

# Biological Assessment of Ecologically Important Areas for the Algae Taxonomic Group in the Yellow Sea Ecoregion

## China Part

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### 1. Ecological sub-regions

Definition and description of sub-regions

Sub-region: Western sub-region of the Yellow Sea

Western region of the Yellow Sea is defined as the Chinese coastal waters from the Yalu River mouth down to the mouth of the Yangtze River, including the Bohai Sea (Tseng et Chang, 1962).

### 2. Common Criteria for identification of Ecologically Important Areas of Yellow Sea Ecoregion (YSE)

The Algae Taxonomic Group adopted the following common criteria to identify Ecologically Important Areas for Algae in the YSE (Table 1).

**Table 1. List of Adopted Common Criteria for Algae Taxonomic Group**

Adopted Common Criteria	Selected Indicator Species/ Species Groups	Definition of Indicator Species	Definition of Ecologically Important Areas
<b>Criterion 1: representative species / habitat types</b>	<i>Ulva pertusa</i> , <i>Laminaria japonica</i> , <i>Undaria pinnatifida</i> , <i>Sargassum confusum</i> , <i>Sargassum thunbergii</i> , <i>Porphyra yezoensis</i> , <i>Gloiopeltis furcata</i> , <i>Gracilaria lemaneiformis</i>	Abundant species	Major area of distribution
<b>Criterion 2: endemism and unique species assemblages</b>	<i>Porphyra katadae</i> var. <i>hemiphylla</i> , <i>Porphyra oligospermatangia</i> , <i>Solieria tenuis</i> , <i>Tsengia nakamurae</i> , <i>Tsengiella spinulosa</i> , <i>Sargassum qingdaoense</i> , <i>Silvetia siliquosa</i>	Endemic to the YSE	Area of distribution in the Shandong Peninsula.
<b>Criterion 3: species richness</b>	not adopted	not adopted	not adopted

Adopted Common Criteria	Selected Indicator Species/ Species Groups	Definition of Indicator Species	Definition of Ecologically Important Areas
<b>Criterion 4: species of special concern 1 (threatened and/or protected species) or depleted stocks</b>	<i>Porphyra tenera</i> , <i>Hizikia fusiformis</i> , <i>Silvetia siliquosa</i>	<i>Porphyra tenera</i> was considered as the typical species of the study of nori's history because of its large population size, but it is no longer found along the coast; hence it needs special attention. <i>Hizikia fusiformis</i> and <i>Silvetia siliquosa</i> are edible and had been collected excessively by local people.	Area of distribution reported in the Liaodong and Shandong Peninsula.
<b>Criterion 5-A: commercially important (Volume)</b>	<i>Porphyra yezoensis</i> , <i>Laminaria japonica</i> , <i>Undaria pinnatifida</i> , <i>Gracilaria lemaneiformis</i>	Economically important species of high yield (harvest data of wild populations is not recorded separately).	Cultivated areas of Dalian district and the Shandong peninsula.
<b>Criterion 5-B: commercially important (Value)</b>	<i>Porphyra yezoensis</i> , <i>Laminaria japonica</i> , <i>Undaria pinnatifida</i> , <i>Gracilaria lemaneiformis</i>	Economically important species of high yield (total sale of wild populations were not recorded separately).	Cultivated areas of Dalian district and the Shandong peninsula,
<b>Criterion 6: intact habitat / ecological processes</b>	Not adopted	Not adopted	Not adopted

## 2.1. Selected Indicator Species under Criterion 1: Representative species/ habitat types

### Definition of Indicator Species under Criterion 1:

Representative species and/or habitat types are those species that are highly abundant in the YSE.

### Selected Indicator Species:

#### [Perforated sea lettuce] *Ulva pertusa* (Kjellman, 1897) [孔石莼, Kongshichun]

Reason for Selection:

*Ulva pertusa* has a highly abundant population in the intertidal zone of the YSE. It is considered to be one of the most abundant species because of its strong adaptability to the eutrophic seawater and high growth rate.

