 28.2 g/m^2.

Thirty-five species of phytoplankton, 18 species of zooplankton, seven species of ichthyoplankton, three species of nekton, and 34 species of intertidal macrobenthos are identified.

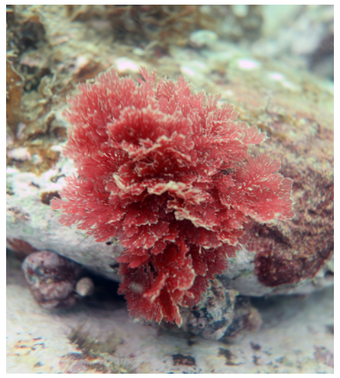
The seawater features a salinity of 33.08, pH value of 8.26, DO concentration of 8.69 mg/L, and chlorophyll a concentration of 1.27 μg/L.

Hong Kong[①] The macroalgae is mostly seasonal, with the highest diversity in the Tung Ping Chau Marine Park, Sai Kung Lung Ha Wan, Bluff Island, Shelter Island, and Stanley. The Sargassum in Tung Ping Chau Marine Park grows into dense patches of brown seaweed in spring, while large areas of *Ulva* appear in the Cape D'Aguilar Marine Reserve seasonally, forming temporary seaweed habitats.



Sargassum hemiphyllum

Colpomenia sinuosa



Plocamium telfairiae

Corallina pilulifera

Padina arborescens

Asparagopsis taxiformis

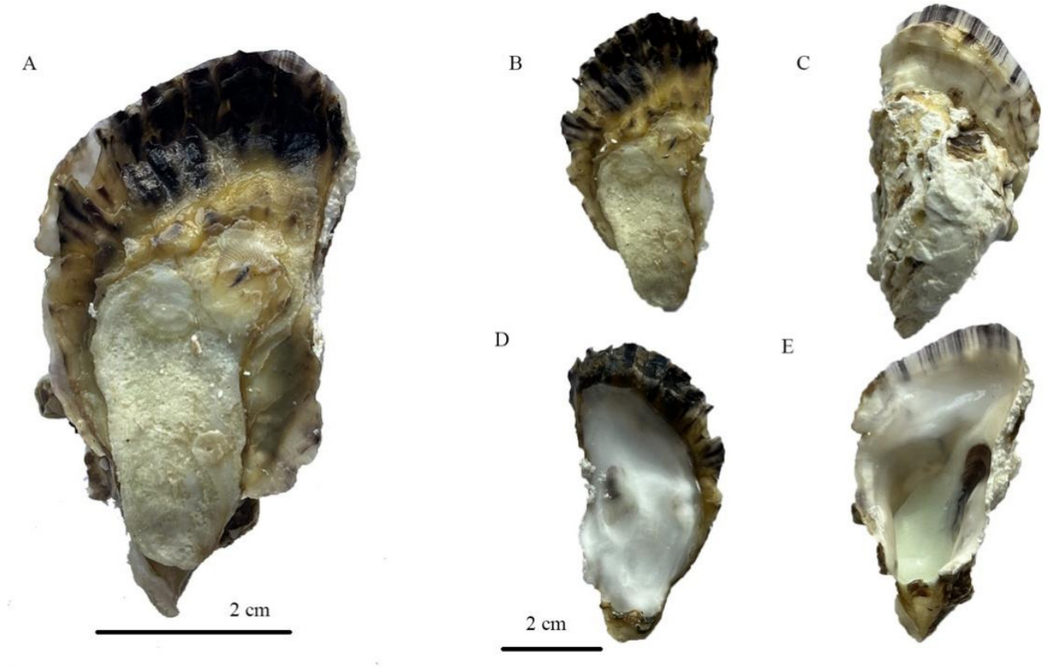
Common macroalgae species in GBA

(VI) Oyster reef ecosystem

The oyster reef ecosystem is composed of living oysters, the shells of dead oysters, and other reef-dwelling organisms. It is distributed in the intertidal and shallow subtidal zones, playing an important role in water purification, coastline protection, and biodiversity preservation. In the GBA, oyster reefs are mainly distributed along the coastal waters of Zhuhai in Guangdong, in waters of Lau Fau Shan, Yung Shue O, and Pak Nai in Hong Kong, and in waters around the Macao Peninsula and Cotai. The dominant reef-building oyster species is *Crassostrea hongkongensis*.

Zhuhai, Guangdong The oyster reefs cover an area of approximately 0.06 square kilometers, mainly distributed in waters of Yinkengjiao and Qi'ao Island, with an oyster density of 1,663 ind./m^2. The dominant species-also the main hermatypic species—is *Crassostrea hongkongensis*. Twenty-eight species of intertidal benthos are identified. Dominant species include Neritina yoldi and Perinereis nuntia.

The seawater features a temperature of 31.2℃, salinity of 14.24, pH value of 7.86, DO concentration of 5.96 mg/L, and a suspended matter concentration of 52.1 mg/L. The bottom material of the reef area is rock, while that of the non-reef area is sand-mudflat.



A: the whole oyster; B: right shell surface; C: left shell surface; D: inside right shell; E: inside left shell

Crassostrea hongkongensis

[①] The Hong Kong Biodiversity Information Hub of AFCD.

