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T/CAOE 20.5-2020

Technical guideline for investigation and assessment of coastal ecosystem —

Part 5:

Coral reefs

海岸带生态系统现状调查与评估技术导则 第5部分：珊瑚礁

(English Translation)

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Foreword

The T/CAOE 20 *Technical Guideline for Investigation and Assessment of Coastal Ecosystem* consists of the following ten parts:

- Part 1: *General*;
- Part 2: *Remote sensing identification and results verification of the coastal ecosystem*;
- Part 3: *Mangroves*;
- Part 4: *Salt marshes*;
- Part 5: *Coral Reefs*;
- Part 6: *Seagrass bed*;
- Part 7: *Oyster Reef*;
- Part 8: *Sandy Coast*;
- Part 9: *Estuary*;
- Part 10: *Bay*.

This is part 5 of the T/CAOE 20.

This part is drafted in accordance with the rules given in the GB/T 1.1-2009.

This part was proposed by the *Marine Early Warning and Monitoring Division, Ministry of Natural Resources*.

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Technical guideline for investigation and assessment of coastal ecosystem —

Part 5: Coral reefs

1 Scope

This section of T/CAOE 20 specifies the general specifications for working procedures, work content, quality control and results archive in the investigation and assessment of the coral reef ecosystems.

This section is applicable to the investigation and assessment of coral reef ecosystems, and other related work can be used for reference.

2 Normative references

The following documents are essential to the application of this document. For dated reference documents, only the dated version applies to this document. For undated reference documents, the latest version (including all amendments) applies to this document.

GB/T 12763.2 Specification for marine investigations — Part 2: marine hydrologic observations

GB/T 12763.3 Specification for marine investigations — Part 3: marine meteorological observations

Specification for marine investigations — Part 8: marine geological and geophysical investigations

GB 17378.3-2007 Specification for marine monitoring — Part 3: Sample collection, storage and transport

GB 17378.4-2007 Specification for marine monitoring — Part 4: Analysis of sea water

GB 17378.7-2007 Specification for marine monitoring — Part 7: Ecological investigation of offshore pollution and biological monitoring

Technical guidelines for the investigation and assessment of the status of ecosystems in coastal zones — Part 1: General principles

3 Terminology and definition

The following terms and definitions apply to this document.

3.1

coral reefs

a special submarine habitat is consisted of living and dead coral skeletons.

3.2

scleractinian coral

any of these various coral species with *Symbiotic Zooxanthellae*, calcium carbonate skeletons, and reef-building abilities under *Scleractinia* under *Hexacorallia*.

3.3

coral reef ecosystem

coral reef habitats and biological communities formed by scleractinian corals, coral algae, etc., which constitutes a unified natural whole.

3.4

coverage

the proportion of the length or area of a vertical projection of any organism or substrate to the length of a transect or area of a quadrat.

3.5

hard coral recruitment

the number of coral larvae per unit area.

4 General rules

4.1 Working Procedure

The working procedure should be carried out in accordance with specifications in Clause 5 of T/CAOE 20.1-2020.

4.2 Quality Control

4.2.1 General rules

Quality control should be carried out in accordance with requirement 4.3 in T/CAOE 20.1-2020.

4.2.2 Special rules

4.2.2.1 Quality inspection of on-site image data

After the completion of the investigation work, the image data should be checked immediately to ensure that the data are complete and clear, and meet the specifications of the later indoor analysis. The field survey record form should be filled in according to the specifications of Annexes A to E. Specific specifications for image quality are as follows:

—The image data is complete and the quantity meets the technical requirement;

—The angle, height and duration of the video meet the technical specifications, and the whole transect is completely photographed. The picture is bright and clear, the playback is uniform and smooth without obvious shaking;

—The angle and height of the photos of the quadrat meet the technical specifications, including the whole quadrat, and the picture is bright and clear.

If the image data is found incomplete, or the pictures are not clear, or the photograph is blurred, the investigation of the station should be restarted.

4.2.2.2 Quality supervision and control of image interpretation analysis

Attention should be paid to the quality supervision and control of image interpretation analysis:

—Carry out image interpretation and analysis in strict accordance with the specifications of this part;

—5% of the stations should be selected for mutual proofreading when multiple persons or units jointly carry out interpretation and analysis;

—The laboratory analysis record forms should be filled in strictly according to the specifications in Annexes F to P. And the forms should be signed by the recorder (also as interpreter and analyst) and checked by verifier (specially-assigned).

4.3 Preparation of investigation and assessment report

The investigation and assessment report should be prepared in accordance with T/CAOE 20.1-2020, 9.1. The specific contents of this section should be included at least:

- Background information of investigation region;
- Introduction to the progress of the investigation on the distribution and status of coral reefs;
- Description of the distribution of coral reefs in the investigation area;
- Status of coral communities, reef-dwelling organisms, and coral reef habitats in the region;
- Reviewing historical data and analyzing the variation trends;
- Assessment on the status of coral reef ecosystems;
- Analysis the causes of ecosystem changes based on the investigation of human activities;
- Conclusions of the report and protection and management measures.

4.4 Archiving of data and results

The archiving of data and results should be carried out in accordance with the specifications in Clause 10 of T/CAOE 20.1-2020.

5. Content of status investigation

The investigation contents should include corals, environmental factors, biotic communities and threat factors. See Table 1 for the specific investigation items, elements, means and methods. Different investigation elements can be selected according to the investigation purpose and assessment needs.

Table 1 Contents of the investigation on the ecological status of coral reefs

Contents	Investigation factors	The way of investigation	Methods
Corals	Scleractinian corals: species, live coral coverage coral mortality, hard coral recruitment, coral bleaching and disease	Field survey	See 7.3
Biological communities	Coral reef fish: species, abundance, and body length range	Field survey	See 7.2
	Benthic macroinvertebrate: Species and density of benthic macroinvertebrate commonly found in coral reefs	Field survey	See 7.5
	Benthic macroalgae: species, coverage, height	Field survey	See 7.6
Environmental elements	Seawater: Salinity, pH, dissolved oxygen, nitrate, nitrite, ammonia nitrogen, active phosphate, total nitrogen, total phosphorus, chlorophyll a, suspended solids, oils	Field survey	See 7.8
	Hydrology and meteorology: water temperature, transparency, water depth, sea conditions, simple weather conditions	Field survey	See 7.9
	Sediment: sediment size, sedimentation rate, sediment covering the reef	Field survey	See 7.10 and 7.12
	Substrate: reef-rock, rubble, sand, mud cover	Field survey	See 7.11
Threats	Coastal engineering projects: the status of the completed and ongoing coastal engineering projects in the past five years, including but not	Data gathering, social	See 7.13.1