#### [Nori] *Porphyra yezoensis* (Ueda, 1932) [条斑紫菜, Tiaobanzicai]

Reason for Selection:

Nori has a highly abundant seasonal population in the intertidal zone of the YSE. Its thallus appears in winter and spring. It is considered to be one of the most abundant species because it covers almost all areas with suitable substrate for attachment. The alga is one of two most important mariculture species of macroalgae in China.

#### [Kelp] *Laminaria japonica* (Areschoug, 1851) [海带, Haidai]

Reason for Selection:

Kelp is an adventitious species in the YSE. It is distributed from low intertidal zones to sub-tidal zones. It is also one of the two most important mariculture species of macroalgae in China. Kelp is considered one of the most abundant species because of its wide cultivation, huge thallus and big coverage.

**[Wakame] *Undaria pinnatifida* (Harvey Suringar, 1873) [裙带菜, Qundaicai]**

Reason for Selection:

*Undaria pinnatifida* has a highly abundant population existing in the areas ranging from the low intertidal zone to the sub-tidal zone in the YSE. It is considered as one of the most abundant species because of its large thallus and high density in its habitats. It is the third most important mariculture species of macroalgae in China and Korea.

**[Gulfweed] *Sargassum confusum* (C. Agardh, 1824) [海蒿子, Haihaozi]**

Reason for Selection:

*Sargassum confusum* has a highly abundant population in areas ranging from the low intertidal zone to the sub-tidal zone of the YSE. It has large thallus and is considered to be one of the most abundant species in the YSE.

**[Gulfweed] *Sargassum thunbergii* ((Mertens ex Roth) O' Kuntze, 1893) [鼠尾藻, Shuweizao]**

Reason for Selection:

*Sargassum thunbergii* has a highly abundant population in areas ranging from the intertidal zone to the sub-tidal zone of the YSE. It has large thallus and is considered to be one of the most abundant species in the YSE.

***Gloiopeltis furcata* ((Post. et Rupr.) J. Agardh, 1851) [海萝, Hailuo]**

Reason for Selection:

*Gloiopeltis furcata* is distributed in large numbers in the intertidal zone of the YSE. It is considered to be one of the most abundant species.

***Gracilaria lemaneiformis* ((Bory) Weber-van Bosse, 1928) [龙须菜, Longxucai]**

Reason for Selection:

*Gracilaria lemaneiformis* is a common macroalga in the intertidal zone of the YSE. It is considered to be one of the most abundant species because of its large population size. As an economic species it is the fourth most important mariculture species of macroalga in the YSE.

**Definition of Ecologically Important Areas for the Selected Indicator Species:**

Ecologically important areas of the selected species are defined as these species' major areas of distribution.

**2.2. Selected Indicator Species under Criterion 2: Endemism and unique species assemblages**

**Definition of Indicator Species under Criterion 2:**

The endemic species of algae or macroalgae only found or recorded in the YSE.

**Selected Indicator Species:**

**[Nori] *Porphyra katadae* var. *hemiphylla* (C.K. Tseng et T.J. Chang, 1978) [半叶紫菜华北变型, Banyezicaihuabeibianxing]**

Reason for Selection: it has only been recorded in the YSE.

**[Nori] *Porphyra oligospermatangia* (Tseng et Zheng, 1981) [少精紫菜, Shaojingzicai]**

Reason for Selection: it has only been recorded in the YSE.

***Solieria tenuis* (Xia E. Z. et Zhang, 1984) [细弱红翎菜, Xiruohonglingcai]**

Reason for Selection: it has only been recorded in the YSE.

***Tsengia nakamurae* ((Yendo) Fan et Fan, 1962) [曾氏藻, Zengshizao]**

Reason for Selection: it has only been recorded in the YSE.

***Tsengiella spinulosa* (Zhang et Xia, 1987) [曾氏刺边藻, Zengshicibianzao]**

Reason for Selection: it has only been recorded in the YSE.

**[Gulfweed] *Sargassum qingdaoense* (Tseng et Lu, 2000) [青岛马尾藻, Qingdaomaweizao]**

Reason for Selection: it has only been recorded in the YSE.