(VII) Estuary ecosystem

The estuary[①] ecosystem refers to the comprehensive system composed of the water environment where rivers meet the sea and freshwater mixes and interacts with saltwater and the biotic communities living therein. It is an important area for the convergence of terrestrial and marine materials, the flow of energy, and the reproduction, habitation, and migration of marine organisms, playing a crucial role in climate regulation, flood mitigation, environmental purification, and biodiversity preservation. The main estuary in the GBA region is the Pearl River estuary.

the Pearl River Located at the southern end of the Pearl River Basin where it meets the South China Sea, the Pearl River estuary boasts a unique geographical pattern featuring the "convergence of three rivers and eight outlets to the sea." The Pearl River has the second largest annual runoff in the country. Influenced by the Pearl River's runoff, the coastal currents of Guangdong, and the waters of the South China Sea, the estuary is rich in biodiversity, serving not only as a key breeding and growing area for Chinese white dolphins, but also a crucial spawning, feeding and wintering ground for various aquatic organisms. Typical marine ecosystems like mangroves, coastal salt marshes, and coral reefs are found here.

Altogether 122 species of phytoplankton, 167 species of zooplankton, 183 species of macrobenthos, and 63 species of intertidal benthos are identified, with the number of species and diversity index for phytoplankton and zooplankton remaining stable, while the number of macrobenthos species declining. Fishery resources are dominated by fish, crustaceans, and cephalopods, with 54 species of ichthyoplankton identified.

The area of seawater eutrophication has decreased compared to 2023. Surface sediment is dominated by silt, with moderate and stable sediment quality.

Remote sensing image of Pearl River estuary

① The section where the end of a river meets the sea, including the near-mouth section, estuarine section, and the coastal section outside the mouth.

(VIII) Bay ecosystem

The bay[①] ecosystem refers to a comprehensive natural system composed of organisms living in the bay and their semi-enclosed environment. It plays a crucial role in water purification and biodiversity preservation. Typical bay ecosystems within the GBA include the Daya Bay and the Dapeng Bay.

Daya Bay, Guangdong Located in the northern part of the South China Sea and the east side of the Pearl River estuary, the Daya Bay is a subtropical, semi-enclosed, shallow bay covering an area of approximately 650 square kilometers, with a coastline stretching about 245 kilometers. It is a weak tidal bay because of its irregular semi-diurnal tide. Typical marine ecosystems include coral reefs, mangroves, and seaweed beds.

The biotic communities are structurally stable. Altogether 150 species of phytoplankton, 94 species of zooplankton, 127 species of macrobenthos, 56 species of intertidal benthos, and 32 species of ichthyoplankton were identified. Compared to the average number over the previous five years, the number of species of phytoplankton, zooplankton, and ichthyoplankton, as well as the diversity index of intertidal benthos, both increased.

Water quality is good[②]. Marine sediment, primarily composed of silt, is of good quality and has remained stable[③].

Remote sensing image of Daya Bay, Guangdong

① A coastal area that is indented into the land and has a surface area greater than or equal to that of a semicircle whose diameter is the width of the bay's mouth.

② In accordance with the *Seawater Quality Standard* (GB3097-1997), twelve elements, namely pH, DO, COD, inorganic nitrogen, active phosphate, mercury, arsenic, zinc, cadmium, lead, copper, and chromium, are measured to determine the seawater quality at Daya Bay. It is found that monitoring stations meeting type-I and type-II standards account for ≥80%. In accordance with the *Technical Specification for Offshore Environmental Monitoring: Part 10 Evaluation and Report* (HJ442.10-2020), seawater quality in the region is good. Same for Dapeng Bay.

③ In accordance with the *Marine Sediment Quality* (GB18668-2002), nine elements, namely mercury, arsenic, copper, zinc, cadmium, lead, chromium, organic carbon, and sulfide, are measured to determine the sediment quality at Daya Bay. It is found that all monitoring stations meet the type-I standards for marine sediments. Same for Dapeng Bay.

Dapeng Bay Located between the Dapeng Peninsula in east Shenzhen and the Kowloon Peninsula in Hong Kong, the Dapeng Bay, with its mouth facing southeast, is a subtropical, semi-enclosed, deep-water bay covering an area of approximately 335 square kilometers, of which roughly 174 square kilometers belong to Shenzhen. It is a weak tidal bay because of its irregular semi-diurnal tide. Typical marine ecosystems include coral reefs and seaweed beds.

Biotic communities are structurally stable. Altogether 59 species of phytoplankton, 83 species of zooplankton, 38 species of macrobenthos, and 31 species of ichthyoplankton were identified. Compared to the average number over the previous two years, the number of species of ichthyoplankton, the diversity index of zooplankton, and the density of macrobenthos all increased.

Water quality is good. Marine sediment, primarily composed of sand and silt, is of good quality and has remained stable.

Dapeng Bay

Panel 5

National Observation and Research Station of Coastal Ecological Environments in Macao

—a national outpost for GBA marine ecological protection

The National Observation and Research Station of Coastal Ecological Environments in Macao, commonly known as the Macao Field Station, is the first national field station established in Hong Kong and Macao. Undertaken by the Macao University of Science and Technology (MUST) and regulated by the Macao Environmental Protection Bureau, the station marks Macao's comprehensive integration into the nation's sci-tech innovation system.

Core mission: Filling the gap in the monitoring of subtropical coastal ecosystems

In response to the serious challenges facing the GBA coastal zones, such as natural coastline retreat, near-shore eutrophication, and dwindling biological resources, the Macao Field Station focuses on three major tasks—

Establishing an integrated sky-land-sea observation platform. Integrating technologies such as satellite remote sensing, ground monitoring, and ocean buoys, the field station has established a multidimensional monitoring network covering the atmosphere, water bodies, sediments, and organisms, filling the gap in comprehensive observation of subtropical coastal ecosystems in China.