limited to reclamation, bank dike, wharf, bridge, trestle, etc., and the key investigation project name, proprietor, location, use, environmental protection measures and ecological compensation measures, etc.	investigation & field survey	
Dredging, quarrying and sand mining activities: the activities of seabed dredging, quarrying and sand mining in the investigation area in the past five years, with the focus on the investigation of the construction unit, scope, quantity and use, etc.	Data gathering, social investigation & field survey	See 7.13.2
Tourism development: the tourism development activities related to coral reefs in the region in the past five years, focusing on the investigation into tourism project name, activity scope, number of visitors, etc.	Data gathering, social investigation & field survey	See 7.13.3
Sewage and temperature drainage: the situation of sewage and temperature drainage in the investigation area in the recent five years will be recorded with an emphasis on the location of sewage discharge enterprises, discharge outlet, treatment situation, pollutants exceeding the standards, etc.	Data collection, social investigation & field survey	See 7.13.4
Fishing: the fishing situation of the region in the recent five years, focusing on the number, tonnage, fishing methods, fishing types and fishing quantity	Data gathering, social investigation & field survey	See 7.13.5
Aquaculture: the situation of aquaculture in the region in the recent five years, focusing on the location, area, mariculture mode, mariculture varieties, mariculture quantity and other information of the mariculture region	Data gathering, social investigation & field survey	See 7.13.6
Surface and seabed artificial facilities: the situation of surface and seabed artificial facilities discovered in the recent five years in the investigation area, with an emphasis on the name, location, use and environmental impacts of the facilities	Data gathering, field survey	See 7.13.7
Emergent accidents: the emergent accidents occurred in the investigation area in the past five years, including but not limited to shipwreck,	Data gathering, social	See 7.13.8

	stranding, chemical leakage, oil spill, etc., with an emphasis on the type of accident, occurrence place, emergency treatment, environmental impact, etc.	investigation	
	Marine garbage: types, quantity and distribution of marine garbage on the surface and seabed of the investigation area	Field survey	See 7.13.9
	Typhoons: typhoons affecting the investigation area in the last 5 years	Data gathering	See 7.14
	Extreme high or low temperatures: data on extreme high or low temperatures affecting the investigation area in the past five years	Data gathering	See 7.14

6 Preliminary work

6.1 Data Collection

Data of the ecology, water quality, topography, hydrology, meteorology and human activities of coral reefs in the region should be collected in order to know the information of coral reefs distribution, environmental conditions and human activities in the region.

6.2 Distribution investigation

6.2.1 Purpose and contents

When there is insufficient data in the investigation area or the distribution status is unknown, distribution status investigation should be carried out in advance for preparation, in order to determine the investigation scope and specific area for the follow-up ecological status investigation and assessment. The distribution investigation mainly includes:

- Boundary of coral reef distribution;
- General distribution of corals.

6.2.2 Range of water depth investigation

The water depth range can be limited to shallow waters with a depth less than 15m in most of coasts. In some coastal areas where coral reef distributes over relatively deep water, the range can be appropriately extended to deeper waters according to the actual situation.

6.2.3 Transect layout

The vertical direction of the coastal line is from 1m-2m water depth to 15m water depth, and an investigation transect of coral reef distribution is set up every 500m.

6.2.4 Investigation methods

The investigation transect was taken by the combination of shipborne portable underwater camera equipment, underwater robot and snorkeling/diving investigation. Taking the criteria that no scleractinian corals exist on the 50m range as the assessment standard of coral reef distribution edge points, the longitude and latitude of coral distribution edge points are determined and recorded by floating ball and GPS positioning, and the general distribution of corals in each transect is qualitatively interpreted on-site or in the laboratory.

6.2.5 Interpretation of coral distribution

According to the sparsity of coral distribution, the status of coral distribution is generally divided into the following levels:

- a) Scattered distribution. Coral coverage is estimated to be less than 5%, or less than 10 scleractinian coral colonies within a 10m vision;
- b) General distribution. Coral coverage is estimated to be above 5%, below 10%, or more than 10, less than 20 scleractinian corals colonies within a 10m vision;
- c) Centralized distribution. Coral coverage is estimated to be higher than 10%, or more than 20 scleractinian corals colonies within a 10 m vision.

6.3 Sites layout

According to the historical data or distribution investigation results, the investigation scope can be determined and investigation stations can be set up. The positioning principles are as follows:

- a) Representativeness. According to the size of the investigation area and the number of stations, the distance between stations should be within 500m-1000m. The more stations there are, the stronger the overall representativeness will be, and the results are more likely to

reflect the ecological situation.

b) Continuity. Historical stations should be retained, especially those on which the base value is determined;

c) Uniformity. The distribution of stations should maintain a certain uniformity. Stations should be distributed in all directions and in different depths.

6.4 Investigation plan design

The investigation plan should be designed in accordance with the specifications in Clause 6 of T/CAOE 20.1-2020.

7 Field survey

7.1 Transect and sample belt layout

One to three transects should be arranged along the contour at 2m to 4m, 5m to 7m and 9m to 12m depth. The transects should be parallel to each other and the length of the transects is 50m. If the actual distribution depth of coral is more than 12m, three transects should be arranged. The depth of each transect can be adjusted appropriately. According to the specifications of transect layout, a strip tape with a length of more than 50m can be set as a transect under water. When the strip tape is laid, the tape should be straightened and fixed on the reef every 10m. The starting and ending point of the tape should be fixed. Floating balls should be placed to mark the position and record the starting and ending point of the transect as well as the water depth. Transect position and depth records are shown in Annex A. After the transect tape is laid, reef fish investigation, coral communities investigation, hard coral recruitment investigation, large benthic invertebrates investigation, and large benthic algae investigation should be taken in turn. For the first investigation, the position of the transect should be identified with any possible means using tools such as nails and floats, and longitude and latitude recorded.

7.2 Reef fish investigation

The banded transect video method is used in coral reef fish investigation. During the on-site works, the reef fish investigation should be carried out at each station first. After laying the strip tape, after waiting for 10 min, a technical staff should take a hand-held camera, starting from the starting point along the strip tape, swimming slowly at a constant speed. The lens should be located 0.5m up the bottom with a front vision of about 35m, horizontally stabilized and directed to the front. The video should contain the fish within the scope of 2.5 m on both sides of the tape. Any shaking should be avoided and the stability of the picture should be guaranteed. The recording time is at least 5min until the end of the tape. During the shooting, other personnel should avoid appearing in front of the shooting lens. Another technician should take macro photographs of the cross-transects and flanks of the fish afterwards. These will be the aid to identification and analysis. The field survey is recorded in Table B.1 of Annex B.

7.3 Coral community investigation

An investigation technician holds a hand-held camera with the lens 0.2m-0.3m away from the tape, and swims slowly and uniformly along the tape from the starting point. The camera aims vertically downward at the tape and shoots the tape, to record the organisms and substrate below the tape. The camera shaking should be avoided to ensure clear images. The recording time is at least 10min until the end of the tape. Another technician should take macro photographs of various corals under the tape measure afterwards, and collect a small number of specimens of rare species for species identification and cataloguing illustrations. The field survey data is recorded in Table B.1 of Annex B.

7.4 Hard coral recruitment investigation

10 quadrats with 50cm×50cm or 40 quadrats with 25cm×25cm should be randomly placed on the reef within 2.5m of each side of the strip tape to take quadrats photos. Quadrats should be randomly arranged to avoid areas with sand, coral, algae, or other organisms. The field survey is recorded in Table B.1 of Annex B.