**[Carrageen] *Silvetia siliquosa* ((Tseng et Chang) Serrão, Cho, Boo et Brawley, 1999) [鹿角菜, Lujiaocai]**

Reason for Selection: it has only been recorded in the YSE.

**Definition of Ecologically Important Areas for the Selected Indicator Species: Areas of distribution of these species.**

**2.3. Selected Indicator Species under Criterion 4: Species of Special Concern**

**Definition of Indicator Species under Criterion 4:**

Species that were once common but experienced declines in populations recently were selected as Indicator Species.

**Selected Indicator Species:**

**[Nori] *Porphyra tenera* (Kjellman, 1897) [甘紫菜, Ganzicai]**

Reason for Selection: this species was once common in the YSE and was used as a typical species for the study of the history of red algal genera *Porphyra*. It is currently rarely found in this ecoregion.

***Hizikia fusiformis* ((Harvey) Okamura, 1932) [羊栖菜, Yangqicai]**

Reason for Selection: this species is large and edible. It is not found in the YSE now because of over-collection.

**[Carrageen] *Silvetia siliquosa* ((Tseng et Chang) Serrão, Cho, Boo et Brawley, 1999) [鹿角菜, Lujiaocai]**

Reason for Selection: This edible species is rarely found in the YSE now because of over-collection.

**2.4. Selected Indicator Species under Criterion 4: commercially important in terms of volume**

**Definition of Indicator Species under Criterion 5-A:**

Economically important species of high yield.

*Laminaria japonica*, *Porphyra yezoensis*, *Undaria pinnatifida*, *Gracilaria lemaneiformis* are the top four cultured maroalgae species in the YSE in terms of yield.

**2.5. Selected Indicator Species under Criterion 5-B: commercially important in terms of value**

**Definition of Indicator Species under Criterion 5-B:**

Economically important species of high output value.

*Porphyra yezoensis*, *Laminaria japonica*, *Undaria pinnatifida*, *Gracilaria lemaneiformis* are the top four cultured macroalgae species in YSE in terms of output value.

**Table. 2 List of selected Indicator Species**

Adopted Criteria Selected Indicator Species	Criterion 1: Representative species/ habitat types	Criterion 2:Endemism and unique species assemblages	Criterion 4:Species of Special Concern	Criterion 5A: commercially important (Volume)	Criterion 5B: commercially important (Value)
Chlorophyta					
<i>Ulva pertusa</i>	X				
Phaeophyta					
<i>Laminaria japonica</i>	X			X	X
<i>Sargassum thunbergii</i>	X				
<i>Sargassum confusum</i>	X				
<i>Undaria pinnatifida</i>	X			X	X
<i>Silvetia siliquosa</i>		X	X		
<i>Sargassum qingdaoense</i>		X			
<i>Hizikia fusiformis</i>			X		
Rhodophyta					
<i>Porphyra yezoensis</i>	X			X	X
<i>Gracilaria lemaneiformis</i>	X			X	X
<i>Gloiopeltis furcata</i>	X				
<i>Porphyra katadae</i> var. <i>hemiphylla</i>		X			
<i>Tsengiella spinulosa</i>		X			
<i>Tsengia nakamurae</i>		X			
<i>Solieria tenuis</i>		X			
<i>Porphyra oligospermatangia</i>		X			
<i>porphyra tenera</i>			X		

Note: X indicates that the species was selected under the corresponding criterion.

**4. Maps and Description of Ecologically Important Areas for Algae Taxonomic Group**

The Shandong Peninsula

The Liaodong Peninsula

**4.1. Table 3. List of Maps, Area Numbers, and Area Names for Algae Ecologically Important Areas**

Map Number	Indicator Species	Algae Ecologically Important Areas	
Map 1	<i>Ulva pertusa</i>	The Shandong Peninsula	The Liaodong Peninsula
Map2	<i>Hizikia fusiformis</i>	The Shandong Peninsula	The Liaodong Peninsula
Map3	<i>Laminaria japonica</i>	The Shandong Peninsula	The Liaodong Peninsula
Map4	<i>Sargassum qingdaoense</i>	The Shandong Peninsula	
Map5	<i>Sargassum confusum</i>	The Shandong Peninsula	The Liaodong Peninsula
Map6	<i>Sargassum thunbergii</i>	The Shandong Peninsula	The Liaodong Peninsula
Map7	<i>Silvetia siliquosa</i>	The Shandong Peninsula	The Liaodong Peninsula
Map8	<i>Undaria pinnatifida</i>	The Shandong Peninsula	The Liaodong Peninsula

