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Social Organization Standard

T/CAOE 20.4-2020

Technical guideline for investigation and assessment of coastal ecosystem —

Part 4:

Salt marshes

海岸带生态系统现状调查与评估技术导则 第 4 部分：盐沼

（*English Translation*）

Contents

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 4 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*.

This standard was prepared by *China Association of Oceanic Engineering*.

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Technical guideline for investigation and assessment of coastal ecosystem —

Part 4: Salt marshes

1 Scope

This part of T/CAOE 20 specifies the general provisions, investigation contents, investigation methods and ecological status assessment methods for the investigation and assessment of the coastal salt marshes status.

This part is applicable to the investigation and assessment of the coastal salt marshes status.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 12763.2, *Specifications for oceanographic investigation- Part 2: Marine hydrographic observation*

GB/T 12763.4, *Specifications for oceanographic investigation- Part 4: Investigation of Seawater Chemical Elements*

GB/T 12763.6, *Specifications for oceanographic investigation- Part 6: Marine Biological Investigation*

GB/T 12763.8, *Specifications for oceanographic investigation- Part 8: Marine Geology and Geophysical Investigation*

GB 17378.4, *The Specification for marine monitoring- Part 4: Seawater analysis*

GB 17378.5, *The Specification for marine monitoring- Part 5: Substrate analysis*

GB/T 17501-2017, *Specification for marine engineering topographic investigating*

CH/T 2009, *Specifications for global positioning system real-time kinematic (RTK) investigations*

HJ 710.4, *Technical guidelines for biodiversity monitoring—birds*

HY/T 147.1, *Code of practice for marine monitoring technology-Part 1: seawater*

NY/T 1121.16, *Soil Testing-Part 16: Method for determination of total water-soluble salt*

T/CAOE 20.1-2020, *Technical guideline for investigation and assessment of coastal ecosystem—Part 1: General*

T/CAOE 20.2, *Technical guideline for investigation and assessment of coastal ecosystem—Part 2: Remote sensing identification and results verification of the coastal ecosystem*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

salt marshes

wetlands with high salinity

NOTE: the coastal salt marshes are distributed in estuaries or coastal shoals and are formed by
    the action of seawater immersion or tidal alternation.

3.2

salt marsh vegetation

communities that grow in the range of salt marshes

NOTE: The main dominant plants in salt marshes in China are Phragmites australis, Spartina
    alterniflora, Scirpus mariqueter, Suaeda salsa, Cyperus malaccensis var. brevifolius and so
    on. Among them, Spartina alterniflora was included in the list of the first batch of invasive

alien species in China.

4 General provisions

4.1 Working procedure

The working procedure shall be implemented according with the requirements specified in Clause 5 of T/CAOE 20.1-2020.

4.2 Quality control

Quality control is implemented in accordance with the requirements specified in 4.3 of T/CAOE 20.1-2020.

4.3 Investigation plan design

The investigation plan is designed in accordance with the requirements specified in Clause 6 of T/CAOE 20.1-2020.

4.4 Investigation and assessment report preparation

The investigation and assessment report should be prepared in accordance with the requirements specified in T/CAOE 20.1-2020 9.1.

4.5 Archive of data and results

Data and results archiving should be implemented in accordance with the requirements specified in Clause 10 of T/CAOE 20.1-2020.

5 Status investigation content

The scope of status investigation of salt marsh ecosystem is in the land-sea transition zone. The location is periodically or intermittently affected by ocean tides, and is covered with herbs or low shrubs in the silty or sandy intertidal wetland ecosystem, with vegetation coverage ≥30%. The investigation content includes salt marsh vegetation, biological community, environmental factors and threat factors, etc. The specific investigation content, investigation elements and methods of investigation are shown in Table 1. According to the purpose of the investigation and assessment needs, different investigation elements can be selected.