7.5 Benthic macroinvertebrates investigation

The range within 1m on each side of the strip tape and a length of 50m is used to obtain image data. All visible benthic macroinvertebrates, including soft corals, gorgonians, sponges, sea lilies, sea anemones, sea stars, sea cucumbers, bivalves and snails, are recorded. The harmful organisms (*Acanthaster planci* and *Drupa*) should be recorded separately. Filming should be carried out in one of the following ways:

a) Video recording. When shooting the video, the lens should be kept 45 degrees forward and downward, aiming at a range of 1m on one side of the sample strip tape. The benthic macroinvertebrates visible within a range of 1m on both sides of the sample strip tape should be taken in both directions. The recording duration is at least 10min. The on-site investigation is recorded in Table B.1 of Annex B;

b) Photographing. All visible large benthic invertebrates within 1m of each side of the strip tape should be photographed. The field survey is recorded in Table B.1 of Annex B.

7.6 Benthic macroalgae investigation

10 quadrats with 50cm×50cm or 40 quadrats with 25cm×25cm are randomly placed within a range of 2.5m on both sides of the transect to take photos. Photos of various algae are taken at macro distance, and samples of various algae are collected when necessary. The field survey is recorded in Table B.1 of Annex B.

7.7 Station patrol

After the completion of on-site investigation of all projects in each transect of each station, technicians should be sent to the area beyond the transect line respectively to inspect the coral and its biological conditions and shoot a video at the same time. The field survey is recorded in Table B.1 of Annex B.

7.8 Collection of seawater samples

In accordance with the specifications specified in Clause 4 of GB 17378.3-2007.

7.9 Hydrology and meteorological observations

Hydrological observation is conducted in accordance with the specifications specified in GB/T 12763.2. The surface and bottom water temperature and transparency are measured at each station, and the water depth at each transect is measured at each station. Meteorological observations should be made in accordance with the specifications specified in GB/T 12763.3, and the sea conditions and simple weather conditions should be recorded once a day.

7.10 Sediment investigation

7.10.1 Sediment collection

Sediment collection should be conducted in accordance with the specifications in section 6.1 of GB/T 12763.8-2007. Sediment samples within 0cm-5cm thick layer on the surface are collected by diving. Samples at channels, low-lying areas, and other places where sediment is naturally deposited should be collected at each station.

7.10.2 Sediment settling rate

7.10.2.1 Station position

5 to 6 stations are selected to investigate the sediment settling rate, and stations are uniformly arranged. If there are ocean engineering projects nearby, stations are arranged around the locations of ocean engineering, and 1–2 comparison stations are arranged far away from the project site.

7.10.2.2 Equipment

The sediment collector is 69cm high with a sharp lower end and three iron cans fixed on the upper end. The height of the iron cans is 14cm and the inner diameter is 7cm. The lower end is closed and the upper end is open. The schematic diagram of sediment collector is shown in Figure 1. When installed under water, the pipe mouth should be kept 30cm above from the bottom.

7.10.2.3 Sampling frequency and method

Samples should be collected at least once a year, and the PVC pipe should be kept for 1 month each time. The PVC pipe should be retrieved every time when sampling, and a new PVC pipe should be placed. Sediment overflow should be avoided when retrieving the PVC pipe. After taking off PVC pipe, one should seal it with a large sealing bag (labeled in advance) to prevent sediment and water overflow.

7.10.2.4 On-site handling

The seawater and sediment in the sealed bag and PVC pipe will be put into the large beaker, and then rinsed with a small amount of fresh water for three times, to wash away the salt. A suction device will be used to remove most of the washing liquid, and one can transfer all the sediment and a small amount of water into the clean sealing bag. The sediment samples transferred from each PVC pipe are separately bagged, labeled and stored in cold storage. On-site records of sediment collection are shown in Table B.1 of Annex B.

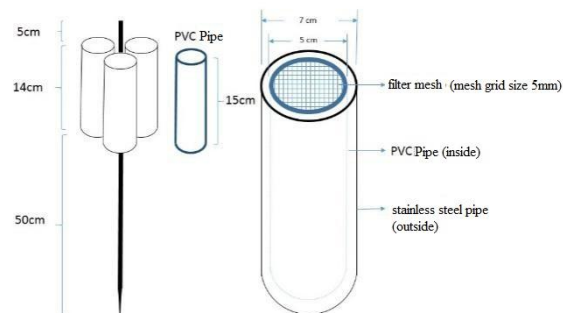


Figure 1. Schematic diagram of sediment collector

7.11 Substrate investigation

The substrate is an area uncovered by large organisms such as living corals, benthic macroalgae, sponges and soft corals, including reefs, rubble, sand, and mud. The field survey method is shown in section 7.3.

7.12 Investigation of sediment cover on reefs

Sediment cover on reefs caused by human activities, accidents, or natural disasters within the investigation area can be investigated with underwater observation. The severity of sediment coverage is classified into four levels according to the thickness of sediment, including small amount, medium amount, large amount, and serious amount. The severity of the

sediment coverage is assessed by the investigators on site and recorded in Table B.1 of Annex B.

7.13 Human activity investigation

7.13.1 Coastal engineering

Coastal engineering projects completed or under construction in the investigation area within the last five years should be investigated, including but not limited to reclamation, bank dike, pier, bridge, trestle, beach restoration, etc., Technicians should verify project status on site, take photos, record positions, and calculate the area of encroachment on coral reefs. They can visit relevant administrative departments, project implementation units or surrounding people when necessary to obtain detailed information. The information is specified in Table C.1 in Annex C.

7.13.2 Dredging, quarrying and sand mining

Dredging, quarrying and sand mining engineering data of the investigation area in recent five years should be investigated, in order to master the dredging scope, amount and use of dredging. Technicians should check the underwater situation on site, take photos, record the location, and calculate the dredging scope and area. They can visit relevant administrative departments, construction units or surrounding people when necessary to obtain detailed information. The information needed is specified in Table C.1 in Annex C.

7.13.3 Tourism development

Information on the development of coral reef related tourism projects in the investigation area in the past five years should be collected, such as diving sightseeing, semi-submersible boat or submarine sightseeing. Investigators should check the actual situation on site and take photos. They can visit relevant administrative departments, tourism companies or surrounding people to obtain detailed information when necessary. The information needed is detailed in Table C.1 in Annex C.

7.13.4 Sewage and warm water drainage

The discharge and warm water drainage data of the investigation area in recent five years should be collected, in order to master the discharge and warm water discharge conditions. Technicians can verify the actual situation on site, taking photos, recording positions, collecting water samples of sewage outlet and warm water outlet, and collecting surface and bottom water samples of 2-3 stations in the mixing area. The content of main pollutants can then be tested. They can visit relevant administrative departments or surrounding people when necessary to obtain detailed information. The information needed is specified in Table C.1 in Annex C.

7.13.5 Fishing

Fishing data in the investigation area within the past five years should be collected. Technicians should verify the actual situation on site, observe and shoot the operation of fishing boats. They can visit relevant administrative departments or surrounding fishermen when necessary to obtain detailed information. The information is specified in Table C.1 in Annex C.

7.13.6 Aquaculture

Information of aquaculture in the investigation area in the recent five years should be collected. Technicians should check the actual situation on site, record information such as location and breed of aquaculture, and take photos. They can visit relevant administrative

departments, farmers or surrounding people when necessary to obtain detailed information. The information is specified in Table C.1 in Annex C.

