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China Association of Oceanic Engineering

Social Organization Standard

T/CAOE 20.6-2020

Technical guideline for investigation and assessment of coastal ecosystem —

Part 6:

Seagrass bed

海岸带生态系统现状调查与评估技术导则 第6部分：海草床

（English Translation）

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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 6 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 *Chinese Association of Oceanic Engineering.*

This part was drafted by Fourth Institute of Oceanography, Ministry of Natural Resources; North China Sea Environmental Monitoring Center of State Oceanic Administration.

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Technical guideline for investigation and assessment of coastal ecosystem —

Part 6: Seagrass bed

1 Scope

This part of T / CAOE 20 provides the general provisions, survey content, survey methods and ecological status assessment methods for the investigation and assessment of the status of seagrass bed ecosystem.

This section is applicable to the investigation and assessment of the current situation of coastal seagrass bed ecosystem.

2 Normative references

The following documents are essential for the application of this document. For reference files of note date, only the version of note date is applicable to this file. For reference files without dates, the latest version (including all revisions) is applicable to this file.

GB/T 12763.2 *Marine survey specification Part 2: Marine hydrological observation*

GB/T 12763.4 *Marine survey specification Part 4: Marine chemical factors survey*

GB/T 12763.6 *Marine survey specification Part 6: Marine biological survey*

GB/T 12763.8 *Marine survey specification Part 8: Marine geological and geophysical survey*

GB 17378.4 *Marine monitoring specification Part 4: Seawater analysis*

GB 17378.5 *Marine monitoring specification Part 5: Sediment analysis*

GB/T 17501 *Specification for marine engineering topographic survey*

T/CAOE 20.1 - 2020 *Technical guidelines for the survey and assessment of coastal ecosystems Part1: General*

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

seagrass

aquatic angiosperms, which are confined to the marine environment.

3.2

seagrass bed

seagrass community consisting of one or more seagrass species.
NOTE: Rewrite HY / T 083 - 2005, Definition 3.1.

3.3

seagrass ecosystem

the natural system dominated by seagrass, and consisting of other biotic community and the surrounding environment.

3.4

shoot

above aerial part of a ramet of seagrass, consisting of stems, sheaths and leaves.

3.5

coverage

percentage of vertical projection area of standing plants to the surface area of ground.

4 General rules

4.1 Work procedure

The working procedures are implemented as required by Chapter 5 of T / CAOE 20.1 - 2020.

4.2 Quality control

The quality control is implemented as required in T / CAOE 20.1 - 2020 4.3.

4.3 Investigation design

The design of investigation is implemented as required by chapter 6 of T / CAOE 20.1 - 2020.

4.4 Work results

The compilation of work results is implemented as required by 9.1 in T / CAOE 20.1 - 2020.

4.5 Archives of data and results

The archiving of data and results is implemented as required by Chapter 10 of T / CAOE 20.1 - 2020.

5 Status investigation contents

The investigation on the status of seagrass bed includes seagrass vegetation, biotic community, environmental factors, and threat factors (see Table 1). According to the investigation purpose and assessment needs, different investigation elements can be selected. See Annex A for the key elements and statements of the seagrass bed investigation. See Annex B for the equipment and materials required for the investigation.

Table 1—Contents and methods of investigation on the status of seagrass bed ecosystem

Investigation content	Investigation elements	Investigation methods	Investigation methods	Remark
Seagrass vegetation	Seagrass beds: total area, total type	Field investigation or aerial photography	See 6.1	Aerial photogrammetry area of seagrass beds exposed to low tide or clear seawater.
	Seagrass: species, coverage, shoot density of stems and branches, shot height, biomass, sexual reproduction		See 6.4	
Biotic community	Macroalgae: Coverage, type	Field investigation	See 6.5.1	-
	Attaching organisms: biomass		See 6.5.2	
	Macrobenthos: Species, density, biomass		See 6.5.3	
	Necton: Species, biomass		Execute according to GB/T 12763.6	
	Eggs and larvae of fish: Type, density		Execute according to GB/T 12763.6	
Environmental elemen	Water environment: transparency, water temperature, salinity, dissolve	Field investigation	Water temperature and salinity were performed according	Petroleum surveys are limi