Table 1 — Contents and methods of investigation on the status quo of salt marshes

Investigation content	Investigation elements	Investigation method	specific method
Vegetation	Salt marsh: area, distribution and width of vegetation zone	Remote sensing interpretation and on-site verification	See 6.4.1
	Quadrat plants: type and quantity	Field survey	See 6.4.2
	Sample plants: density, coverage, average height and biomass	Field survey	See 6.4.2
Biotic community	Macrobenthos: species, density and biomass	Field survey	See 6.5.1
	Birds: species and numbers	Field survey	See 6.5.2
Environmental factors	Substrate: particle size, total salt content, pH value, total organic carbon, oxidation-reduction potential, total nitrogen and total phosphorus	Field survey	See 6.6.1
	Water body: temperature, salinity, turbidity, dissolved oxygen, pH value, total organic carbon, ammonium salt, nitrate, nitrite, reactive phosphate	Field survey	See 6.6.2
	Terrain: elevation	Field survey	See 6.6.3

| Threat factors | Natural factors: natural hazards，sea level changes, coastal erosion, invasion of alien species, etc. | Data collection, Field survey, social investigation, etc. | See 6.7.1 |
| | Human factors: aquaculture activities, fishing, coastal engineering, pollution discharge status, nearby resource utilization, tourism activities, etc. | Data collection, Field survey, social investigation, etc. | See 6.7.2 |

6 Status investigation methods

6.1 Layout of sections and stations

6.1.1 Principles

The principles of comprehensiveness, typicality and representativeness shall be followed when layout of investigation sites is made, details are as follows:

——Comprehensiveness: the layout of sections shall cover the entire investigation area spatially, with a balanced layout, which can reflect the overall picture of the saltmarsh vegetation and habitats in the investigation area;

——Typicality: the layout of sections shall ensure that the typical and special plant communities in the area are investigated in detail, and provide a basis for continuous management such as community review and long-term monitoring;

——Representativeness: the layout of sections shall include all representative plant community types, which is the main content of the community investigation.

6.1.2 Quantitative requirements for the sections and stations

The number of sections shall be determined according to the saltmarsh area, specific requirements are shown in Table 2. At least three stations shall be set for each section. Station setting shall fully reflect the vegetation distribution of tidal zone (high tidal zone, middle tidal zone, low tidal zone). For typical and special plant communities that cannot be covered by the section, separate investigation stations shall be set up.

Table 2 — Quantitative requirements for the sections in saltmarsh investigation

Distribution area of salt marsh / (hm^2)	Number of sections
>50~≤100	≥1
>100~≤500	≥3
>500	≥5

6.2 Quadrat and sample grid layout of investigation stations

A quadrat of 10 m × 10 m shall be set at each station, and a buffer zone of more than 10 m shall be set around the quadrat. The dominant plant species in the buffer zone shall be consistent with those in the quadrat. Each quadrat shall set up five 1m×1m sample grids, the sample grids shall be arranged in the four corners and center of the quadrat. If the plant species in the quadrat are diverse and the distribution is uneven, all the samples shall be investigated; if the plant species are single and the plants are evenly distributed, the number of investigation samples grids shall not be less than three. The design of quadrat and sample grid is shown in Figure 1.
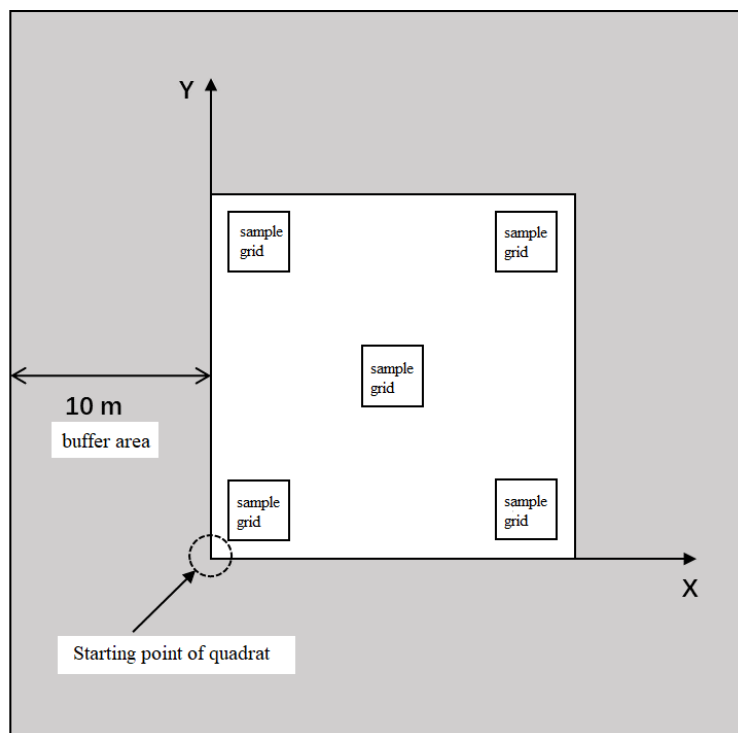
Fig 1 — Design drawing of the quadrat and sample grids