7.13.7 Surface and seabed man-made facilities

Data of surface and seabed man-made facilities in the investigation area in recent five years should be collected. Technicians should verify the actual situation on site, record information such as location, size, usage and environmental impact, and take photos. The information is specified in Table C.1 in Annex C.

7.13.8 Emergency

Data on shipwrecks, stranding, chemical spills, oil spills and other marine or onshore emergencies occurring in and around the investigation area in the past five years should be collected, in order to grasp the emergent incidents and their impacts. For shipwrecks and stranding accidents within coral reef distribution areas, investigators should go to the accident site for on-site verification. They should record the location, take photos, observe the damage and recovery, etc. They can visit relevant administrative departments or surrounding people when necessary to obtain detailed information. The information is specified in Table C.1 in Annex C.

7.13.9 Marine garbage

At each station, investigators should observe and record the types and quantities of garbage on the sea and seabed, and take photos. marine garbage information is recorded in Table D.1 of Annex D.

7.14 Natural disasters

Data on natural disasters in the investigation area in the recent five years should be collected, and detailed information is recorded in Table E.1 of Annex E. The investigation includes:

—Typhoons passing through and affecting the investigation area and their impacts on coral reefs;

—Extreme high or low temperatures occurring in the investigation area and their impacts on coral reefs.

8 Interior analysis

8.1 Video interpretation of coral transect

The method of point intercept transect (PIT) was used in the interpretation of sample tape video. All scleractinian corals, other sessile organisms (including soft corals, sponges, sea anemones, etc.), dead corals, bleaching corals and substrate (reef-rock, rubble, sand and mud) distribution should be interpreted in the image. Starting from 0 to 10 cm scale, it is the first scale point to be interpreted. Every 10 cm interval is used to interpret a scale point until the "50m" scale point is read. The interpretation analysis results are recorded in Annex F, table F.1. The elements of interpretation include:

a) Species identification. The reef coral species (more than 2 cm) at each 10 cm scale point of the transect belt should be interpreted. If the species should be difficult to be identified in the image, the coral macro photos should be used to assist identification, and clear photos of each coral species should be collected;

b) Live coral coverage. The number of 10 cm scale points of all living reef corals (greater than 2 cm) should be counted. The number divided by 500 was the living coral coverage rate of the sample zone, and the coverage rate was calculated as%;

c) Coral mortality. Determine whether there are scleractinian corals (more than 2cm) with

recent death (within 1 month, 1-6 months, 6-12 months and more than 1 year) at each 10cm scale point of the transect belt, and count the number of 10cm scale points with dead scleractinian corals. The number divided by 500 is the coral mortality rate in each period of time in the sample belt, and the mortality rate is calculated in%. The total mortality rate was the sum of the mortality rates in each period. The time of death of corals was determined according to the following criteria:

- Within 1 month. The skeleton of scleractinian corals are white, complete and clear;
- 1-6 months. The skeletons of scleractinian corals are covered by small algae or thin sediments;
- 6-12 months. The skeleton structure of scleractinian corals are slightly corroded, with more algae attached, but the genus classification units of corals can still be distinguished;
- More than 1 year. The skeleton structure of scleractinian coral has disappeared, or the attached organisms (algae, invertebrates, etc.) on the single body have been difficult to remove.

d) Disease status. It is necessary to determine whether there are any diseases occurring in live coral reef at each 10cm scale of tape. The number of 10cm scale points is counted, which is divided by 500, that is, the incidence rate of corals and the percentage of units per unit area.

e) Coverage rate of other sessile organisms. Determine whether there are soft corals, sponges, sea anemones and other sessile organisms at the 10 cm scale points of the transect tape. The number of 10 cm scale points with other organism distribution is counted according to major categories. The number divided by 500 is the coverage rate of other organisms in each major category in the transect, and the coverage rate is calculated as%;

f) Substrate type and coverage. Determine the matrix type without sessile organisms coverage at each 10 cm scale point of the sample belt, and whether it is reef-rock, rubble, sand, mud. Count the number of 10 cm scale points with each matrix type distribution. Divide the number by 500, the coverage rate of each matrix type is calculated as%.

8.2 Video interpretation of fish samples

Fish identification should be based on fish macro photos or physical samples to species level. In the process of quantity statistics, attention should be paid to the statistical boundary (within 2.5m on both sides of the tape) and repeated counting should be avoided. The interpretation analysis results are recorded in Annex g, table G.1. The following methods should be used for interpretation:

- a) Manual interpretation. The fish species and body length range in the fish transect images should be manually interpreted, and the number of each species was counted;
- b) Software identification. Using the software, the species, quantity and body length of fish in the image data can be automatically interpreted and identified.

8.3 Interpretation of hard corals recruitment

The number of scleractinian coral larvae less than 2 cm in the sample plot was counted. The number divided by the area of the quadrat was the supplement amount of hard coral, and the unit was ind/m². The species should be classified into families or genera, and attention should be paid to distinguish the larvae from the small living bodies left after death. The interpretation analysis results are recorded in Annex h, table h.1.

8.4 Interpretation of benthic macroinvertebrate

The classification and quantity of all benthic macroinvertebrate, including Alcyonacea, Gorgonacea, Actiniaria, Crinoidea, Asteroidea, Echinoidea, Ophiuroidea, Holothuroidea,

Spongia, Ascidiacea, Crustacea, Bivalvia, Gastropoda and so on, should be interpreted. The species and quantity of harmful organisms and indicator organisms, including *Acanthaster planci*, *Drupa*, *Linckia laevigata*, *Charonia tritonis*, Tridacnidae, *Diadema setosum*, *Heterocentrotus mammillatus*, Palinuridae, etc., should be interpreted separately. The interpretation analysis results are recorded in Annex I, table I.1.

8.5 Interpretation of benthic macroalgae

The species, coverage and height of benthic macroalgae in the sample quadrat were interpreted. Species identification should be based on the algal macro photos or collected samples, and clear photos of each species should be collected. The interpretation analysis results are recorded in Annex J, table j.1.

8.6 Sea water element analysis

The content of chlorophyll a was analyzed according to the requirements in Clause 8 of GB 17378.7-2007.

The indoor test and analysis of other sea water elements are carried out according to the requirements in Clause 4 of GB 17378.4-2007.

8.7 Hydrology and meteorology

Hydrological data processing and analysis should be carried out in accordance with the requirements of GB / T 12763.2. Meteorological data processing and analysis should be carried out according to the requirements of GB / T 12763.3.

8.8 Sediment

8.8.1 Sediment particle size

The laboratory test analysis of sediment particle size is carried out according to the specifications of 6.3 in GB/T 12763.8-2007.

8.8.2 Sediment settling rate

The sediment samples in the sealed bags are evenly spread in the porcelain plate, and then put into the oven for drying. The drying temperature is 105 °C and the drying time is generally 2 h. Put it in a desiccator to cool for 15min to 20min, and then weigh it on a balance with a sensitivity of 0.001g. The sediment settling rate analysis data are recorded in Annex K, table k.1.