Developing technologies for integrated land-sea governance. The field station focuses on key technologies in areas such as synergistic multi-pollutant control, coastal ecological restoration, and policy models for regional collaborative governance, supporting the construction of a "Beautiful Bay" in the GBA.

Researching climate change adaptation. The field station has conducted long-term observation and systematic research on coastal erosion caused by sea-level rise and extreme weather events, providing data for resilient coastline planning and climate change adaptation and mitigation, and also supporting the development of responses to climate disasters and ecological risks commonly seen in coastal zones.

Innovation: Driving coordinated ecological governance in GBA

Since 2022, the Macao Field Station has been continuously collecting first-hand data on the water quality and biodiversity in Macao and its surrounding waters, providing scientific evidence for pollution control in the GBA. It has launched the "Coastal Changes and Key Technologies for Integrated Land-Sea Governance in Macao." In collaboration with the State Key Laboratory of Marine Pollution (SKLMP) of the City University of Hong Kong, it monitors estuarian coastlines in GBA based on the Global Estuaries Monitoring Programme. It also shares data with national-level platforms such as the Dinghushan Forest Ecosystem Research Station in Guangdong, promoting interconnected ecosystem observation across the GBA.

Playing a pivotal role in China's marine science program, the Macao Field Station helps identify and address challenges to the integrated land-sea governance in GBA while also serving as an incubation and testing ground for green and low-carbon technologies.

Unveiling ceremony of Macao Field Station[1]

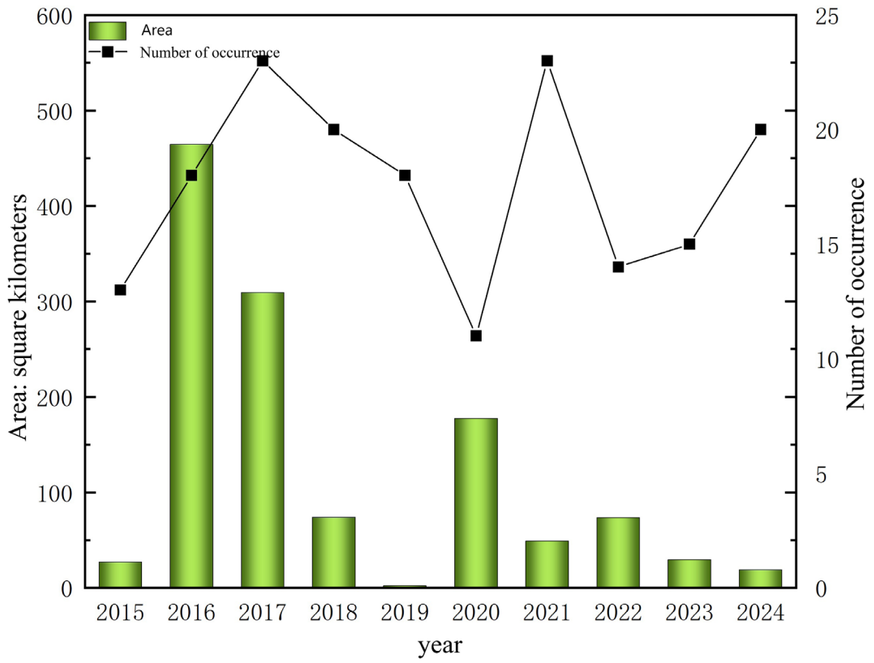
[1] Official website of MUST.

Marine Ecological Disasters and Issues 03

Marine ecological disasters refer to the phenomena that environmental changes or human factors lead to the explosive proliferation or high concentration of one or more marine organisms, damaging the structure and functions of marine ecosystems. The major marine ecological disaster happening in the GBA in 2024 was red tide. Besides, coastline erosion damages the habitats of marine organisms and affects the structure and functions of marine ecosystems.

(I) Red tide

In 2024, the GBA experienced 22 red tide events, including four times in Shenzhen, three times in Zhuhai, once each in Guangzhou and Dongguan-all in Guangdong province, 11 times in Hong Kong, and twice in Macao. Main red tide plankton species included *Phaeocystis globosa*, *Noctiluca scintillans*, and *Gyrodinium instriatum*. During these events, no abnormal marine life deaths or human intoxication were recorded, nor were there significant economic losses. The largest single red tide, spanning approximately 8.00 square kilometers, occurred in August in Shenzhen's Dapeng Bay near Nan'ao and in waters near Da'ao Bay. The longest red tide, lasting 45 days, was observed in December in waters around Zhuhai's Dayinzui, Gongbei Bay, and other areas.



Red tide occurrences in GBA, 2015-2024

Over the past decade, a total of 175 red tide events have been recorded in GBA—mostly in winter and spring, affecting an accumulative area of approximately 1,226.29 square kilometers, with the Pearl River estuary experiencing the most red tides. The year 2016 recorded the largest affected areas, while 2017 recorded the highest number of occurrences. There are primarily 16 species of red tide plankton, of which *Noctiluca scintillans*, *Akashiwo sanguinea*, *Phaeocystis globosa*, and *Skeletonema costatum* are the most frequent culprits.