6.3 Investigation frequency

In general cases, the investigation shall be conducted once per year, and the investigation period shall be from July to October. The specific time should be adjusted according to the maturity time of the plants in each climate zone. If it is necessary to understand the seasonal variation of saltmarsh vegetation, four investigations shall be carried out every year, which are from January to March, April to June, July to September and October to December.

6.4 Investigation of saltmarsh vegetation

6.4.1 Remote sensing identification and current status verification of saltmarsh habitats

Indicators such as saltmarsh area, saltmarsh distribution, and width of saltmarsh vegetation zone are obtained through RS identification and status verification. The width of the salt marsh vegetation zone is calculated according to the average length of the saltmarsh habitat along the vertical coastline. The technical methods for RS identification and status verification of the distribution area of coastal saltmarsh habitats should be implemented in accordance with the relevant regulations of T/CAOE 20.2.

6.4.2 Investigation of plant community quadrat

Plant community characteristics of each selected sample grid shall be investigated. Fill in Form A.1 in Annex A during the investigation. Specific requirements are as follows:

a) English names of plants shall be recorded in field investigation, corresponding Latin names should be filled when come back;

b) Plant coverage, density, average height and other indicators shall be investigated and recorded from two levels: sample grids and species. See Annex B for the measurement methods of coverage, density and height;

c) Digital photos shall be taken during the investigation to record the community characteristics and working process directly. Photos of community sample grids shall visually show the appearance and vertical structure of community. The resolution of digital photos shall be above 3 million pixels;

d) For the areas within the quadrat and outside the sample grids, the plants not appearing in the sample grids shall be recorded;

e) The average coverage of the quadrat should be represented by the average coverage of the grids;

f) Biomass is measured by harvesting the above-ground part of the plant in the sample grid. The plants above the ground in the sample grids should be cut off with scissors and put into plastic bags, numbered and brought back to the laboratory for processing. After the sample is brought back indoors, the dead grass should be removed. The fresh weight should be weighed. Then the sample should be placed in a paper bag with appropriate size, dried in a drying box at 80° C to a constant weight, and then the dry weight is weighed.

6.5 Investigation of biotic community

6.5.1 Macrobenthos

Macrobenthos community investigation shall be carried out synchronously with plant community quadrat investigation. The species, quantity, and biomass of macrobenthos in each quadrat should be investigated. For biomass, only measures wet weight. The technical requirements for the investigation should be implemented in accordance with the relevant regulations of GB/T 12763.6.

6.5.2 Birds

The investigation time of birds shall be determined according to local phenological characteristics, the investigation methods and technical requirements for the species and quantity of birds should be implemented in accordance with the relevant regulations of HJ 710.4.

6.6 Investigation of environmental factors

6.6.1 Substrate environment

The Substrate environment investigation shall be carried out synchronously with plant community quadrat investigation, and the samples shall be collected in the sample grid of plant community investigation. Specific requirements are as follows:

a) Soil/Substrate samples of 0 cm to 15cm shall be taken using cutting ring of 100 cm^3 in each grid;

b) The samples from different grids shall be mixed and collected into a sealed bag and recorded the number on the sealed bag with an oil pen. The number shall be recorded on site in Table A.1 in Annex A;

c) The samples shall be brought back to the laboratory for testing and analysis;

d) The determined indicators and methods are shown in Table 1;

e) The determination of particle size should be carried out in accordance with the relevant regulations of GB/T 12763.8;

f) The determination of total salt content should be carried out in accordance with the relevant regulations of NY/T 1121.16;

g) The determination of pH value should be carried out in accordance with the relevant regulations of GB/T 12763.8. The determination of total organic carbon, redox potential, total nitrogen and total phosphorus should be carried out in accordance with the relevant regulations of GB 17378.5.