9 Data filling and storage

9.1 On-site investigation record and interior analysis data

The field survey record and interior analysis record of each element should be filled according to the specifications of field survey and interior analysis. After the completion of the analysis, the data should be sorted out, including:

a) Coral reef ecological data. Statistical reports should be completed and saved in excel form, and the format is shown in Annex L.

b) Category directory. A list of species of corals, fish, benthic macroalgae and benthic macroinvertebrate is made and kept in excel, in the form shown in Annex M;

c) Data of sea water investigation elements. The statistical report of sea water investigation elements should be completed and saved in the excel form, and the format is shown in Annex N.

d) Hydrological and meteorological data. The statistics of hydrological and meteorological elements are completed and saved in Excel form, and the format is shown in Annex O.

e) Sediment data. The statistical statement of sediment investigation elements is

completed and saved in excel form, and the format is shown in Annex P.

9.2 Image data

Image data should be sorted and stored by category, including:

- Video of coral transect, fish and benthic macroinvertebrate;
- Quadrat photograph;
- Photographs of coral, fish, benthic macroinvertebrate and benthic macroalgae species;
- Other photos or videos taken in the investigation work of each station.

10 Ecological status assessment

10.1 Assessment indicators

Assessment indicators include key indicators reflecting the ecological structure, ecological function and habitat status of coral reefs, including:

- Coral coverage at each station;
- The number of scleractinian corals species, including the number of species at each station and the total number of species in each region;
- Supplementary quantity of hard corals at each station;
- Indicating species density of fish at each station;
- Indicating species density of benthic macroinvertebrate at each station;
- Coverage rate of benthic macroalgae in each station;
- Content of suspended solids in sea water at each station.

10.2 Reference system

The frame of reference is selected and used in the following ways:

The reference system should be selected and used follow the requirements below:

- a) Collect historical data of the investigation area, including routine monitoring, special investigation, and literature data, etc., and establish a reference system.
- b) The reference system should adopt relevant data representative of the above data that can reflect the changes of the ecosystem.
- c) When historical data are complete, they should be used as the reference frame for comprehensive assessment.
- d) When part of the historical data is available, the available part should be used as the reference frame for the assessment of a single part. Some indicators that lack historical data should include only the description of the status.
- e) When there is not any historical data, only a description of the current situation is made, and the results should be used as a reference frame for future assessment.

10.3 Assessment Methods

10.3.1 Single station assessment

10.3.1.1 Changes in coral coverage

The change of coral cover is the most important indicator of the changing state of coral reef ecosystem. The relative change value of the coral coverage of a single station compared with the base value represents the relative change amplitude of the coral coverage of the station. The calculation method is shown in Formula (1):

$$\delta C = (C_i - C_{i0}) / C_{i0} \dots\dots\dots (1)$$

In which:

- δC —the relative change of the coral coverage of a single station from the base value;
- C_i —Coral coverage at station i ;
- C_{i0} —Baseline coral coverage of station i .

The classification and assignment of the relative change values of coral coverage in a single station are shown in Table 2.

Table 2 Classification and assignment of coral coverage in a single station

Classification	δC Scope	Condition	Assignment (full score: 100)
I level	$\delta C \geq -10\%$	Stable	50
II level	$-10\% > \delta C \geq -50\%$	Reduce	25
III level	$\delta C < -50\%$	Significantly reduce	0

NOTE: the first I level, 50% or greater delta $C > 10\%$, indicates increased, assignment, 75; $C > 50\%$, indicating a significant increase, assign 100.

10.3.1.2 Changes in the number of scleractinian coral species

The change of the number of scleractinian corals species is one of the typical features of coral reef damage or recovery. The relative change of the number of coral species in a single station over the base value represents the relative change amplitude of the number of coral species in a single station. The calculation method is shown in Formula (2):

$$\delta S = (S_i - S_{i0}) / S_{i0} \dots\dots\dots (2)$$

where:

δS —the relative change of the number of single-station coral species from the base value;

S_i —The number of types of station i , in unit of species;

S_{i0} —The reference value of the number of types of station i , whose unit is species.

The classification and assignment of the relative change values of coral coverage in a single station are shown in Table 3.

Table 3. Classification and assignment of coral species number in a single station

Classification	δS Scope	Condition	Assignment (full score: 100)
I level	$\delta S \geq -10\%$	Stable	25
II level	$-10\% > \delta S \geq -50\%$	Reduce	12.5
III level	$\delta S < -50\%$	Significantly reduce	0

NOTE: the first I level, 50% or greater delta $S > 10\%$, said increased, assignment 37.5; $S > 50\%$, indicating a significant increase, assign a value of 50.

10.3.1.3 Changes in hard coral recruitment

The replenishment amount of hard coral represented the replenishment ability of coral larvae, and the change of the replenishment amount of hard coral reflected the weakening or strengthening of the replenishment function of coral reef ecosystem. The relative change value of hard coral recruitment in a single station over its base value represents the relative change amplitude of hard coral recruitment in that station. The calculation method is shown in Formula (3):

$$\delta R = (R_i - R_{i0}) / R_{i0} \dots\dots\dots (3)$$

where:

δR —the relative change of the quantity of hard coral replenishment from the base value at a single station;

R_i —Hard coral replenishment in units per square meter (ind/m²) at station i ;

R_{i0} —Reference value of hard coral recruitment at station i in units per square meter (ind/m²).

Table 4 shows the classification and assignment of the relative change values of single station hard coral recruitment.

Table 4 Classification and assignment of hard coral recruitment in a single station

Classification	δR Scope	Condition	Assignment (full score: 50)
I level	$\delta R \geq -10\%$	Stable	25
II level	$-10\% > \delta R \geq -50\%$	Reduce	12.5
III level	$\delta R < -50\%$	Significantly reduce	0
NOTE: the first I level, 50% or greater delta $R > 10\%$, said increased, assignment 37.5; $R > 50\%$, indicating a significant increase, assign 50.			

10.3.1.4 Changes in density of indicators species of coral reef fish

Among coral reef fish, butterfly fish, parrotfish and grouper are good indicators of coral reef ecosystem, and their density variation is an indicator of the health of coral reef ecosystem to some extent. The relative changes in the density of all species of the family Chaetodontidae, Scaridae and Epinephelus in a single station compared to the base value represent the relative changes in the density of species indicated by the fish at the station. The calculation method is shown in Formula (4):

$$\delta F = (F_i - F_{i0}) / F_{i0} \dots\dots\dots (4)$$

where:

δF —the relative change of the density of all fish species in a single station from the base value;

F_i —Total indicated species density of all fish at station i in units of tail per 250 square meters (IND/(250m)²);

F_{i0} —Reference value of species density for all fish at station i , in units of tail per 250 square meters (IND/(250m)²).

Table 5 shows the classification and assignment of the relative variation values of the indicated species density in a single station.

Table 5 Classification and assignment of density of fish indicators in a single station

Classification	δF Scope	Condition	Assignment (full score: 50)
I level	$\delta F \geq -10\%$	Stable	25
II level	$-10\% > \delta F \geq -50\%$	Reduce	12.5
III level	$\delta F < -50\%$	Significantly reduce	0
NOTE: the first I level, 50% or greater delta $F > 10\%$, said increased, assignment 37.5; $F > 50\%$, indicating a significant increase, assign 50.			