Investigation content	Investigation elements	Investigation methods	Investigation methods	Remark
ts	d oxygen, suspended solids, inorganic nitrogen, active phosphate, petroleum		to GB/T12763.2; Transparency, suspended solids and petroleum are implemented according to GB17378.4; Other parameters are executed according to GB / T 12763.4	ted to areas where ships are active.
	Sediment environment: particle size, organic carbon, sulfide, total phosphorus, total nitrogen	Field investigation	Particle size is performed according to GB/T12763.8; Other parameters are performed according to GB 17378.5	Seagrass beds (Surfgrass, etc.) growing on reefs do not measure sediment parameters. For seagrass beds (shrimp grass, etc.) growing on reefs, measurement of sediment parameters is not required.
	Representative section: elevation	Field investigation	Execute according to GB/T 17501	
Threat factors	Natural factors: typhoon, storm surge, biological invasion	Field investigation	Quantitative and qualitative description	-
	Human factors: fishing (catch, fishing port distribution); Harvesting of benthic organisms (number of employees, harvesting methods); Marine aquaculture (aquaculture type, aquaculture species, aquaculture area, aquaculture time); Marine engineering (type, scale); Pollution emission (number of outlets)		Quantitative and qualitative description	

6 Status investigation method

6.1 Seagrass bed distribution investigation

Seagrass bed area: Using the global positioning system to locate the boundary of seagrass bed (seagrass coverage is greater than or equal to5 %) by ship or field investigation, the measuring point interval is 25m~50m (the boundary shape change can be appropriately increased positioning density) Seagrass beds with clear water surface or seawater can be exposed after ebb tide, and the area of seagrass beds can be investigated by aerial photography. The sonar method can be used to estimate the area of large seagrass distributed in water depth greater than 2 m (height greater than 40 cm). After the field investigation, using geographic information system platform to analyze the data of field investigation, plot the distribution range of seagrass, calculate the distribution area of seagrass bed.

Seagrass species: Record all seagrass species found in the field trips, photograph and collect suppressed specimens.

6.2 Layout of stations

6.2.1 Layout principles

The stations shall be arranged according to the following principles:

——The gradient variation of environmental factors such as salinity, water depth and nutrient salt should be considered in the section arrangement of layout, and all species of seagrass should be included.

——As soon as the site is defined, it is kept as constant as possible for long-term monitoring.

6.2.2 Layout methods

Based on the investigation data of seagrass bed distribution, the representative sites were selected to lay the cross section and station. The number of sections laid depends on the size of the seagrass bed (see Table 2).

Table 2—Layout requirements of seagrass bed investigation section

Distribution area of seagrass bed hm^2	Number of sections
Area ≤20	≥1
20＜Area≤100	≥2
100＜Area≤500	≥3
Area＞500	≥4

For the seagrass beds distributed in the intertidal zone, survey sections are arranged perpendicular to the direction of the coastal zone. In each section, no less than 3 environmental factors stations are arranged along the water depth (from shallow to deep). The position is marked with a Global Position System or permanent marker. The number of sites depends on the distribution of seagrass beds and habitat conditions. The layout is shown in Figure 1.

A 50m long and 1m to 3m wide transect parallel to the coastal zone was set up near each station of environmental elements (see **Figure 1**). In each transect, 0.5m × 0.5m quadrants were randomly assigned. The quadrangles were fixed with PVC pipes or other markers for biological investigation. The number of quadrats depends on the species diversity of seagrass in the transect. The number of quadrats of each species in the transect should not be less than 2.