6.6.2 Water environment

When there are ditches or coastal waters near the investigation section, water environment investigation shall be carried out simultaneously with plant community quadrat investigation. Specific requirements are as follows:

——The determination of temperature and salinity should be carried out in accordance with the relevant regulations of GB/T 12763.2;

——The determination of turbidity should be carried out in accordance with the relevant regulations of GB 17378.4;

——The determination of dissolved oxygen, pH value, ammonium salt, nitrate, nitrite, and active phosphate should be carried out in priority according to the relevant regulations of HY/T 147.1 first, and should be carried out according to the relevant regulations of GB/T 12763.4 when conditions are not met. The determination of total organic carbon shall be carried out in accordance with the relevant regulations of GB 17378.4.

6.6.3 Topographic investigation

The topographic investigation shall be carried out simultaneously with plant community quadrat investigation to measure the average value of the corresponding elevations of 5 sample grids of the plant community quadrat. Priority shall be given to implementation in accordance with the relevant regulations of CH/T 2009. If communication signals were not available, it should be implemented in accordance with the relevant regulations in Clause 7 of GB/T 17501-2017.

6.7 Investigation of threatening factors

6.7.1 Natural threat

The investigation of natural threat shall collect the natural factors that threaten the distribution and development of salt marshes in the investigation area. The investigation results shall be recorded in Table C.1 in Annex C, including but not limited to the following contents:

a) Natural disasters. Record whether the investigation area has been damaged by natural disasters such as typhoon, storm surge, etc., and record the frequency, intensity of occurrence and other relevant information;

b) Sea level changes. Record the trend of sea level change in the investigation area;

c) Coastal erosion. Record whether there is erosion in the investigation area. Record the location and extent of erosion and other relevant information;

d) Alien species invasion. Record the alien species found in the investigation area. Record the species name, introduction time, distribution range, area and other relevant information.

6.7.2 Human threat

The investigation of Human threat shall collect human activities near the investigation area. The investigation results shall be recorded in Table C.1 in Annex C, including but not limited to the following contents:

a) Aquaculture activities. Record the breeding situation of the tidal flat in the investigation area. Record the location, area, breeding methods and other relevant information of the breeding area;

b) Fishing. Record the fishing scale and extent, whether there are fishing devices and other relevant information in the investigation area;

c) Coastal engineering. Record the types, scales, environmental impact assessment conclusions and other relevant data of coastal projects existing around the salt marsh;

d) Sewage status. Record whether there are sewage outlets, the location of the sewages outlets, on-site sewage discharging status, and other relevant information in the investigation area;

e) Nearby resources utilization. Record whether there is sand excavation, mining, oil extraction and other activities around salt marsh;

f) Tourism activities. Record the activities of tourism development around the salt marsh, whether the saltmarsh is occupied and other relevant information.

7 Ecological status assessment

7.1 Assessment index and weight

The ecological status of the salt marsh is assessed from three aspects: saltmarsh vegetation, biotic community, and environmental elements. The assessment indexes and weights are shown in Table 3. The assessment is only for the native saltmarsh investigation in China.

Table 3 — Assessment index and assignment of salt marsh ecological condition（*continued*）

Assessment content	Assessment index	Weights
Saltmarsh vegetation	Saltmarsh area	20
	Coverage of saltmarsh vegetation [a]	20
	Width of saltmarsh vegetation zone	10
Biotic community	Density of macrobenthos	15
	Biomass of macrobenthos	15
Environmental elements	Substrate pH value	10
	Substrate organic carbon	10
[a] the vegetation coverage of the salt marsh is the average coverage of all sample grids in the assessment area.		

7.2 Reference ecosystem

Reference ecosystem is selected and used as follows:

a）Collect the historical data of the investigation area, including conventional monitoring, special investigation, literature *et al*, to establish reference ecosystem;

b）Reference ecosystem should use representative information that reflects changes in ecosystems;

c）When historical information is complete, use the historical information first to establish the reference ecosystem;

d）When historical data is partly available, assess the indexes with available data, and only describe the status of the indexes without available data;

e）In the absence of historical information, only ecological status description are carried out and the results should be used as a reference for future assessments.