Noctiluca scintillans

Panel 6 Localized biotic outbreak

Localized biotic outbreaks refer to the abnormal proliferation or large-scale concentration of a specific biotic population within a particular area over a short period, disrupting the existing ecological balance and triggering a chain of detrimental effects. Over the past decade, the GBA sea areas have seen localized biotic outbreaks of Afairy shrimp (*Acetes* sp.), sharp sea butterfly (*Creseis acicula*), and jellyfish, which are emerging as new types of marine ecological disasters.

Fairy shrimp

Phylum: Arthropoda
Class: Crustacea
Order: Decapoda
Family: Sergestidae
Genus: *Acetes*

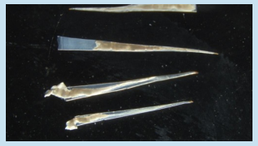
Adult fairy shrimp typically measure 3-5 cm in length and are relatively weak swimmers. They are nocturnal animals that avoid strong light and are attracted to weak light, usually living in large quantities in nearshore and coastal waters with sandy-muddy bottoms.

Acetes sp.

Sharp sea butterfly

Phylum: Mollusca
Order: Pteropoda
Family: Cavoliniidae
Genus: *Creseis*
Species: *Creseis acicula*

This is a colorless, somewhat needle-shaped plankton with slender shell. Adult sharp sea butterfly typically measures 3 cm in shell length.

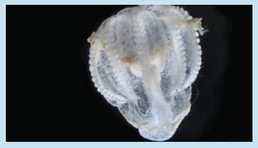


Creseis acicula

Ctenophores

Phylum: Ctenophora

Adult Ctenophores typically measures 1-10cm in length. Species with the risk of outbreak include *Pleurobrachia globosa*, *Beroe cucumis*, and *Bolinopsis vitrea*.

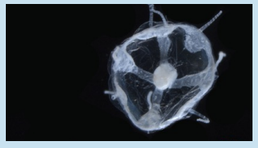


Pleurobrachia globosa

Hydromedusa

Phylum: Cnidaria
Class: Hydrozoa

Hydromedusa is relatively small, ranging from a few millimeters to over ten centimeters. Species with the risk of outbreak include *Aequorea*, *Liriope tetraphylla*, and *Blackfordia manhattensis*.



Liriope tetraphyla

(II) Coastline erosion

In 2024, the Guangdong Provincial Department of Natural Resources monitored key erosion-prone coastal sections in three cities within the GBA-Shenzhen, Huizhou, and Jiangmen, and coastal erosion was observed in all monitored areas, with Huizhou's Haigui Bay section the most severe case.

At the Dameisha beach in eastern Shenzhen and the Wangtou Bay beach in Jiangmen's Haiyan, the average erosion depth increased compared with 2023. In contrast, at the Haigui Bay, Honghai Bay, and Golden Coast in Huizhou as well as the Langqin Bay beach in Jiangmen's Beidou, the average erosion depth decreased compared with 2023.

Monitoring data of key erosion-prone coastal sections in GBA, 2024

City	Section	Coastal type	Degree of erosion	Max. erosion distance (m)	Average erosion distance (m)	Average depth of beach degradation (cm)
Shenzhen	Dameisha	Sandy	Slight erosion	—	—	+3.8 ⇑
Huizhou	Haigui Bay, Huidong	Sandy	Serious erosion	—	—	+19.5 ⇓
	Golden Coast, Daya Bay	Sandy	Strong erosion	—	—	+12.2 ⇓
	Honghai Bay, Huidong	Sandy	Slight erosion	—	—	+2.7 ⇓
Jiangmen	Langqin Bay, Beidou	Sandy	Erosion	+12.6 ⇑	+1.2 ⇑	-0.2 ⇓
	Wangtou Bay, Haiyan	Sandy	Slight erosion	+11.7 ⇓	-0.2 ⇓	+2.0 ⇑

Note: The maximum erosion distance refers to the greatest coastline retreat recorded during the monitoring period; the average erosion distance is the ratio of the coastline retreat area to the length of the eroded coastline during the monitoring period; the average beach erosion depth refers to the average decrease in beach surface elevation during the monitoring period. In the table, "-" indicates siltation and "+" indicates erosion. Arrows represent changes compared with 2023, "⇑" indicating an increase and "⇓" decrease. "—" means no data is available.

Marine Ecological Conservation and Restoration Initiatives 04

Since the 18th CPC National Congress, under the guidance of the Xi Jinping Thought on Ecological Civilization, China has comprehensively advanced marine ecological conservation and restoration work. Policy support, guiding plans, and technological progress have been continuously strengthened, and the *Law on Wetlands Protection* has been enacted and the *Marine Environment Protection Law* revised. China has also issued the *Master Plan on Major Projects for the Conservation and Restoration of National Key Ecosystems* (2021-2035), along with technical standards such as the *Technical Guidelines for Marine Ecological Restoration* (Trial). To build a "Beautiful Bay Area," Guangdong, Hong Kong, and Macao have enhanced institutional design and regional coordination, steadily optimized the system of protected areas, and carried out ecological restoration in a scientific manner, jointly establishing a robust ecological security barrier for the GBA.

(I) Improving the regulatory system

In face of new circumstances, new tasks, and new requirements, all regions in GBA have actively responded to the nation's strategic arrangements, and consistently improved the institutional system for marine ecological conservation and restoration, striving to effectively implement the new tasks and requirements for conservation and restoration for tangible results.

