# Science-Based Biodiversity Mapping and Governance[1]

## A Multidimensional Approach to Island Biodiversity Conservation in Nan'ao County, Guangdong Province, China

**Abstract:** Islands and their surrounding waters are centers of marine biodiversity, but they often face geographic isolation, ecological fragility, conflicts between human use and conservation, and limited conservation resources. To address these challenges, Nan'ao County, Guangdong Province, China, brought research and management institutions together to establish a biodiversity baseline using eDNA, real-time underwater video, and AI-assisted species identification. In addition, they built an intelligent marine biodiversity monitoring system—combining aerial, satellite, terrestrial, marine, and on-site surveillance—launched ecological restoration efforts, and delivered a public outreach campaign. Together, these efforts form a coordinated model for island biodiversity conservation that can inform similar work on other islands.

**Keywords:** Islands; intelligent monitoring; marine biodiversity; multidimensional conservation

## I. Background

Although islands are geographically small and separated from the mainland, they provide breeding grounds for birds, spawning areas for migratory fishes, habitats for corals, and refuges for threatened marine animals such as Chinese white dolphins and sea turtles. They are major reservoirs of global biodiversity and genetic diversity. China has more than 11,000 islands, one of the largest national totals worldwide, although islands account for only about 0.8% of the country's land area. Island ecosystems are fragile. Climate change, overfishing, land-based pollution, and other human pressures make biodiversity conservation in these systems especially urgent and complex.

Nan'ao County is the only island county in Guangdong Province. Located near the Tropic of Cancer, at the transition between tropical and subtropical climate zones, Nan'ao lies along a major route for marine species moving among the South China Sea, East China Sea, and western Pacific. As ocean temperatures rise, the island has also become an important refuge for warm-water tropical species shifting northward. In the past, overfishing, unmanaged island tourism, and coastal development reduced habitat availability for threatened nearshore marine mammals and degraded marine ecosystems. Nan'ao therefore faced a common problem for space-constrained island systems: how to improve biodiversity conservation with limited resources. The county responded by combining management reform, new monitoring technologies, and collaboration among multiple institutions.

[1] Case provided by CCICED Special Policy Study on *Promoting Nature-positive Policies and Practice Innovation*



**Figure 1. Aerial view of Nan'ao County**
(Credit: Guangdong Nanpeng Islands National Marine Nature Reserve Administration)

## II. Key Measures

### (1) Using Science and Technology to Establish the Biodiversity Baseline

To address gaps in baseline knowledge, Nan'ao brought together the Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou), the Guangdong Nanpeng Islands National Marine Nature Reserve Administration, Guangdong University of Technology, Shantou University, and other research and management partners. The teams surveyed rocky reefs, seagrass beds, seaweed beds, offshore islets and reefs, and priority groups, including cetaceans, birds, sea turtles, corals, and fishes. They combined real-time underwater video, eDNA, AI-assisted species identification, and other monitoring methods to build a multidimensional intelligent monitoring system. The partners also established the Guangdong Nanpeng Islands Marine Biodiversity Field Observation and Research Station.

Comprehensive surveys recorded the Critically Endangered Chinese crested tern, a national Class I protected species, in the area for the first time. Researchers added 22 scleractinian coral species, 96 fish species, and 28 invertebrate species to local records, increasing the documented number of marine species in Nan'ao County and adjacent waters from 1,341 to 1,487. Long-term monitoring has documented regular use of these waters by 12 Chinese white dolphins and more than 100 bottlenose dolphins. The greater crested tern population has also increased from more than 4,000 individuals in 2018 to over 10,000 today. The surveys further confirmed that Nan'ao and its surrounding waters constitute an important migration corridor connecting the South China Sea, East China Sea, and western Pacific, and serve as a refuge for tropical marine species shifting northward as the climate warms.

Based on this evidence, managers identified key disturbances such as egg collection at seabird colonies, vessel traffic in core cetacean breeding areas, and shellfish collection on rocky reefs, and strengthened regulation and enforcement accordingly. The county also carried out near-natural restoration of rocky reefs, seaweed beds, and seagrass beds. In core waters around Dingpeng and Zhongpeng islands, teams installed 60 coral nursery frames, transplanted more than 1,000 coral colonies, and restored more than 200 $m^2$ of degraded coral reef.