10.3.1.5 Benthic macroinvertebrate indicate species density changes

Tridacnidae among large benthic invertebrates has a good indication of coral reef ecosystem, and its density change to a certain extent indicates the health status of coral reef ecosystem. The relative changes in the density of all species of Tridacnidae in a single station from the base value represent the relative changes in the density of this station of Tridacnidae. The calculation method is shown in Formula (5):

$$\delta GC = (GC_i - GC_{i0}) / GC_{i0} \dots\dots\dots (5)$$

where:

δGC —the relative change of the density of a single station in Tridacna from its base value;

GC_i —The i -station Tridacna division has a total density of all types in units of 250 square meters ($IND/(250m)^2$);

GC_{i0} —The benchmark value of the i -station tridacna's density is in units of 250 square meters ($IND/(250m)^2$).

The classification and assignment of the relative change values of single station Tridacna's density are shown in Table 6.

Table 6 Classification and assignment of density of Tridacnidae in a single station

Classification	δGC range	Condition	Assignment (full score: 50)
I level	$\delta GC \geq -10\%$	Stable	25
II level	$-10\% > \delta GC \geq -50\%$	Reduce	12.5
III level	$\delta GC < -50\%$	Significantly reduce	0

NOTE: the first I level, 50% or greater delta $GC > 10\%$, said increased, assignment 37.5; $GC > 50\%$, indicating an obvious increase, assign 50.

10.3.1.6 Change of macrobenthic algae coverage rate

The change of benthic macroalgae coverage rate is also one of the main features of coral reef ecosystem damage or recovery. The relative change value of the coverage rate of large benthic algae in a single station compared with the base value represents the relative change amplitude of the coverage rate of large benthic algae in the station. The calculation method is shown in Formula (6):

$$\delta A = (A_i - A_{i0}) / A_{i0} \dots\dots\dots (6)$$

where:

δA —the relative change of the coverage rate of large benthic algae in A single station from the base value;

A_i —Large benthic algae coverage at station i ;

A_{i0} —Reference value of large benthic algae coverage rate at station i .

Table 7 shows the classification and assignment of the relative change values of single station large benthic algae coverage.

Table 7 Classification and assignment of macrobenthic algae coverage in a single station

Classification	δA range	Condition	Assignment (full score: 50)
I level	$\delta A \leq 10\%$	Stable	25
II level	$50\% \geq \delta A > 10\%$	Increase	12.5
III level	$\delta A > 50\%$	Significant increase	0

NOTE: in the first level I, $- >$ the delta $A - 50\%$ or 10% , said reducing, assignment 37.5; $A < -50\%$, indicating A significant reduction, assign 50.

10.3.1.7 Change of seawater suspended solids content

The content of suspended solids in seawater is very important to the growth and recovery

of coral and is an important indicator of habitat change and human activities. The relative change value of the seawater suspended solids content of a single station compared with the base value represents the relative change amplitude of the seawater suspended solids content of the station. See formula (7) for calculation:

$$\delta SS = (SS_i - SS_{i0}) / SS_{i0} \dots\dots\dots (7)$$

where:

δSS —the relative change of the content of suspended solids in seawater of a single station from the base value;

SS_i —The seawater suspended solids content of station i in milligrams per liter (mg/L);

SS_{i0} —The reference value of suspended seawater content at station i in milligrams per liter (mg/L).

Table 8 shows the classification and assignment of the relative change values of seawater suspended solids content in a single station.

Table 8 Classification and assignment of seawater suspended solids content in a single station

Classification	δSS range	Condition	Assignment (full score: 50)
I level	$\delta SS \leq 10\%$	Stable	25
II level	$50\% \geq \delta SS > 10\%$	Increase	12.5
III level	$\delta SS > 50\%$	Significant increase	0

NOTE: in the first level I, $- >$ the delta $SS - 50\%$ or 10% , said reducing, assignment 37.5; $SS < -50\%$, indicating a significant reduction, assign 50. .

10.3.1.8 Comprehensive assessment of multiple indicators in a single station

The comprehensive assessment of a single station is carried out according to the values assigned by the above 7 indicators. The calculation method is shown in Formula (8):

$$V_{site} = \sum_{i=1}^n V_i / \sum_{i=1}^n V_{iMAX} \dots\dots\dots (8)$$

where:

V_{site} — Comprehensive assessment and calculation results of a single station;

V_i —Sum of the assignment results of n indicators, $n \leq 7$;

V_{iMAX} —Sum of the full marks of the assignment of N indicators, $n \leq 7$.

If some indicators cannot be evaluated due to the lack of current data or benchmark values, the remaining indicators can be discarded for assessment, and only full marks of the remaining indicators can be used for calculation. The level results of single station ecological assessment are shown in Table 9.

Table 9 Level table of ecological status assessment results in single station

Classification	V_{site} range	Ecological status
I level	$V_{site} \geq 50\%$	Stable
II level	$25\% \leq V_{site} < 50\%$	Damage
III level	$V_{site} < 25\%$	Severe damage

10.3.2 Regional assessment

The regional assessment results are obtained from the assessment results of each station in the region. The calculation method is shown in Formula (9):

$$I_{cr} = \sum_{i=1}^n V_{site} / n \dots\dots\dots (9)$$

where:

I_{cr} —Calculation results of regional comprehensive ecological assessment;

V_{site} —Comprehensive assessment and calculation results of a single station;

N —Number of regional investigation and assessment stations.

Regional coral reef ecosystem classification is shown in Table 10.

Table 10 Level table of Regional Coral reef ecological status assessment results

Classification	I_{cr} range	Ecological status
I level	$I_{cr} \geq 50\%$	Stable
II level	$25\% \leq I_{cr} < 50\%$	Damage
III level	$I_{cr} < 25\%$	Severe damage

In the investigation results report, the internal causes and external driving factors of the changes in the ecological status of coral reefs are comprehensively analyzed and corresponding management measures are proposed by combining the results of the above comprehensive ecological status assessment and threat factors and other investigation elements that are not included in the above quantitative assessment. Table 11 shows the classification of regional coral reef ecosystem assessment results.

Table 11 Regional Coral reef ecological status assessment Results classification and management measures recommended table

Classification	Hierarchical description	Management measures
I level	The ecosystem is stable, the ecological structure and ecological function remain stable or improved, the biodiversity remains unchanged, and the self-recovery ability is strong	Continuous follow-up monitoring and scientific management
II level	The ecosystem is damaged, the stability of the ecological structure is reduced, the ecological function is missing to some extent, the biodiversity is reduced and the ability of self-recovery is reduced	We will strengthen ecological management, control threat factors, and promote natural restoration of ecosystems
III level	The ecosystem is seriously damaged, the stability of the ecological structure is significantly reduced, the ecological function is significantly missing, the biodiversity is significantly reduced, and the ability of self-recovery is significantly reduced	Ecological management should be strengthened to control the threat factors, and artificial restoration measures should be taken to improve the ecosystem condition

Annex A
(annex normative)
Position record of transect in reef ecological investigation

Table A.1 shows the record format of the location of the transect of the coral reef ecological investigation.