Guangdong Guangdong has delineated approximately 6,233.2 square kilometers of marine ecological conservation red line (ECRL) areas, and worked out relevant management methods and established a regulatory mechanism to strengthen ECRL oversight, rigorously safeguarding the ecological security boundary. A slew of plans have been issued, including the *Guangdong Provincial Territorial Spatial Ecological Restoration Plan (2021-2035)*, *Guangdong Provincial Special Plan for Mangrove Protection and Restoration*, and *Guangdong Provincial Three-Year Action Plan for Coastal Ecological Conservation, Restoration*, and *Disaster Reduction in the Guangdong-Hong Kong-Macao Greater Bay Area (2020-2022)*. Great efforts are made to guide the nurturing and restoration of mangroves and the clearing of Spartina alterniflora, gradually improving the quality and stability of marine ecosystems in GBA.

Hong Kong Hong Kong has enacted a number of regulations, such as the *Marine Parks and Marine Reserves Regulation, Wild Animals Protection Ordinance*, and *Fisheries Protection Ordinance*, to systematically promote ecological restoration work. Greater efforts have been made to restore and reconstruct coral reef habitats, protect the breeding, nursing and living places of Chinese white dolphins, protect and enhance fisheries resources, and protect and restore coastal wetland systems. These efforts have effectively protected the marine ecological environment and fisheries resources.

Macao In December 2015, the Chinese government confirmed the sea areas of Macao SAR as 85 square kilometers. Following this, Macao has successively issued the *Maritime Areas Management Framework Law, Marine Functional Zoning of Macao SAR*, and *Marine Area Plan of Macao SAR*. These documents are designed to intensify the protection and restoration of natural coastline and coastal wetlands, and to consistently nurture and restore mangroves, with a view to improving the wetland habitats and functions.

(II) Promoting regional collaboration

In recent years, Guangdong, Hong Kong and Macao have made greater efforts to coordinate their work in marine ecological conservation and restoration within the framework of "One Country, Two Systems," aiming to promote high-quality development through high-standard protection.

In 1995, relevant authorities of the three regions forged a primary partnership, listing the protection of Chinese white dolphins as a long-term cooperation. When the Hong Kong-Zhuhai-Macao Bridge was being built between 2009 and 2018, the three regions, by formulating protection and management methods as well as countermeasures, and strengthening in-process and ex-post regulation, worked side by side to make sure the Chinese white dolphins did not have to relocate.

In 2016, the State Oceanic Administration and the Macao SAR government signed the *Cooperation Agreement on Maritime Development within Waters Administered by the Macao SAR*, highlighting their cooperation in areas such as enhanced maritime functional zoning, management of the use of sea areas, and coordination mechanisms.

In 2023, relevant authorities of Shenzhen and Hong Kong signed the *Framework Arrangement for the Collaborative Conservation of Shenzhen Bay (Deep Bay) Wetlands*. Synchronisedwaterfowl monitoring andother conservation work arenow underway, turning a new page in Shenzhen-Hong Kong cooperation in the conservation of important wetlands. In the same year, the *Mangroves Protection and Restoration Plan for Guangdong-Macao In-Depth Cooperation Zone in Hengqin (2023-2030)* was released. It is intended to guide the collective efforts between Macao and Zhuhai to nurture, restore and monitor mangroves, helping foster stable, healthy, and sustainable mangrove ecosystems.

Panel 7 Shenzhen, Hong Kong protecting mangrove wetlands together

The Shenzhen Bay (also known as Deep Bay), located in the heart of GBA, serves as a crucial stopover point along the East Asian-Australasian Flyway. Each year, some 46,000 to 66,000 migratory birds fly a long distance to either winter at or pass through the wetland. The Shenzhen Futian Mangrove National Nature Reserve and Hong Kong's Mai Po Inner Deep Bay Ramsar Site in Hong Kong areecologically linked, safeguarding the ecological security of Shenzhen Bay (Deep Bay)

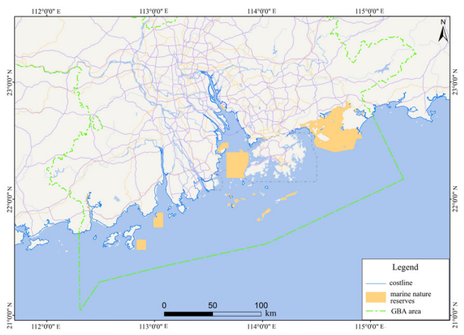
In 2023, Shenzhen and Hong Kong signed the *Framework Arrangement for the Conservation of Shenzhen Bay (Deep Bay) Wetlands*. Leveraging their respective strengths and integrating resources, they have adopted a cross-border cooperation model for coastal wetland protection and development, turning a new page in the joint conservation of important wetlands. The two sides have worked together and exchanged experience in a wide range of areas: ecological baseline surveys, surveys and monitoring of waterfowls like Black-faced Spoonbill, preservation of key habitats and foraging sites, protection of mangroves and tidal flats, and nature-themed education activities. They are making collective efforts to protect and develop the Shenzhen Bay (Deep Bay) wetlands, striving to maintain the integrity of the East Asian-Australasian Flyway and creating a comfortable stopover for migratory birds.

Shenzhen Bay mangrove wetland

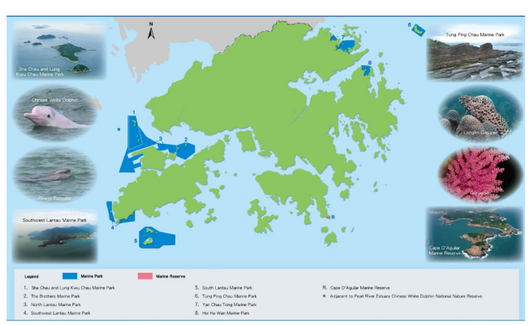
(III) Improving the protection system

The GBA firmly upholds the ecological principle of respecting, adapting to, and protecting nature. It has continuously improved the marine ecological protection system through measures such as establishing nature reserves and marine parks, laying a solid foundation for the ecological security in GBA.