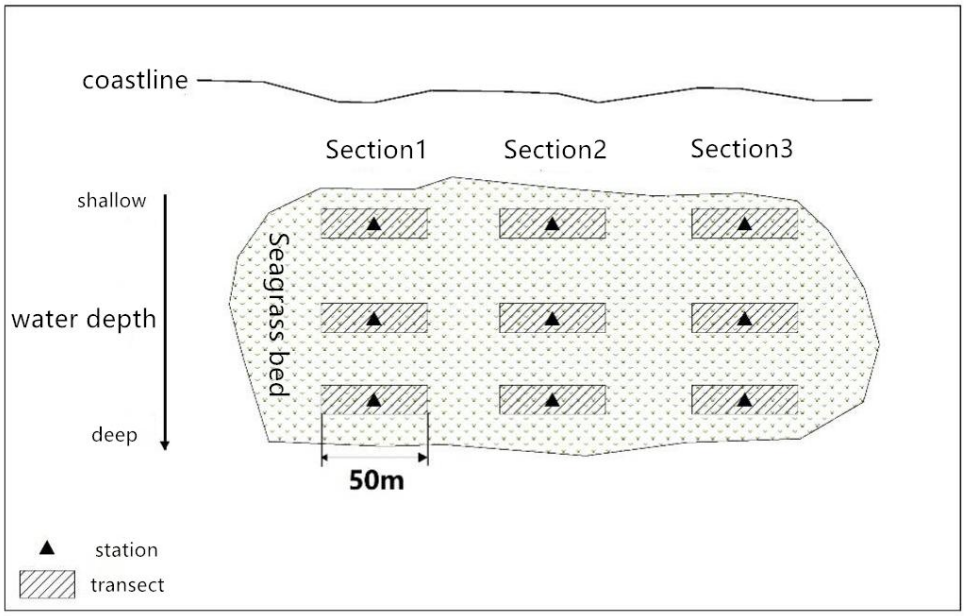

Figure 1—Seagrass bed investigation section and station setting

6.3 Frequency of investigation

The frequency of investigations depends on the purpose of the investigation. The investigation should be conducted 4 times a year, and the investigation time should be arranged in spring, summer, autumn and winter. The investigation should be carried out once a year, and the investigation time should be arranged in summer (June to August).

6.4 Seagrass quadrat investigation

Quadrats were set in the sampling strips, see 6.2.2. The investigation methods vary with the species of seagrass. Specific indicators and methods are as follows:

——Species: Record the species present in the quadrat.

——Coverage: Estimation of the coverage of each 0.5m×0.5m. If it is a mixture of species, the coverage ratio of each species is estimated separately.

——Height and density of stem and branches: after estimating the coverage of seagrass, the height and density of stem branches in sample square were statistically analyzed. For large and medium-sized seaweeds, the height and density of stem and branch in the range of 0.25m×0.25m were calculated. For small seagrass, the height and density of stem and branch in a 6.7cm inner diameter cylindrical sampler were calculated. The morphological structure and type classification of seagrass refer to Annex C and Annex D respectively.

——Biomass: Seagrass biomass in samples were obtained after statistic height and density. For large and medium-sized seagrass, the sample size of biomass was 0.25m×0.25m and the sampling depth was 20cm to 30cm. For small seagrass, a cylindrical sampler with an internal diameter of 6.7cm and a sampling depth of 15cm was used. Clean the seaweed and divide it into three parts :leaf, vertical stem and horizontal rhizome(+Root). For species without vertical stem, divide it into leaf and horizontal rhizome (+Root).Put them into a constant temperature drying oven (60℃ to 80℃) and dry them to a constant weight and weigh them.

——Sexual reproduction: Check the reproduction of seagrass, record the number of flowers and fruits.

6.5 Biotic community investigation

6.5.1 Macroalgae

Investigate the coverage and species of macroalgae in each 0.5m×0.5m.

6.5.2 Attaching organisms

Biomass survey of seagrass attaching organisms: for large seagrass, 3 to 5 leaves (from different branches) were collected near the sampling site. For medium-sized seagrass, 10 to 15 leaves were taken from the survey sample. For small seagrass, all the leaves in a 6.7 cm internal diameter cylindrical sampler should be obtained. The adhesion organisms on the blade surface of sea grass were scraped and put into a mesh bag (mesh 1mm). After cleaning, they were put into a constant temperature drying box (60℃ to 80℃) and dried to constant weight, and the adhesion biomass was measured.

6.5.3 Macrobenthos

The species, density and biomass of macrobenthos on the bottom surface and in the bottom of the sample square (0.25 m × 0.25 m) were measured at a depth of 20 cm to 30 cm. Macrobenthos may be sampled with seagrass biomass but treated separately. See GB/t 12763.6 for the treatment.

6.5.4 Necton

The species and biomass of the swimming animals were investigated at each site of the environmental factors. See GB/t 12763.6 for the method of investigation.

6.5.5 Fish eggs and larvae

The species and density of fish eggs and larvae were calculated by large-scale plankton net horizontal trawl. The investigation method is Gb/t 12763.6.

6.6 Survey of environmental factors

6.6.1 Water environment

The key elements of water environment investigation are as follows:

——Hydrological investigation: The investigation of water temperature and salinity is carried out according to Gb/t 12763.2

——Optical element: Transparency Investigation is performed according to GB 17378.4;

——Sea water chemical element: The investigation of dissolved oxygen, inorganic nitrogen (ammonia, nitrate, nitrite) and active phosphate was carried out according to Gb/t 12763.4, and the investigation of suspended matter was carried out according to GB 17378.4

——Petroleum: As defined in GB 17378.4.

6.6.2 Sediment environment

The investigation of environmental factors of bottom sediment and grain size shall be carried out in accordance with the provisions of Gb/t 12763.8. The investigation of organic carbon, sulfide, total nitrogen and total phosphorus shall be carried out according to GB 17378.5.