Map9	<i>Gloiopeltis furcata</i>	The Shandong Peninsula	The Liaodong Peninsula
Map10	<i>Gracilaria lemaneiformis</i>	The Shandong Peninsula	
Map11	<i>Porphyra katadae</i> var. <i>hemiphylla</i>	The Shandong Peninsula	The Liaodong Peninsula
Map12	<i>Porphyra oligospermatangia</i>	The Shandong Peninsula	
Map13	<i>Porphyra tenera</i>	The Shandong Peninsula	The Liaodong Peninsula
Map14	<i>Porphyra yezoensis</i>	The Shandong Peninsula	The Liaodong Peninsula
Map15	<i>Solieria tenuis</i>	The Shandong Peninsula	The Liaodong Peninsula
Map16	<i>Tsengia nakamurae</i>	The Shandong Peninsula	The Liaodong Peninsula
Map17	<i>Tsengiella spinulosa</i>	The Shandong Peninsula	The Liaodong Peninsula

## 4.2. Brief Introduction to the two major algae distribution areas

### 4.2.1. The Shandong Peninsula

#### Location and environmental setting:

The Shandong Peninsula is the largest peninsula in China. Stretching out between the Bohai Sea and the Yellow Sea, the Peninsula has an indented coastline with a total length of 3,000 kilometres. Dotted by numerous bays, capes, islands and islets, the Peninsula has some of China's best ports, including the ports of Qingdao and Yantai.

The substrate of the nearshore area is largely rocky. Most species of algae (more than 150) distributed in YSE can be found in the area. Since almost all early studies, surveys, and cultivation experiments of algae started on this peninsula (particular in the city of Qingdao), it is regarded as China's cradle of algal research.

#### Knowledge gaps and specific studies needed:

At present, studies on marine benthic algae are focused only on the intertidal zone due to limitations in research conditions such as lack of diving equipment. Algae population and biology in the extensive subtidal zone are poorly known and need to be further studied.

### 4.2.2. The Liaodong Peninsula

#### Location and environmental setting:

Situated in northeast China, the Liaodong Peninsula is China's second largest peninsula, facing the Shandong Peninsula in the south across the Bohai Straits. It partly separates the Bohai Sea on the west from the Korea Bay on the east. The Peninsula's coastline is about 2200 kilometers. The south coast is rocky, dotted with large numbers of bays; the northeast coast is muddy with wide, flat beaches; and the coast in the middle is generally gritty.

In China, the Liaodong Peninsula's ecological importance to marine algae is second only to the Shandong Peninsula. Like the later, the Liaodong Peninsula's uniqueness in geographical position, substrates, and system of sea currents contributes to its status as the distribution centre of marine algae.

#### Knowledge gaps and specific studies needed:

At present, studies on marine benthic algae are focused only on the intertidal zone due to limitations in research conditions such as lack of dive equipment. Algae population and biology in the extensive subtidal zone are poorly known.

## 4.3. Algae Ecologically Important Area (AEIA) by Species

### 4.3.1. AEIA for *Ulva pertusa* (Map 1)

Area Name: The Shandong Peninsula And the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Ulva pertusa* is a dominant species in the area. As a green alga, it has strong adaptability to eutrophic

seawater. The possibility of using this species to reduce organic pollution needs to be explored. The prospect for cultivation also needs to be further examined.

#### 4.3.2. AEIA for *Hizikia fusiformis* (Map 2)

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Hizikia fusiformis* is an edible alga. As a valued seaweed, its population declined due to over-collection by local people. More studies on the natural populations and their conservation are needed.