Guangdong Fourteen marine nature reserves have been established within the GBA, totaling an area of approximately 1,942.5 square kilometers. These reserves protect a diverse range of subjects, including biological resources of marine economy, rare and endangered marine species like Chinese white dolphins, sea turtles, and Bahaba croakers, as well as typical ecosystems such as coral reefs, mangroves, bays, and islands. They have effectively preserved marine resources and biodiversity.



Main marine nature reserves in Guangdong



Marine parks and marine reserve in Hong Kong

Hong Kong Hong Kong has established eight marine parks and one marine reserve, totaling a protected area of approximately 85.2 square kilometers. In accordance with the *Wild Animals Protection Ordinance* (Cap. 170), two restricted areas have been established at the Mai Po Inner Deep Bay and the Sham Wan of Lamma Island, totaling around 9.0 square kilometers. They are intended to protect coral communities, Chinese white dolphins, fishes, sea turtles, mangroves, and other important marine lives and their habitats, effectively reinforcing the natural preservation of coastal wetlands and wild animals.

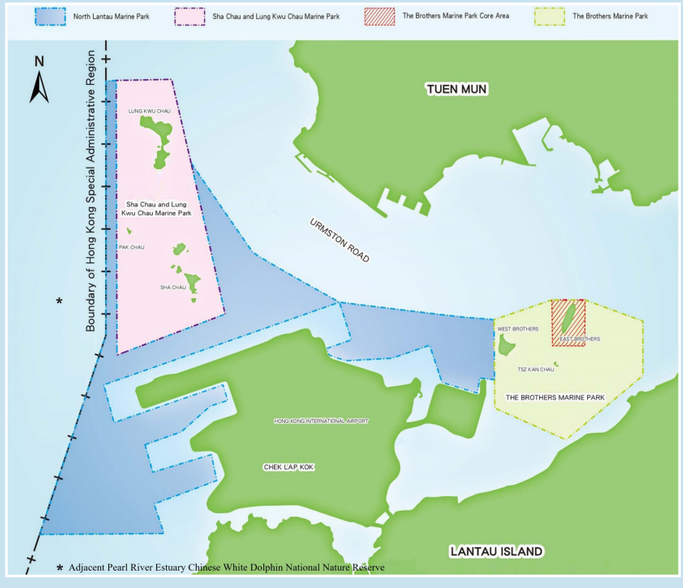
Macao Macao has designated the Cotai Marine Nature Reserve and the Coloane Special Protection Zone, totaling a protected area of approximately 2.5 square kilometers. The Cotai Marine Nature Reserve primarily protects rare and endangered marine species, economic biological species, and their habitats, while the Coloane Special Protection Zone focuses on preserving unique geographical locations and landscape resources.

Panel 8 Hong Kong's largest marine park further protects Chinese white dolphins

Hong Kong has implemented numerous measures to conserve Chinese white dolphins. These include establishing marine parks to protect critical habitats, monitoring their population distribution and numbers, strengthening environmental impact assessments on projects near their habitats, and organizing educational and public awareness activities. In November 2024, the AFCD announced the establishment of the North Lantau Marine Park.

Covering approximately 24 square kilometers in the northern waters of Lantau Island, the North Lantau Marine Park is the 8th - also the largest - marine park in Hong Kong. This new park, along with the nearby Sha Chau and Lung Kwu Chau Marine Parks and The Brothers Marine Park, creates an interconnected network of marine reserves totaling about 45.7 square kilometers. Particularly, the North Lantau Marine Park is adjacent to the Pearl River Estuary Chinese White Dolphin National Nature Reserve in Guangdong, further protecting the key habitats for this rare animal.

The AFCD is currently seeking to work with the Guangdong Pearl River Estuary Chinese White Dolphin National Nature Reserve Administration and other relevant agencies to establish a platform for the joint protection of Chinese white dolphins. This initiative aims to enhance Guangdong-Hong Kong collaboration in areas such as protected area management and monitoring, public education, ecological surveys, and scientific research. Additionally, AFCD and the Marine Development Bureau of Shenzhen signed the Working Memorandum on the Joint Protection Mechanism for Large Marine Wild Animals in August 2025, further coordinating their efforts in this field.

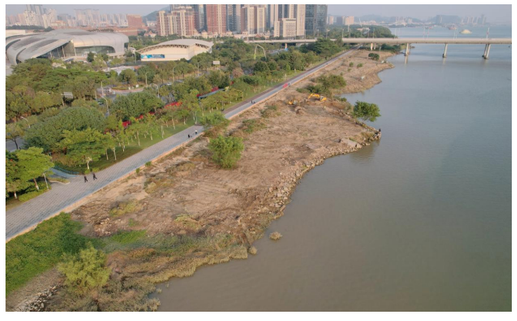


North Lantau Marine Park

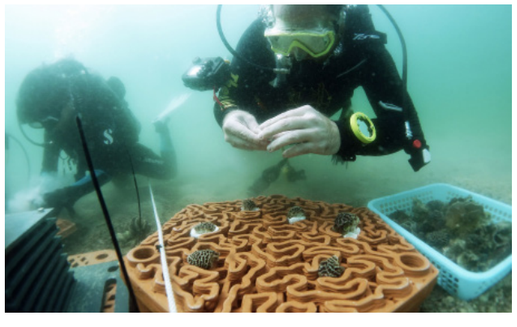
(IV) Implementing ecological restoration

In response to habitat degradation and the loss of ecological functions in local sea areas, Guangdong, Hong Kong and Macao have actively mobilized funds to carry out a range of marine ecological conservation and restoration initiatives, focused on mangrove planting, restoring aquaculture ponds to wetlands and tidal flats, coral reef restoration, and island and reef restoration. These efforts have steadily improved the marine ecological quality in the GBA.