6.6.3 Representative section

Determine the elevations representing the stations in the section. The survey was carried out in accordance with Gb/t 17501 and the 1985 National Elevation Datum was adopted.

6.7 Investigation of threat factors

6.7.1 Natural factors

Collect the data of typhoon frequency, storm surge frequency, biological invasion (species, area) and so on.

6.7.2 Human factors

Survey of human activity in the seagrass bed distribution area, these include fishery fishing (catch, distribution of fishing ports, etc.), bottom-dwelling organisms harvesting (number of workers, mode of harvesting), mariculture (type, species, area and time of mariculture), marine engineering (type and scale), and pollution discharge (see Table 1). The investigation factors can be adjusted according to the actual conditions of different sea areas.

7 Assessment of ecological conditions

7.1 Assessment indicators

The ecological assessment of seagrass bed was carried out from the aspects of seagrass bed, biological community and environmental factors, see Table 3 for specific evaluation indicators and assignment values.

Table 3—Evaluation index and weight assignment of seagrass bed ecological status

Assessment content	Elements of assessment	Evaluation indicator	Index weight assignment
Seagrass vegetation	Seagrass vegetation	Total area	50
		Shoot density	
		Coverage	
Biotic community	Macrobenthos	Biomass	25
	Macroalgae	Coverage	
Environmental factors	Water environment	Dissolved Oxygen	15
		Suspended matter	
		Inorganic nitrogen	
		Active phosphate	
	Sediment environment	Organic carbon	10
		Sulfide	

7.2 Frame of reference

The reference frame is selected and used in the following manner:

a) To collect historical data of the investigation area, including routine monitoring, special investigation, documentation and so on, and establish a frame of reference;

b) It would be appropriate to use as a frame of reference relevant information from the above-mentioned data that is representative and can reflect changes in ecosystems;

c) When the historical data are available, the historical data shall be taken as the reference for the comprehensive assessment;

d) When part of the historical data is available, part of the historical data is used as a reference for individual assessment;

e) In the absence of historical data, only the current situation is described and the results should be used as a reference for future evaluation.

7.3 Assignment methods

7.3.1 Seagrass bed

7.3.1.1 Evaluation indicators and assignment

The evaluation index, classification and evaluation of seagrass bed are shown in Table 4.

Table 4—Evaluation index, classification and valuation of seagrass bed

NO.	Indicators	I Stable	II Damaged	III Severely damaged
1	Change in seagrass bed area	≥-10%	≥-30% to <-10%	<-30%
2	Change in coverage	≥-10%	≥-30% to <-10%	<-30%
3	Change in density of stem-branch	≥-10%	≥-30% to <-10%	<-30%
Assignment		50	30	10

7.3.1.2 Calculation method

Seagrass bed assessment is calculated as follows.

a) The change in seagrass bed area is calculated by Formula (1):

$$V_1 = \frac{A - A_0}{A_0} \times 100\% \quad \cdots\cdots (1)$$

Where:

V_i——Rate of area change of seagrass beds, in percentage (%)

A—— The total measured area, in hectares (hm^2);

A_0——The historical area, in hectares (hm^2).

b) Seagrass coverage index is calculated according to Formula (2):

$$\bar{C} = \frac{\sum_1^N C_i}{N} \quad \cdots\cdots (2)$$

Where:

$\bar{C}$——Average of seagrass coverage monitoring, in percentage (%);

C_i——A number, in percent (%),of sample coverage (i) ;

N——Total number of samples in a region to be evaluated.

The change of seagrass coverage is calculated according to Formula (3):

$$V_2 = \frac{\bar{C} - C_0}{C_0} \times 100\% \quad \cdots\cdots (3)$$

where:

V_2——Rate of change in coverage of seagrass, in percentage (%);

$\bar{C}$——Average of seagrass coverage monitoring;

C_0——Data of reference system.

c) The stem-branch density index of seagrass is calculated according to Formula (4):

$$\bar{D} = \frac{\sum_1^N D_i}{N} \quad \cdots\cdots (4)$$

Where:

$\bar{D}$——Stem and branch density monitoring average, unit for plant per square meter (ind/m^2);

D_i——Stem branch density in the i^{th} quadrat, per square meter per plant (ind/m^2);

N——Total number of samples in a region to be evaluated.