#### 4.3.3. AEIA for *Laminaria japonica* (Map 3)

Area Name: The Shandong Peninsula

Area Name: The Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Laminaria japonica* is an exotic species in China, and it is also a dominant species in the YSE. As a classic case of Chinese algal cultivation, the biology of *Laminaria japonica* has been extensively studied.

#### 4.3.4. AEIA for *Sargassum qingdaoense* (Map 4)

Area Name: The Shandong Peninsula

Knowledge gaps and specific studies needed:

*Sargassum qingdaoense* is only found in the coastal waters around Qingdao. Except for taxonomical knowledge, the biology of this species has not been studied.

#### 4.3.5. AEIA for *Sargassum confusum* (Map 5)

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Sargassum confusum* is a dominant species in the YSE. This species is experiencing a decline in the size of its population and the underlying reasons need to be investigated.

#### 4.3.6. AEIA for *Sargassum thunbergii* (Map 6)

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

Like *Sargassum confusum*, *Sargassum thunbergii* is a dominant species in the YSE. *Sargassum thunbergii* is generally distributed along the intertidal zone. At present, there are some attempts to cultivate this alga as feed for abalone and sea cucumber. The biology of *Sargassum thunbergii* remains largely unknown except for its taxonomy.

#### 4.3.7. AEIA for *Silvetia siliquosa* (Map 7)

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Silvetia siliquosa* is also edible. The biology of *Sargassum thunbergii* remains largely unknown except for its taxonomy.

#### 4.3.8. AEIA for *Undaria pinnatifida* (Map 8)

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Undaria pinnatifida* is a dominant species in the YSE. It is distributed mainly in areas ranging from the low intertidal zone to the subtidal zone. It has been farmed for years, but its basic biology has not been fully studied.

#### **4.3.9. AEIA for *Gloiopeltis furcata* (Map 9)**

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Gloiopeltis furcata* is a dominant species in the area. Except for the taxonomy, the biology of this red alga remains largely unknown.

#### **4.3.10. AEIA for *Gracilaria lemaneiformis* (Map 10)**

Area Name: The Shandong Peninsula

Knowledge gaps and specific studies needed:

Wild *Gracilaria lemaneiformis* is distributed along the coast of the Shandong Province. The biology of this species is relatively well studied.

#### **4.3.11. AEIA for *Porphyra katadae* var. *hemiphylla* (Map 11)**

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Porphyra katadae* var. *hemiphylla* is endemic to the west coast of the Yellow Sea. Its biology remains largely unknown.

#### **4.3.12. Algae Ecologically Important Area for *Porphyra oligospermatangia* (Map 12)**

Area Name: The Shandong Peninsula

Knowledge gaps and specific studies needed:

*Porphyra oligospermatangia* is an endemic species of the west coast of the Yellow Sea. Its biology remains largely unknown.

#### **4.3.13. AEIA for *Porphyra tenera* (Map 13)**

Area Name: The Shandong Peninsula the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Porphyra tenera* was used as a typical species for the study of the biology of red algal genera *Porphyra*. However in recent years, this species has not been found in the YSE under China's jurisdiction. Surveys need to be conducted to clarify the presence of *Porphyra tenera* in its historical habitats.

#### **4.3.14. AEIA for *Porphyra yezoensis* (Map 14)**

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

This important economic species has been studied in detail. At present, no significant gaps remain to be filled.

#### **4.3.15. AEIA for *Solieria tenuis* (Map 15)**



Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Solieria tenuis* is endemic to the west coast the Yellow Sea. The biology of this alga remains largely unknown except for the taxonomy.

#### 4.3.16. AEIA for *Tsengia nakamurae* (Map 16)

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Tsengia nakamurae* endemic to the west coast of the Yellow Sea and the biology of this alga is largely unknown.

#### 4.3.17. AEIA for *Tsengiella spinulosa* (Map 17)

Area Name: The Shandong Peninsula and the Liaodong Peninsula

Knowledge gaps and specific studies needed:

*Tsengiella spinulosa* is endemic to the coast of the west Yellow Sea. The biology of this alga is largely unknown.