Guangdong From 2020 to 2024, Guangdong received approximately 2.68 billion yuan in central government funds for five marine ecological conservation and restoration projects, including roughly 1.55 billion yuan of central fiscal funds. Approximately 4.29 billion yuan in local funds were also allocated to support 79 conservation and restoration projects. By the end of 2024, about 83.0 kilometers of coastline had been restored, and 12.2 square kilometers of mangroves newly planted with another 9.0 square kilometers restored. In 2023, five islands—the Dong'ao Island, Shangchuan Island, Wailingding Island, Guishan Island, and Sanjiao Island—were successfully selected by the Ministry of Natural Resources in the first batch of "Harmonious and Beautiful Islands," recognized for their beautiful ecology, good life, and vibrant economy.




Remediation of the northern bank of Jiaomen waterway in Nansha, Guangzhou
(Left: before; Right: after)

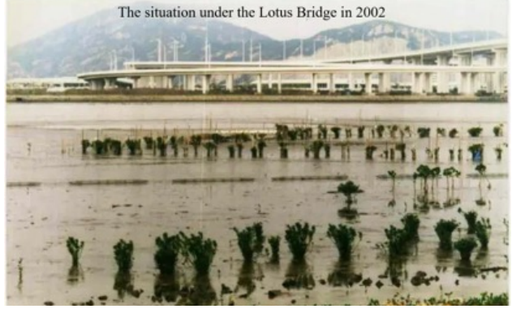



Transplanting coral fragments on 3D-printed reef tiles[①]

[①] Data source: Hong Kong University

Hong Kong Hong Kong is actively carrying out research and pilot trials on coral reefs and mangroves restoration methods, in order to advance restoration technologies. From 2020 to 2024, it invested HK$2.8 million in deploying about 100 3D-printed reef tiles withbiomimetic features andtransplanting around 400coral fragments in Hoi HaWan Marine Park. Around90% of coral fragmentstransplanted onto these tilessurvived and thrived after a4-year monitoring period.Inaddition, 100 artificial reefswere deployed in the waters to the west of the SouthRunway of the Hong kongInternational Airport, and liveoyster spats were seeded toachieve positive ecological benefits[①]. Additionally, more than 50,000 exotic mangrove plants, spanning over 1.8 square kilometers, have been cleared in the Mai Po Inner Deep Bay Ramsar Wetland, effectively ensuring its ecological functions and value.

Macao Macao has achieved great success in mangrove conservation and restoration[②]. Ever since 2000, mangrove restoration has been conducted continuously in the Cotai Ecological Reserve to enhance biodiversity in the reserve and its surrounding tidal flats. From 2011 to 2013, approximately 0.02 square kilometers of mangroves were transplanted. Concurrently, waterways were dredged and weeds cleared to expand the shoal area and improve habitats. The Environmental Protection Bureau and Municipal Affairs Bureau of Macao are responsible for the daily care and management of the restored mangroves. From 2021 to 2024, about 17,000 mangroves were planted along the Taipa coastline. The number of migratory birds returning to Macao is largely stable in recent years.



Mangrove conservation in Macao

[①] Data source: official website of Hong Kong International Airport
[②] Data source: official website of Fairy Lake Botanical Garden, Shenzhen

Panel 9 Mangroves turn valuable assets in a decade
—Mangroves in Kaozhouyang today

Located in the south of the Renping Peninsula in Huidong County, Guangdong Province, Kaozhouyang used to be a main distribution area for mangroves in eastern Guangdong. Over the past century, land reclamation, pond aquaculture, and urban development have encroached upon the native mangrove habitats in Kaozhouyang, leading to a significant reduction in their area. In 2013, it was home to about 1,200 *mu* (one *mu* equals roughly 666.67 m^2) of native mangroves but up to 29,000 *mu* of aquaculture areas (around 67.5% of the total area of Kaozhouyang). Waste from aquaculture and garbage and sewage from urban living seriously polluted Kaozhouyang, damaging habitats, severely undermining the regional ecosystems, and degrading ecosystem services.

Since 2013, Huizhou has scientifically planned and implemented ecological conservation and restoration. By restoring aquaculture ponds to the sea, rehabilitating tidal flats, and planting mangroves, the city has nurtured about 8,857 *mu* and restored 1,965 *mu* of mangroves. Through over a decade of unremitting efforts, Kaozhouyang now boasts lush restored mangroves expanding tens of thousands of *mu*, steadily improving water quality and recovering biodiversity, with continuously enhanced mangrove ecosystem quality and stability. The area has successfully created a “Beautiful Countryside elite tourist route,” and primarily developed an ecological industry chain, blazing a path of transforming natural resources into valuable assets that involves and benefits all. A sound environment has truly become a new engine for economic development.