The change of stem and branch density of seagrass is calculated by Formula (5):

$$V_3 = \frac{\bar{D} - D_0}{D_0} \times 100\% \quad \cdots\cdots (5)$$

Where:

V_3——The rate of change in branch density of a flower tree, in percent (%);

$\bar{D}$——Average of branch density monitoring for a flower stem;

D_0——Reference data.

d) Seagrass bed assessment index is calculated by Formula (6):

$$I_V = \frac{\sum_1^q V_i}{q} \quad \cdots\cdots(6)$$

Where:

I_V—— Seagrass bed evaluation index;

V_i——The ith seagrass bed evaluation index assignment (see Table 4);

q——Total number of seagrass evaluation indicators.

When $37 \leqslant I_V \leqslant 50$, the seagrass bed was stable and rated as Grade I; when $30 \leqslant I_V < 37$, the seagrass bed was damaged and rated as Grade II; when$10 \leqslant I_V < 30$, the seagrass bed was seriously damaged and rated as Grade III.

7.3.2 Biotic community

7.3.2.1 Evaluation indicators and assignment

The evaluation index, classification and valuation of biome are shown in Table **5**.

Table 5—Evaluation index, classification and valuation of biological community

NO.	Indicators	I Stable	II Damaged	III Severely damaged
1	Macroalgae coverage	≤15%	＞ 15% to ≤30%	＞ 30%
2	Changes in macrobenthos biomass	≥-5%	＞-10% to ≤-5%	＜-10%
Assignment		25	15	5

7.3.2.2 Methods for assessment of biological communities

Biome assessment is calculated as follows.

a) The average coverage of macroalgae is calculated by Formula (7) :

$$B_1 = \frac{\sum_1^N MA_i}{N} \quad \cdots\cdots(7)$$

Where:

B_1—— The average coverage of macroalgae in percentage (%)

MA_i——The coverage of macroalgae in the ith quadrat, in percentage (%) ;

N——Total number of samples in a region to be evaluated.

b) Macrobenthic biomass is calculated according to Formula (8):

$$\overline{BA} = \frac{\sum_1^N BA_i}{N} \quad \cdots\cdots(8)$$

Where:

$\overline{BA}$——Average monitored biomass of macrobenthos, in grams per square meter (g/m^2);

BA_i——The biological quantity of macrobenthos in the ith quadrat is(g/ m^2) ;

N——Total number of samples in a region to be evaluated.

c) The rate of change in macrobenthic biomass is calculated by Formula (9):

$$B_2 = \frac{\overline{BA} - BA_0}{BA_0} \times 100\% \quad \cdots\cdots(9)$$

Where:

B_2——The change rate of macrobenthos biomass in percentage (%)

$\overline{BA}$——Mean monitored biomass of macrobenthos, in grams (g);

BA_0——Reference data.

d) The biome (I_B) condition index is calculated by Formula (10):

$$I_B = \frac{\sum_1^q B_i}{q} \quad \cdots\cdots(10)$$

Where:

I_B——Biocommunity status index;

B_i——The evaluation index of the ith biological community was assigned (see Table 5) ;

q——Total biological community assessment indicators.

When19≤I_B≤25, the community is in a stable state and the evaluation grade was Grade I; when 15≤I_B<19, the community is damaged and the evaluation grade is Grade II; when5≤I_B<15, the community is seriously damaged and the evaluation grade is Grade III.

7.3.3 Water environmental factors

7.3.3.1 Assessment indicators and valuation

The index, classification and evaluation of water environment assessment are shown in Table 6.

Table 6—Water environment assessment indicators, classification and valuation

NO.	Indicators	I Fit	II Moderate	III Not suitable
1	Dissolved oxygen/(mg/L)	≥ 6	>5 to≤6	≤5
2	Suspended solids/(mg/L)	≤10	>10 to≤50	>50
3	Inorganic nitrogen/(g/L)	≤200	> 200 to ≤ 300	>300
4	Active phosphate/(g/L)	≤15	>15 to ≤30	> 30
Assignment		15	10	5

7.3.3.2 Assessment of water environmental factors

Water environment assessment is calculated as follows.

a) Each indicator of the water environment is assigned according to Formula (11):

$$W_q = \frac{\sum_1^n W_i}{n} \quad \cdots\cdots(11)$$

Where:W_q—— The qth evaluation index assignment;W_i——The qth evaluation index of the ith station is assigned (see Table 6) ;

n——Number of stations in the area evaluated.

b) The water environment condition index is calculated according to Formula (12) :

$$I_W = \frac{\sum_1^m W_q}{m} \quad \cdots\cdots(12)$$

Where:

I_W——Water environment index;W_q——The qth evaluation index assignment;

m——Total number of regional evaluation indicators.

When 12≤I_W≤15, the water environment is suitable and the evaluation grade is Grade I; when10≤I_W<12, the water environment is moderately suitable and the evaluation grade is Grade II; when 5≤I_W<10, the water environment is unsuitable and the evaluation grade is Grade III.

7.3.4 Sediment environment factors

7.3.4.1 Assessment indicators

The Assessment Index, classification and valuation of the bottom sediment environment are shown in Table 7.

Table 7—Assessment index, classification and valuation of bottom sediment environment

NO.	Indicators	I Fit	II Moderate	III Not suitable
1	Organic carbon content	≤2.0%	＞ 2.0% to ≤3.0%	＞ 3.0%
2	Sulfide content/(μg/g)	≤300	＞ 300 to ≤500	＞ 500
Assignment		10	5	1

7.3.4.2 Assessment of environmental factors of the sediment

a) Assessment of the sediment environment shall be based on Formula (13):

$$S_q = \frac{\sum_1^n S_i}{n} \quad \cdots\cdots(13)$$

Where:

S_q——The qth evaluation index assignment of the sediment environment;

S_i——The qth evaluation index of the ith station in the sediment environment is assigned (see Table 7) ;

n——Number of stations in the area evaluated.

b) The sediment environmental condition index is calculated by Formula (14):

$$I_S = \frac{\sum_1^q S_q}{q} \quad \cdots\cdots(14)$$

Where:

I_S——Sediment environmental condition index;

S_q——The qth evaluation index assignment;

q——Total number of evaluation indicators for the evaluation region.

When $7 \leqslant I_S \leqslant 10$, the bottom environment is suitable and the assessment grade is Grade I; when $5 \leqslant I_S < 7$, the bottom environment is moderately suitable and the assessment grade is Grade II; when $1 \leqslant I_S < 5$, the bottom environment is unsuitable and the assessment grade is Grade III.

7.3.5 Integrated assessment index for seagrass bed ecosystems

The comprehensive assessment index for the ecological status of seagrass beds is calculated by Formula (15):

$$I_{SG} = I_V + I_B + I_W + I_S \quad \cdots\cdots(15)$$

Where:

I_{SG}——Comprehensive assessment index of ecological status of seagrass bed;

I_V——Seagrass bed condition index;

I_B——Biocommunity status index;

I_W——Water environment index;

I_S——Sediment environmental condition index.

When $I_{SG} \geqslant 75$, the seagrass bed ecosystem is stable and rated as Grade I; when $60 \leqslant I_{SG} < 75$, the seagrass bed ecosystem is damaged and rated as Grade II; when $I_{SG} < 60$, the seagrass bed ecosystem is seriously damaged and rated as Grade III (see Table 8).

In the report of the results of the survey, combined with the results of the comprehensive assessment of the ecological situation of the seagrass bed in Shanghai and other threatening factors, which have not been included in the above-mentioned quantitative assessment, the internal and external driving factors of the ecological changes of seagrass bed were comprehensively analyzed, and the corresponding management measures were put forward.

Table 8—Classification statement and management measures of the assessment results of ecological status of seagrass bed

Grading	Grading instructions	Management measures
Class I	Ecosystems are relatively stable. Seagrass vegetation, biological community, and environmental factors, such as the overall stability of self-sustainment	Continuous monitoring and scientific management
Class II	Ecosystem damage. The damage of seagrass vegetation, biological community and environmental factors can maintain the basic structure of the ecosystem and reduce the ability of self-recovery	Strengthen the ecological management, control the threatening factors, and promote the natural recovery of the ecosystem
Class III	The ecosystem is severely damaged. Seagrass vegetation, biological community and environmental factors were severely damaged, which made it difficult to maintain the basic structure of the ecosystem and reduced the ability of self-recovery	To strengthen ecological management and control the threatening factors, it is suggested to carry out artificial restoration measures to improve the condition of ecosystem

Annex A
(annex normative)
Records and reports of seagrass bed survey elements

Table A.1 ~ A.5 Records and reports of seagrass bed survey elements.