Table A.1 Location record table of coral reef ecological investigation transect

Project Name: _____

Page: _____

Area								Task number					
No	Station number	The transect layout						Water depth measurement		Investigation date	Investigation time	location mode	Note
		The transect number	Starting longitude (E)	Starting latitude (N)	Terminal longitude (E)	Terminal latitude (N)	The length of transect /m	Starting depth /m	Terminal depth /m				
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													

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Annex B
(annex normative)

Reef ecological investigation field record sheet

Table B.1 shows the record format of the coral reef ecological investigation site.

Table B.1 Field record of coral reef ecological investigation

Project Name: _____

Page: _____

Area		Task number		Position		Investigation date		
The investigation of time		The weather		Sea state		Underwater head-up distance/ (m)		
The serial number	The sample with		Transect 1		Transect 2		Transect 3	
	The transect number							
1	The investigation		Shooting time	The length	Shooting time	The length	Shooting time	The length
2	Sample with filming	Fish						2
3		Coral						3
4		Large benthic invertebrate						4
5	The investigation		Shooting time	Number of samples	Shooting time	Number of samples	Shooting time	Number of samples
6	Quadrat	Hard coral supplementary large benthic algae						6
7	Sediment collector setup with samples collect		Set quantity/sample quantity	Set quantity/sample quantity	Set quantity/sample quantity	Set quantity/sample quantity	Set quantity/sample quantity	Set quantity/sample quantity
8	Sediment cover status and change from last year		The status	Change	The status	Change	The status	Change
9	To have a position of							
10	Marine garbage status							
11	The situation of							
12	Other							
<p>NOTE 1: The shooting time is recorded in the format of "0920".</p> <p>2: Underwater horizontal visibility is the farthest head-up distance from which objects can be clearly seen underwater, and it is the estimated value on site.</p> <p>3: The station inspection column qualitatively describes the growth status of corals, fish and other dominant organisms in the two areas.</p>								

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Annex C
(annex normative)
Human activity Investigation records

Table C.1 shows the format of human activity investigation records.

Table C.1 Investigation records of human activities

Project name:

Page:

Investigation Area	Investigation way	Investigation date
Classification of human activities		
Basic information of coastal engineering	Record nearly five years investigation of coastal zone of completed or under construction in the area of engineering project information, including but not limited to reclamation project, embankment, wharf, bridge, pier and beach repair, key units to be record the project name, owner, location, purpose, environmental protection and ecological compensation measures such as basic information, such as on coral reefs, and area to occupy.	
Dredging, quarrying, sand - picking basic information	The information of seabed dredging, rock quarrying, sand mining and other activities in the investigation area in the past five years is recorded, and the information of construction unit, scope, amount of mining and use is mainly recorded.	
Tourism development activities Basic situation	Record the information of tourism development activities related to coral reefs in the investigation area in the past five years, and mainly record the information of tourism project name, activity scope, number of visitors and so on.	
Sewage and temperature drainage Basic situation	The information of sewage discharge and warm water outlet in the investigation area is recorded, with an emphasis on the information of pollutant discharging enterprises, location of the outlet, treatment situation and pollutants exceeding the standard.	
Fishing basic situation	Record the fishing situation within the investigation area, with an emphasis on recording the number, tonnage, fishing methods, varieties and quantity of fishing vessels.	
Aquaculture basics situation	Record the situation of aquaculture in the investigation area, and mainly record the location, area, mariculture mode, mariculture variety, mariculture quantity and other information of the mariculture area.	
Basic information of surface and seabed artificial facilities	Record the conditions of artificial surface and seabed facilities found in the investigation area, with an emphasis on recording the information such as the name, location, use and environmental impact of the facilities.	
Emergency basic situation	Records the information of emergent accidents occurred within the investigation area in the past five years, including but not limited to sunken ship, stranding, hazardous chemical leak, oil spill, etc., with an emphasis on recording the type, location, emergency treatment, environmental impact and other information of the accident.	
Other human activities Basic situation	To record basic information about other human activities in the investigation area in the past five years.	

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Annex D
(annex normative)
Marine debris investigation records

Table D.1 shows the format of marine garbage investigation records.

Table D.1 Marine garbage investigation records

Project name: _____

Page: _____

Investigation area				Investigation way			
The serial number	Position	Category	The number of	Sea surface/bottom	Investigation date	Whether to take photos/videos	Note
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

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Annex E
(annex normative)
Natural disaster investigation records

Table E.1 shows the record format of natural disaster investigation

Table E.1 Records of natural disaster investigation

Project name: _____

Page: _____

Investigation Area	Investigation way
The typhoon	(Record the information about typhoons in the investigation area in the past five years, with an emphasis on typhoon times, damage, disaster treatment and recovery, etc.)
Extreme heat	(Record the information of extreme high temperature in the investigation area in the past five years, with an emphasis on the record of extreme high temperature occurrence times, damage situation, disaster treatment and recovery, etc.)
Extreme low temperature	(Record the information of extreme low temperature in the investigation area in the past five years, with an emphasis on the record of extreme low temperature occurrence times, damage conditions, disaster treatment and recovery, etc.)
Other	

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Annex F
(annex normative)

Coralline band image interpretation and analysis record sheet

Table F.1 shows the record format of coral-like band image interpretation analysis.

Table F.1 Coralline band image interpretation and analysis record table

Project Name:		Project Name:														
area		Position number		The transect number				Water depth/m								
Tape length /m		Investigation date		Date of interpretation				Water depth/m								
The serial number	Sample with location	Chinese name	Latin name	Disease status		Bleaching conditions	Dead coral				Bottom sediment types				Other biological	
				Whether or not disease	Disease type		Whether or not Bleaching	a	b	c	d	reef	gravel	sand		mud
1	1															
2	2															
...	...															
500	500															
A combined		Growth status of coral	Living coral coverage /%	Disease incidence /%		An albino rate / %										
		Deaths	1- year mortality rate /%	Total mortality rate /%												
		Bottom sediment types	Reef rock coverage /%	Rubble coverage /%		Sand coverage /%										
		Other biological coverage /%	Benthic macroalgae	Alcyonacea	Gorgonacea		Spongia									
<p>NOTE 1: The swath position 1 represents the 0m10cm scale position on the 50m swath tape measure, 2 represents the 0m20cm scale position, and so on. 2: fill in the species name if there are corals in the sample zone, fill in "+" in the corresponding position if there are corals with disease, bleaching, dead corals and substrate types, and fill in the blank if there are no corals. 3 the "other organisms" column should be filled in truthfully. If soft coral is present, fill in soft coral; if seaweed is present, fill in seaweed. 4 disease B is albinism, BB is black edge disease, WB is white belt disease, RW is erosive disease, YB is macular disease, RB is red belt disease. 5: Dead coral A means less than one month after death, B means 1-6 months after death, C means 6-12 months after death, D means more than one year after death, the death within one year is the sum of the first three, and the total death rate is the sum of the four.</p>																

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Annex G
(annex normative)
Reef fish analysis records

Table G.1 shows the record format of coral reef fish analysis

Table G.1 Analysis record of coral reef fish

Project

Name:

Page:

Position		The transect number					Task number			
Area / (m ²)		Investigation date					Date of interpretation			
The serial number	Chinese name of fish	Latin name for fish	The individual number						Note	
			(0-5) cm	(5-10) cm	(10-20) cm	(20-30) cm	(30-40) cm	40cm 以上	(0-5) cm	(5-10) cm
1						1				
2						2				
3						3				
4						4				
5						5				
6						6				
7						7				
8						8				
9						9				
10						10				
A combined	Total number of all types (tail)						A combined	Total number of all types (tail)		
	Number of species		Aggregate density Ind/ (250 m ²)							
Note										
NOTE: In the remarks column, mark the indicating species: spearfish (family), butterfly fish (family), grouper (genus) and herbivore fish. For butterfly fish, indicate the species.										