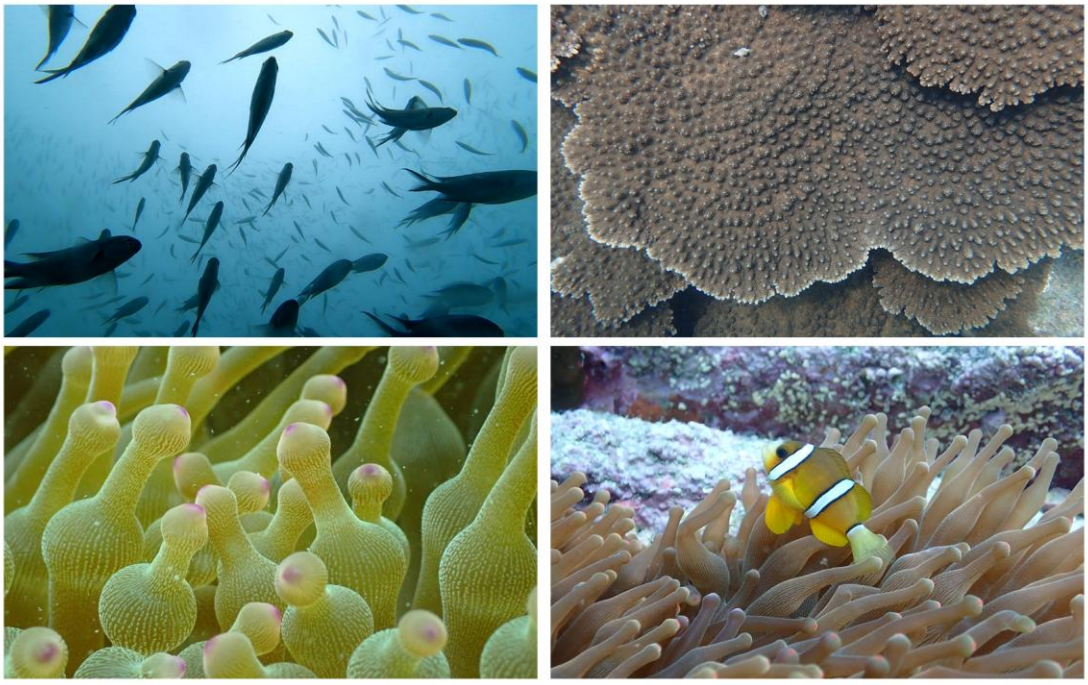


**Figure 2. Marine biodiversity of Nan'ao Island**
(Credit: Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou))

### (2) Coordinating Agencies to Build an Integrated Patrol Network

Nan'ao used electronic geofencing, the Automatic Identification System (AIS), electro-optical radar, and other tools to build an integrated smart patrol system combining aerial, satellite, terrestrial, marine, and on-site surveillance. The coast guard, maritime authorities, and marine law enforcement agencies share information and coordinate operations through this system, creating a regular, multi-layered patrol mechanism. Over the past five years, the agencies have conducted more than 460 patrols targeting illegal fishing, unauthorized island landings, shoreline damage, and other human disturbances. These joint actions have strengthened protection for cetaceans, birds, corals, fishes, and other marine life.



**Figure 3. Joint multi-agency enforcement patrol**
(Credit: Guangdong Nanpeng Islands National Marine Nature Reserve Administration)

### (3) Expanding Public Outreach and Community Participation

Nan'ao translates conservation research into accessible public education for residents and visitors. The county has developed science outreach corridors, exhibition halls, nature classrooms, and live coral reef video displays, making research data more accessible. It also organizes regular activities for Bird-Loving Week, World Wetlands Day, World Migratory Bird Day, Wildlife Conservation Awareness Day, beach cleanups, and related events. Nan'ao conducts an average of 13 public outreach activities each year, attracting more than 3,000 participants.

The county also shares findings from wildlife conservation research and trains local volunteers to help monitor threatened marine mammals such as Chinese white dolphins and collect field data. Residents who once simply watched dolphins now take part in protecting them. An island-wide rescue network for cetaceans and sea turtles further links professional teams with local responders and supports a community-based conservation system.




**Figure 4. Marine conservation outreach activity**
(Credit: Guangdong Nanpeng Islands National Marine Nature Reserve Administration)

## III. Lessons Learned

### (1) Start with Scientific Surveys to Support Targeted Conservation

Many islands and coastal ecosystems still lack reliable biodiversity baselines. When conservation budgets are limited, managers need evidence to decide where to act. Nan'ao partnered with research institutions and used eDNA, AI-assisted identification, and underwater monitoring to establish baseline data and identify priority species, major pressures, and restoration sites. The approach follows a straightforward sequence: establish the evidence base first, then direct management and restoration where they are most needed. This approach is applicable to other island and coastal areas with limited conservation resources.

### (2) Connect Agencies through Shared Information and Joint Enforcement

Marine governance involves multiple enforcement bodies and large areas that are difficult to monitor. No single agency can monitor these areas effectively. Nan'ao linked the coast guard, maritime authorities, and marine law enforcement agencies through electronic geofencing, AIS, electro-optical radar, and an integrated patrol system. Shared information and joint operations reduced

fragmentation across agencies. Nan'ao's experience shows that monitoring technology works best when agencies also establish clear mechanisms for coordination, a lesson relevant to other protected areas with divided management responsibilities.

**(3) Use Public Education to Build Long-Term Community Stewardship**

Top-down enforcement alone cannot sustain conservation over the long term. Nan'ao turns research results into accessible public programs and trains local residents to participate in monitoring and rescuing threatened species. Together, professional support and community participation have strengthened local capacity for routine monitoring and rescue. This arrangement offers a practical model for widening public participation in ecological governance.