### Knowledge Gaps and specific studies needed for Algae of the YSE

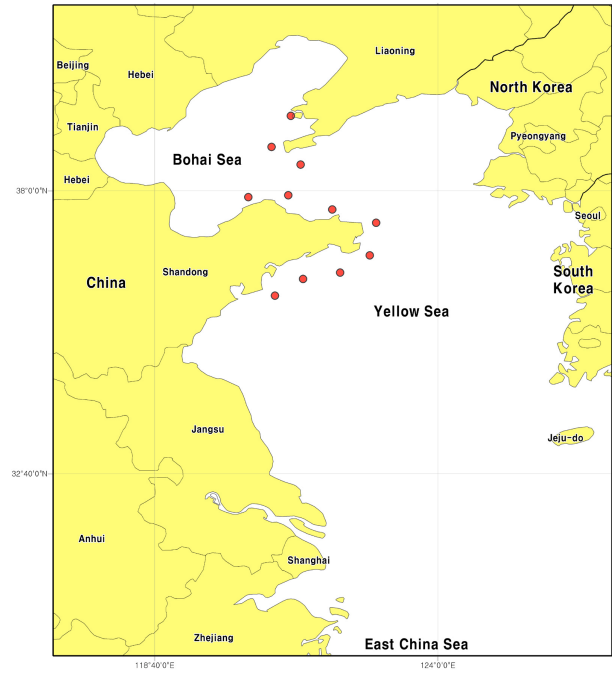
In addition to the knowledge gaps specific to these listed Indicator Species, information at the ecosystem level on the subtidal zone and areas around some remote and uninhabited islands is not available.