Mangrove wetland restoration at Kaozhouyang, Huizhou, Guangdong (Left: before; Right:after)


Mangroves in Kaozhouyang today

Panel 10 A harmonious and beautiful island
—Sanjiao Island in Zhuhai, Guangdong

The Sanjiao Island is located in the northwest of the Wanshan Archipelago in Zhuhai, Guangdong, with a coastline stretching 4.9 kilometers and a total area of 87.3 hectares. From the 1980s to the early 2000s, quarrying and base station construction seriously damaged the island’s mountains and vegetation, leaving about two-thirds of the island exposed, which worsened soil erosion and coastline degradation. In 2017, the Sanjiao Island was publicly put up for tourism development, attracting private investment. Funds from numerous channels were utilized for ecological restoration, including soil improvement, revegetation, water purification, coastline stabilization, and landscaping. This comprehensive approach aimed to rebuild the island’s “mountain, forest, lake, and sea” ecosystems. As a result, 3.9 kilometers of damaged coastline was restored, 5 hectares of slopes and 24 hectares of bare ground were revegetated, and overall vegetation coverage across the island was increased by over 35%.

Through years of unremitting efforts, biodiversity on Sanjiao Island has significantly increased, its ecological protection functions considerably improved, and the environmental quality of surrounding waters greatly enhanced. The barren island is transformed into an oasis, driving the development of eco-tourism. From 2017 to 2023, the total value of the terrestrial ecological products on Sanjiao Island increased by about 76%. The island has explored a new path for the protection and utilization of uninhabited islands, injecting new momentum into the marine economy.


Restoration of Sanjiao Island
(Left: before; Right: after)

Explanations for the Development of the Report

The *2024 Marine Ecological Status Report of Guangdong-Hong Kong-Macao Greater Bay Area* is developed by the South China Sea Bureau of the Ministry of Natural Resources in collaboration with the Department of Natural Resources of Guangdong Province, the Agriculture, Fisheries and Conservation Department and the Environmental Protection Department of Hong Kong SAR, the Environmental Protection Bureau and the Marine and Water Bureau of Macao SAR, and the Marine Development Bureau of Shenzhen. Guangdong, Hong Kong, and Macao adopt different technical standards for their respective sample collection, testing and analysis, data processing, and assessment.

For the chapter on basic marine ecological status, the South China Sea Bureau's marine ecology early warning and monitoring data (2020-2024), Hong Kong's monitoring data of phytoplankton (2020-2024), macrobenthos (2021), seawater environment (2020-2024), and sedimentary environment (2020-2023), and Macao's monitoring data of phytoplankton (2020-2024), zooplankton and macrobenthos (2021), seawater environment (2020-2024), and sedimentary environment (2020-2024) are used. For species diversity, the Shannon-Wiener diversity index is adopted. The South China Sea Bureau and Macao adopt the following standards in their surveys and monitoring: *Seawater Quality Standard* (GB 3097-1997), *Marine Sediment Quality* (GB 18668-2002), *Technical Specification for Offshore Environmental Monitoring: Part 10 Evaluation and Report* (HJ 442.10-2020), *Technical Specification for Assessment of Seawater, Marine Sediment and Marine Biological Quality* (HJ 1300-2023), *The Specification for Marine Monitoring (GB 17378-2007), and Specifications for Oceanographic Survey* (GB/T 12763-2007). Hong Kong in its surveys and monitoring follows the *Standard Methods for the Examination of Water and Wastewater* (APHA 20ed, APHA 22ed) of American Public Health Association, the *Standard Test Methods for Total Kjeldahl Nitrogen in Water* (ASTM D3590-11) of American Society for Testing and Materials, among others.

For the chapter on typical marine ecosystems, the latest survey and monitoring data (2020-2024) of the South China Sea Bureau, Guangdong, Hong Kong, Macao, and Shenzhen are used. For coral reefs in Guangdong's Zhuhai and Daya Bay, mangroves on Zhuhai's Qi'ao Island and in Jiangmen's Zhenhai Bay, seagrass beds in Zhuhai's Tangjia Bay, and salt marshes in Zhuhai's Jitimen waterway, data are collected in 2020 (the mangrove area on Zhuhai's Qi'ao Island and the salt marsh area in Zhuhai's Jitimen waterway are remote sensing data collected in 2024). For mangroves in Shenzhen's Futian, salt marshes in Guangzhou's Jiaomen waterway, seaweed beds in Shenzhen, and oyster reefs in Zhuhai, data are collected in 2023. The remaining data are all collected in 2024. For bay area, coastline length, and average tidal prism, data are quoted from *China Bay Chronicle* and other publicly available materials. For the assessment on coral reef and mangrove ecosystems, the *Technical Specification for the Monitoring, Assessment and Early Warning of Coral Reef Ecosystem (Trial) and the Technical Specification for the Monitoring, Assessment and Early Warning of Mangrove Ecosystem (Trial)* are adopted.

For the chapter on marine ecological disasters and issues, monitoring data (2015-2024) of the South China Sea Bureau, Guangdong, Hong Kong, Macao and Shenzhen are used for red tide and data (2023-2024) of Guangdong and Shenzhen are used for coastline erosion.

For the chapter on marine ecological conservation and restoration initiatives, data and pictures are from the national marine ecological restoration management and service platform, the *2024 Typical Cases of Marine Ecological Conservation and Restoration* and *2025 Typical Cases of Marine Ecological Conservation and Restoration* developed by the Ministry of Natural Resources, and relevant departments of Guangdong, Hong Kong, Macao, and Shenzhen.

Censor code: GS Guangdong (2025) No.1439.