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Annex H
(annex normative)
Record of hard coral recruitment interpretation analysis

Table H.1 shows the record format of interpretation analysis of hard coral recruitment.

Table H.1 Records of hard coral recruitment interpretation analysis

Project Name: _____

Page: _____

Area		Position			Task number			Date of interpretation		
Quadrat specifications		Area of quadrat/m ²			Average hard coral recruitment at station sites ind/m ²					
The serial number	Samples no.	Transect 1			Transect 2			Transect 3		
		Number of coral larvae	The density of ind/m ²	Main family/genus	The coral larvae The number of	The density of ind/m ²	Main family/genus	Number of coral larvae	The density of ind/m ²	Main family/genus
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
The transect average	Transshipment ind/m ²									

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Annex I
(annex normative)

Interpretive analysis record of benthic macroinvertebrate

Table I.1 shows the format of interpretation analysis records for benthic macroinvertebrate.

Table I.1 Interpretation and analysis records of benthic macroinvertebrate

Project Name: _____

Page: _____

Area		Site		Task number				
Investigation area /m ²	50 m × 2 m	Date		Average density ind/ (100 m ²)				
The serial number	Transect		Transect 1		Transect 2		Transect 3	
	Benthic macroinvertebrate		The individual number	density Ind/ (100 m ²)	The individual number	The density of Ind/ (100 m ²)	The individual number	The density of Ind/ (100 m ²)
1	Categories :	Alcyonacea						
2		Gorgonacea						
3		Actiniaria						
4		Crinoidea						
5		Asteroidea						
6		Holothuroidea						
7		Echinoidea						
8		Ophiuroidea						
9		Spongia						
10		Ascidiacea						
11		Crustacea						
12		Bivalvia						
13		Gastropoda						
14								
15								
16		Total						
17	Harmful biologicals	<i>Acanthaster planci</i>						
18		<i>Drupa</i>						
19	Biological indicator	<i>Linckia laevigata</i>						
20		<i>Diadema setosum</i>						
21		<i>Heterocentrotus mammillatus</i>						
22		Palinuridae						
23		<i>Charonia tritonis</i>						
24		Tridacnidae						
25								

NOTE: If other creatures are found, please fill in the blank.

Analysts _____

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Annex J
(annex normative)
Interpretation and analysis chart of benthic macroalgae

Table J.1 shows the record format of interpretation analysis of benthic macroalgae.

Table J.1 Interpretation and analysis record of benthic macroalgae

Project Name: _____

Page: _____

Area		Site		Task number		
Transect number		Quadrat specifications		Date of interpretation		
number	Samples no.	Dominant species of macrobenthos seaweed and seagrass		Coverage /%	Hight /cm	Note
		Chinese name	The Latin name			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Total	Number of seaweed species		Average coverage %		Mean height cm	

NOTE: 1. If there is more than one species of benthic macroalgae in a single quadrat, the names of multiple species should be filled in, and the coverage should be estimated separately.
2. The quadrat specification should be in the form of length x width, length, and width in cm.

Analysts _____ Proofreader _____

Annex K
(annex normative)
Sediment settling rate test and analysis record sheet

Table K.1 gives the record format of sediment settling rate test analysis.

Table K.1 Test and analysis record of sediment settling rate

Project

Name:

Page:

Area				Task number		
Electronic balance				date		
The serial number	Site	Transect	Sample no.	Dry weight /g	Sediment settling rate/(g/(m) ² • d)	Note
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

Analysts _____

Proofreader _____

Annex L
(annex normative)

Statement of ecological elements of coral reef ecological investigation

Table L.1 shows the data format of ecological elements of coral reef ecological investigation.

Table L.1 Data statement of ecological elements of coral reef ecological investigation

Project Name: _____

Site	Transect	Depth /m	Coral communities						Invertebrate				The substrate			
			Number of reef coral species	Live coral coverage	Hard coral recruitment ind/m ²	1-year mortality rate	Total mortality	An albino rate	Number of fish species	Fish density ind / (250m) ²	Invertebrate density ind/ (250m) ²	Benthic macroalgae coverage	Reef-rock coverage	Rubble coverage	Sand coverage	Mud coverage
	1															
	2															
	3															
	average															
	1															
	2															
	3															
	average															
	1															
	2															
	3															
	average															

Recorder _____

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Annex N
(annex normative)

Data statement of seawater elements in coral reef ecological investigation

Table N.1 shows the data format of sea water elements in the coral reef ecological investigation.

Table N.1 Data statement of seawater elements in coral reef ecological investigation

Project Name:

Stand no.	Longitude (E)	Latitude (N)	area	Investigation date	level	The test items													
					m	pH	DO	DO saturation	salinity	Suspended solids	Chlorophyll a	Total phosphorus	Total nitrogen	Active phosphate	nitrate	nitrite	Ammonia nitrogen	Inorganic nitrogen	Oil
							mg/L			mg/L									
1					surface	1													
					bottom														
2					surface	2													
					bottom														
3					surface	3													
					bottom														
4					surface	4													
					bottom														
5					surface	5													
					bottom														
6					surface	6													
					bottom														

Recorder _____

Proofreader _____

Annex 0
(annex normative)
Hydrometeorological data statement of coral reef ecological investigation

Table 0.1 shows the data format of hydrometeorological elements for coral reef ecological investigation.

◦

Table 0.1 Hydrometeorological data statement of coral reef ecological investigation

Project Name: _____

posit ion	Longitude (E)	Latitude (N)	area	Investigati on date	The investigati on of time	The weath er	Sea state	The water / °C		The depth of the water/m	Transparency /m
								The surface layer	The underlying		

Recorder _____

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**Annex P
(annex normative)**

Statement of sediment granularity data from coral reef ecological investigation

Table P.1 presents the format of sediment granularity data for the coral reef ecological investigation.

Project
Name:

No.	level cm	Gravel / %		Sand / %					Silt / %				Clay / %			Grain content /%				Code and Name
		>4	4~ 2	2~ 1	1~ 0.5	0.5~ 0.25	0.25~ 0.125	0.125~ 0.063	0.063 ~ 0.032	0.032~ 0.016	0.016~ 0.008	0.008~ 0.004	0.004~ 0.002	0.002~ 0.001	<0.00 1	gr av el	sa nd	si lt	cl ay	
		-2	-1	0	1	2	3	4	5	6	7	8	9	10	>11					

Recorder _____

Proofreader _____