7.3 Assessment methods

7.3.1 Saltmarsh vegetation

7.3.1.1 Indicators assignment

See table 4 for assessment indiators, classification and assignment of saltmarsh vegetation.

Table 4 — Standard for assessment indicators assignment of saltmarsh vegetation

No.	Indicators	I（Stable）	II（Damaged）	III（Severely damaged）
1	The area of salt marsh decreases	≤5%	＞5%~≤10%	＞10%
	Assignment	20	15	5
2	The coverage of saltmarsh vegetation decreases	≤5%	＞5%~≤10%	＞10%
	Assignment	20	15	5
3	The width of saltmarsh vegetation zone decreases	≤10%	＞10%~≤30%	＞30%

	Assignment	10	5	1

7.3.1.2 Calculation method

The calculation method of saltmarsh vegetation indicators assessment is shown in the formula（1）:

$$VS_i = \frac{A_{0i} - A_i}{A_{0i}} \times 100\%$$ ·························（1）

where

VS_i Change rate of saltmarsh vegetation indicators. ;

A_i Current value of indicator i;

A_0 Value of reference frame of indicator i.

7.3.1.3 Saltmarsh vegetation assessment index classification

The calculation method of the saltmarsh vegetation assessment index is shown in the formula（2）:

$$S_v = \sum_1^n S_{vi}$$ ·························（2）

where

S_v Saltmarsh vegetation assessment index;

S_{vi} Assessment assignment for indicator i.

When S_v=11, the saltmarsh vegetation status is classified as severely damaged; When $11 < S_v \leq 35$, the salt marsh vegetation status is classified as damaged; When $35 < Sv \leq 50$, the salt marsh vegetation status is classified as stable.

7.3.2 Biotic community

7.3.2.1 Indicators assignment

See Table 5 for the assessment indicators, classification and assignment of biotic community status.

Table 5 — Assessment indicators, classification and assignment of biotic community（*continued*）

No.	Index	I（Stable）	II（Damaged）	III（Severely damaged）
1	Density of macrobenthos decreases	≤5%	>5%~≤10%	>10%
	Assignment	15	10	5
2	Biomass of macrobenthos decreases	≤5%	>5%~≤10%	>10%
	Assignment	15	10	5

7.3.2.2 Calculation method

The calculation method of biotic community indicators assessment is shown in the formula（3）:

$$VB_i = \frac{B_{0i} - B_i}{B_{0i}} \times 100\%$$ ·························（3）

where

VB_i Change rate of biotic community indicators. In percentage（%）;

B_i Current value of indicator i;

B_{0i} Reference value of indicator i.

7.3.2.3 Biotic community assessment index classification

The calculation method of biotic community assessment index is shown in the formula（4）:

$$S_b = \sum_1^n S_{bi}$$ ·························（4）

where

S_b Biotic community assessment index;

S_{bi} Assessment assignment for indicator i.

When S_b = 10, the biotic community is classified as severely damaged; When $10 < S_b \leq 20$, the biological community state is classified as damaged; When $20 < S_b \leq 30$, the biological community is classified as stable.

7.3.3 Environmental elements

7.3.3.1 Indicators assignment

See Table 6 for the assessment indicators assignment of environmental elements.

Table 6 — Assessment indicators, classification and assignment of environmental elements

No.	Indicators	I	II	III
1	Substrate pH value	>7.5~≤8.5	>7.0~≤7.5 或>8.5~≤9.0	≤7.0 或>9.0
	Assignment	10	5	1
2	Substrate organic carbon	≤2.0%	>2.0%~≤3.0%	>3.0%
	Assignment	10	5	1

7.3.3.2 Environmental elements assessment index classification

The calculation method of environmental elements assessment index is shown in formula (5):

$$S_e = \sum S_{ei} \quad\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (5)$$

where

S_e Environmental elements index;

S_{ei} Assessment assignment for indicator i.

When S_e =2, the environmental element status is classified as unsuitable; When $10 < S_e \leq 20$, the environmental element status is classified as moderately suitable; when $10 < S_e \leq 20$, the environmental element status is classified as suitable.