Table A. 1—Field collection record of seagrass beds

Sea area_____sampling site_____tide_____ monitoring time_____year_____month_____date_____hour_____minute to_____hour minute

Serial number	Station number	Quadrat serial number	Photo/video serial number	Longitude	Latitude	Seagrass species	Seagrass coverage	Seagrass sample number	Species of macroalg-ae	Macroalgae coverage	Sample number of macroagae	Number of attached biological sample	Sample number of macrobenhos
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													

Sampler_____recorder_____proofreader_____

Table A.2—Record table of biological indicators of seagrass

Page total page

Sea area name_____ sampling site_____ station number_____

Square number_____ date_____ year_____month_____date

Projects	Measured Value
Species name	
Shoot height[a] (cm)	
Number of stem and branch	
Sexual Reproduction	Flower (inflorescence) : Fruit:
Dry Weight (g)	Leaf:
	Vertical stem[b]:
	Horizontal rhizomes + Roots:
Square size (cm^2)	
Drying condition	Weighing apparatus: ; Temperature: ℃

[a]all stem and branch heights;
[b]No vertical stems of seaweed, the vacancy.

recorder_____ proofreader_____

Table A.3—Report of survey factors of seagrass beds

Page Total pages

Task_____ Name_____ Water Area_____ Monitoring date_____ to_____

Sampling site_____ Total area of seaweed bed _____ Analysis date_____ to

Station number	Sample number	Substrate type	Species name	Average shoot height cm	Shoot density Plant /m^2	Coverage %	Biomass g/m^2			Reproduction individual / m^2		Macroscopic algae		Macrobenthos		
							Leaf	Vertical stem	Horizontal rhizome and root	Flowers (inflorescences)	Fruit	Species	Coverage %	Species	Density individual / m^2	Biomass g/m^2

recorder_____ proofreader_____

Table A.4—Report on the elements of seagrass bed environmental investigation

Mission name: _____Sea zone: _____Monitoring date: _____year_____month_____day to_____month_____day

Sampling location: _____ Total seagrass bed area: _____ Analysis date: _____ year_____ month_____ day to_____ month day

Monitoring station	Longitude	Latitude	Monitoring date	Sampling time	Water parameters										Sediment parameters		
					Sampling water depth m	Water temperature ℃	Salinity ‰	Transparency	Suspended matter mg/L	Dissolved oxygen mg/L	Nitrite Nitrogen mg/L	Nitrate Nitrogen mg/L	Ammonia Nitrogen mg/L	Phosphate μg/L	Sulfide ×10^{-6}	Organic-carbon %	Granularity

recorder_____ proofreader_____

Table A.5—Investigation Report on Threat Factors of Seagrass Bed

Page pages in total

Sea waters____Investigating area____Seagrass bed area____Investigation time___year___month____day to month____day

investigation method □consult data □expert consultant □field investigation □questionnaire survey □other methods

Threat factors	Case explanation	Threat
Natural disaster(Record whether there are natural disasters such as typhoon and storm surge in the investigated area)	Description: Photo number:	
Fishing(Record whether there are fishing devices, scale, scope, fishing amount and other information in the survey area)	Description: Photo number:	
Benthic harvesting (Record the number of employees in the survey area and the method of harvesting)	Description: Photo number:	
Bred in sea water(Record the situation, location, area, type, species, breeding method and other information of beach farming in the survey area)	Description: Photo number:	
Coastal engineering(Record whether there are newly built piers, bridges, trestle and other coastal projects around the seagrass bed)	Description: Photo number:	
Pollution condition(Record whether there are sewage outlets, the location of the outlets, the on-site sewage and other information in the survey area)	Description: Photo number:	
Alien species invasion(Record information about alien species and scope in the survey area)	Description: Photo number:	

Investigator Recorder _____ Proofreader _____ Inspector _____ Auditor _____

Instructions for filling out the form:

1. The investigation method can be selected single or multiple, and the specific threat factors of the seagrass bed investigation will be listed according to the actual situation.

2. Describe the specific circumstances of each threat factor and include as much information as possible. Such as typhoon time, wind force, impact area, seagrass bed comparison before and after the typhoon, etc., and the scale of aquaculture or fishing. On-site investigation results should be submitted at the same time as evidence photos or photo numbers, and the source of references should be indicated.

3. The minimum threat level is 1 point and the maximum is 10 points. Each threat factor is scored separately, based on the situation or expert advice.

Annex B
(annex informative)
Necessary Equipment and Materials

The equipment and materials required for the seagrass bed ecosystem survey are as follows:

- Species identification manual;
- Underwater digital camera;
- Handheld GPS;
- 0.25 ㎡ sample box (50cm×50cm);
- 0.0625 ㎡ sample box (25cm×25cm);
- Waterproof record board;
- 30cm ruler;
- Pencil;
- Pencil sharpener;
- Marker pen;
- 50m tape measure;
- PVC pipe or other permanent site markers;
- Shovel;
- Salinity meter;
- Plastic bucket;
- Water dispenser;
- Brown bottle;
- Cylinder sampler (inner diameter 6.7cm);
- Large plastic sealing bag;
- Small plastic sealing bag;
- Diving suit, mask, breathing tube, oxygen cylinder and other light diving equipment.

Annex C
(annex informative)
The morphological structure of seagrass

Fig. C. 1 The morphological structure of seagrass.

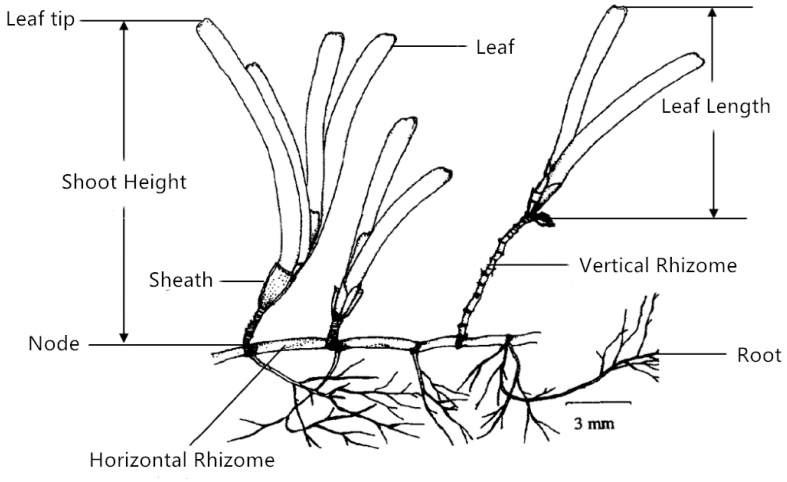

Fig. C. 1—Morphological structure of seagrass (*Cymodocea serrulata*, cited from Lih-Yuh Kuo)

Annex D
(annex informative)
Information of seagrass along the coast of China

Table D.1 shows the distribution of seagrass along the coast of China.

Table D.1—Distribution of Seagrasses along the Coast of China

Family	Genera	Species	Distribution	Size
Cymodoceaceae	*Cymodocea*	*Cymodocea rotundata*	Guangdong, Hainan, Taiwan	Medium grass
		Cymodocea serrulata	Hainan	Medium grass
	Halodule	*Halodule pinifolia*	Guangdong, Guangxi, Hainnan, Taiwan	Small grass
		Halodule uninervis	Guangdong, Guangxi, Hainnan, Taiwan	Small grass
	Syringodium	*Syringodium isoetifolium*	Guangdong, Guangxi, Hainnan, Taiwan	Small grass
	Thalassodendrom	*Thalassodendrom ciliatum*	Guangdong, Hainnan, Taiwan	Medium grass
Hydrocharitaceae	*Enhalus*	*Enhalus acoroides*	Hainnan, Taiwan	Large grass
	Thalassia	*Thalassia hemprichii*	Guangdong, Hainnan, Taiwan	Medium grass
	Halophila	*Halophila beccarii*	Guangdong, HongKong, Guangxi, Hainan, Taiwan	Small grass
		Halophila decipiens	Hainan, Taiwan	Small grass
		Halophila minor	Guangdong, HongKong, Guangxi, Hainan	Small grass
		Halophila ovalis	Fujian, Guangdong, HongKong, Guangxi, Hainan, Taiwan	Small grass

Table D.1—Distribution of Seagrasses along the Coast of China (*continued*)

Family	Genera	Species	Distribution	Size
Ruppiaceae	*Ruppia*	*Ruppiabrevipedunculata*	Jiangsu, Zhejiang, Fujian, Guangdong, Hainan	Medium grass
		Ruppia sinensis	Liaoning, Tianjin, Shandong, Jiangsu, Shanghai、Zhejiang, Fujian, Guangdong	Medium grass
		Ruppia megacarpa	Shandong, Jiangsu	Medium grass
Zosteraceae	*Phyllospadix*	*Phyllospadix iwatensis*	Liaoning, Hebei, Shandong	Large grass
		Phyllospadix japonicus	Liaoning, Hebei, Shandong	Large grass
	Zostera	*Zostera asiatica*	Liaoning	Large grass
		Zostera caespitosa	Liaoning, Hebei, Shandong	Large grass
		Zostera caulescens	Liaoning	Large grass
		Zostera japonica	Liaoning, Hebei, Shandong, Guangdong、Hongkong, Guangxi, Taiwan	Medium grass
		Zostera marina	Liaoning, Hebei, Shandong	Large grass