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Map 1 *Ulva pertusa*



Map 2 *Hizikia fusiformis*



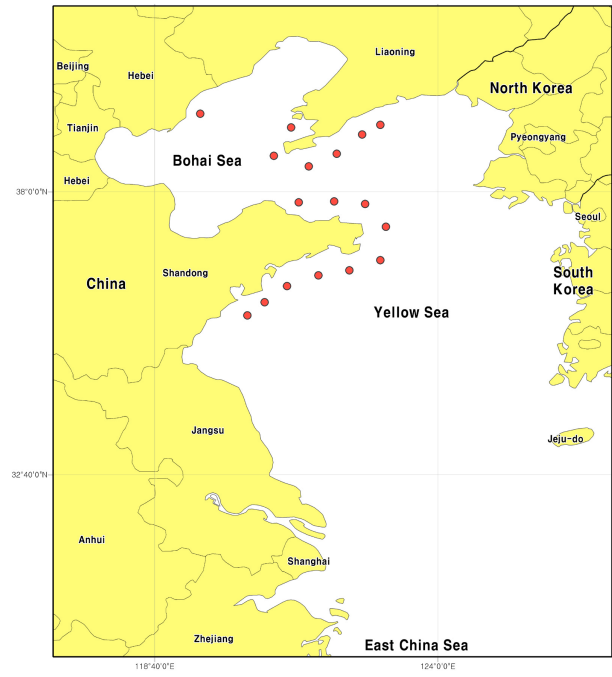
Map 3 *Laminaria japonica*



Map 4 *Sargassum qingdaoense*



Map 5 *Sargassum confusum*



Map 6 *Sargassum thunbergii*



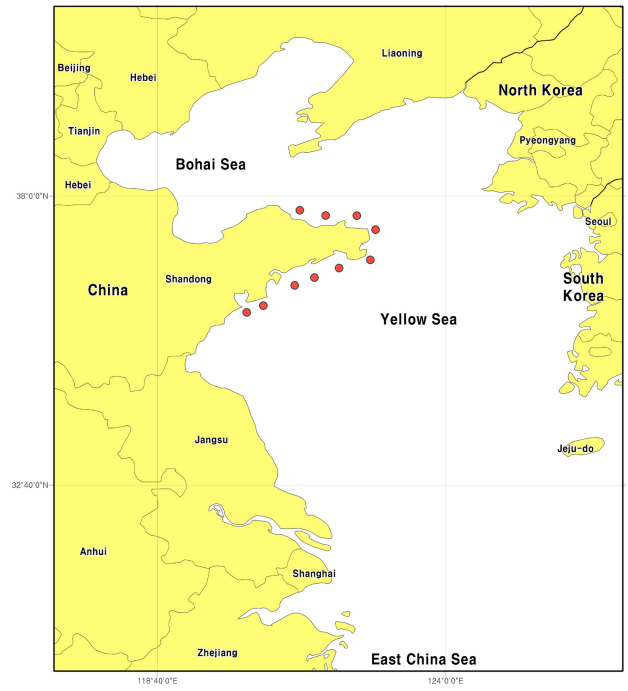
Map 7 *Silvetia siliquosa*



Map 8 *Undaria pinnatifida*



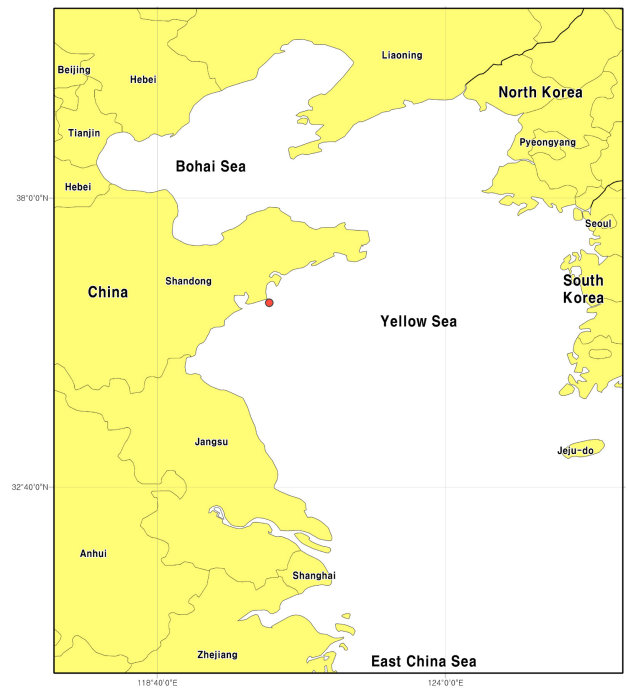
Map 9 *Gloiopeltis furcata*



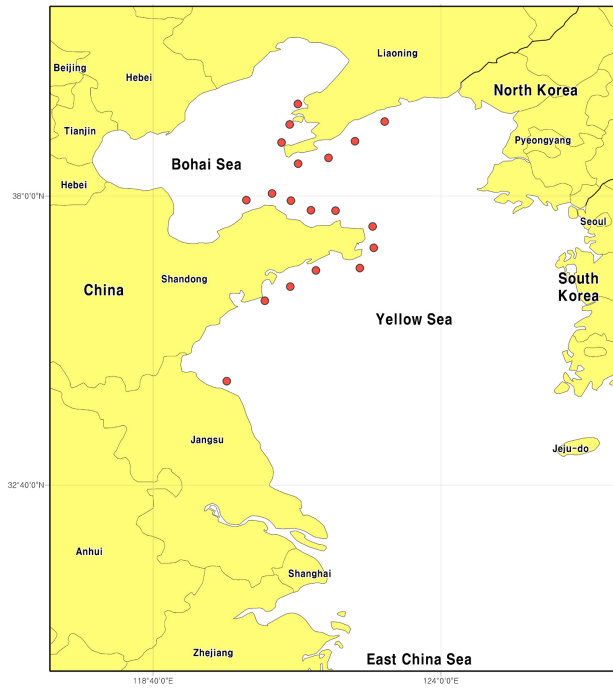
Map 10 *Gracilaria lemaneiformis*



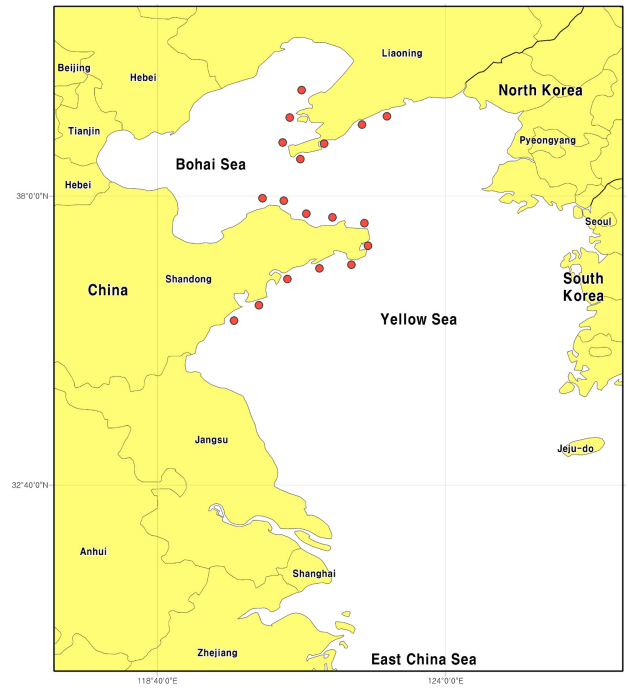
Map 11 *Porphyra katadae* var. *hemiphylla*



Map 12 *Porphyra oligospermatangia*



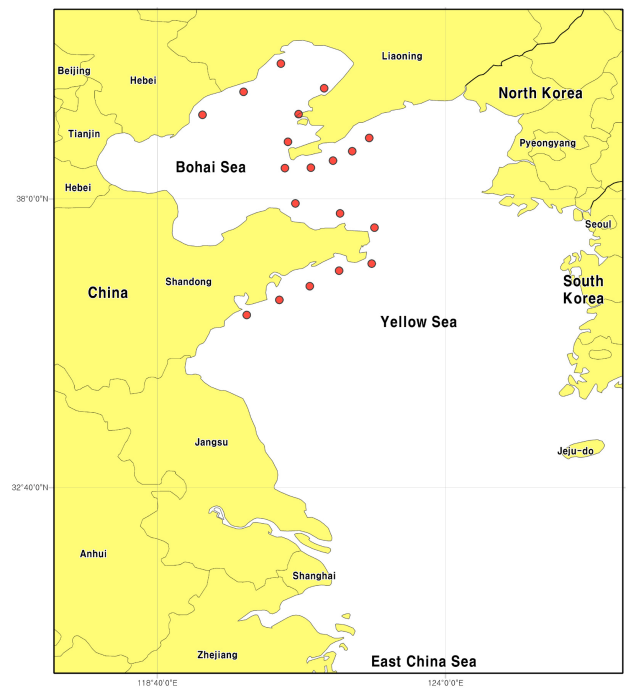
Map 13 *Porphyra tenera*



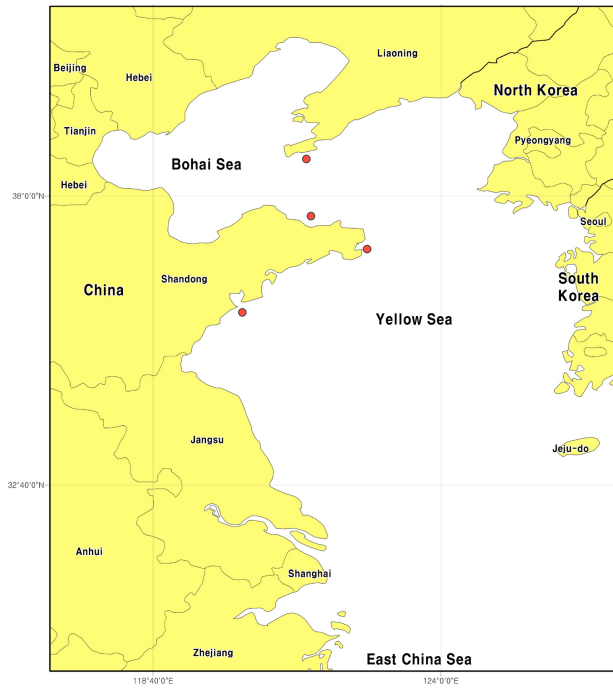
Map 14 *Porphyra yezoensis*



Map 15 *Solieria tenuis*



Map 16 *Tsengia nakamurae*



Map 17 *Tsengiella spinulosa*