7.3.4 Comprehensive assessment of salt marsh ecological status

7.3.4.1 Calculation method

The calculation method of comprehensive assessment index of salt marsh ecological status is shown in formula (6):

$$I_{sm} = S_v + S_b + S_e \quad\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (6)$$

where

I_{sm} Comprehensive assessment index of salt marsh ecological status;

S_v Saltmarsh vegetation assessment index;

S_b Biotic community assessment index;

S_e Environmental elements assessment index.

7.3.4.2 Comprehensive assessment results

When $I_{sm} > 65$, the saltmarsh status is classified as stable, and the assessment level is I; when $23 < I_{sm} \leq 65$, the saltmarsh status is classified as damaged and the assessment level is II; when $I_{sm} = 23$, the saltmarsh status is classified as severely damaged, and the assessment level is III. In the report of the investigation results, the results of the comprehensive assessment of the salt marshes, threatening factors, and the remaining investigation elements that are not included in the above quantitative assessment, should be combined together, for comprehensively analyzing the internal reasons and external driving factors that cause eco-status changes of the salt marsh. Corresponding management measures should be proposed according to comprehensively analysis. The classification description and management measures of the assessment results of the salt marsh status are shown in Table 7.

Table 7 — Classification description and corresponding management measures of salt marsh

Classification	Classification description	Management measures
I	The status is stable. The saltmarsh	Continuous tracking and monitoring,

	vegetation, biotic community and environmental elements are overall stable and the ecosystem is self-sustaining.	scientific management.
II	The status is damaged. The saltmarsh vegetation, biotic community and environmental elements are damaged. The basic structure can still be maintained, and the self-recovery ability is reduced.	Strengthen ecological management, control threats, and promote natural restoration of ecosystems.
III	The status is severely damaged. The saltmarsh vegetation, biological communities and environmental elements are severely damaged. It is difficult to maintain the basic structure, and the self-recovery ability is significantly reduced.	Strengthen ecological management, control threats, and implement artificial restoration projects to improve ecosystem status。

Annex A
(annex informative)
Saltmarsh plant community investigation form

See Table A.1 for the investigation form of salt marsh plant communities.

Table A.1 — Salt marsh plant community investigation form

Investigation area:			Latitude and longitude:					Investigation date:	
Section number:		Station (quadrat) number:				Soil sample number:		Water sample number:	
Sample grid number	Sample grid vegetation			English name of plants	Coverage /%	Average height /cm	Density plant/m²	Photo number	
	Vegetation cover	Average height	Density						
Other species in the quadrat *									
* Plants recorded in quadrats but not in sample grid.									

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Annex B
(annex informative)
Calculation method of plant community characteristics

B.1 Coverage

The calculation of coverage is shown in the formula（B.1）.

$$C = \frac{S_v}{S_b} \times 100\%$$ ·······················（B.1）

where

C　Coverage. In percentages（%）;

S_v　Vertical projection area of aboveground part of plant. In meters（m^2）;

S_b　Quadrat area. In square meters（m^2）.

NOTE　In community investigations, the sum of species coverage may exceed 100 %, but no single species coverage will exceed 100 %.

B.2 Density

Salt marsh plants, especially gramineous plants, are often easy to tiller, and the unit of counting shall distinguish between clusters and plants. The calculation of density is shown in the formula （B.2）.

$$D = \frac{N}{A}$$ ·······················（B.2）

where

D　Density. In plants per square meter or clusters per square meter（ind/m^2）;

N　The number of individual plants in the quadrat. In plants or clusters;

A　Quadrat area. In square meters.（m^2）。

B.3 Average height

The average height shall be estimated by the method of actual measurement combined with visual observation to estimate the average height of a mature individual of a certain plant in the community in its natural state.

Annex C
(annex informative)
Salt marsh threat factor investigation record form

See Table C.1 for salt marsh threat factor investigation record form

Table C.1 — Salt marsh threat factor investigation record form

Threat factors	Description of the situation
Natural disaster	Description: Photo number:
Sea level changes	Description: Photo number:
Coastal erosion	Description: Photo number:
Alien species invasion	Description: Photo number:
Aquaculture	Description: Photo number:
Fishing	Description: Photo number:
Coastal engineering	Description: Photo number:
Status of sewage discharge	Description: Photo number:
Nearby resources utilization	Description: Photo number:
Tourism activities	Description: Photo number: