Identification of Critical Habitats

UNDP/GEF Yellow Sea Large Marine Ecosystem Project

Habitat Classification and Selection of Representative Habitats in the Yellow Sea Coast of China

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Abstract

Intertidal and subtidal areas of the Yellow Sea coast of China are classified into eight Ramsar categories (permanent shallow marine waters, subtidal aquatic beds, rocky shores, sand or pebble shores, estuary, intertidal flats, intertidal marshes, and coastal brackish/saline lagoons) and representative habitats are given for each category. The study area covers the Yellow Sea coast of Liaoning, Shandong and Jiangsu Provinces, encompassing from West Bank of Yalu River Estuary on the north to North Bank of Changjiang (Yangtze) River Estuary on the south. The habitats are described with information on their geographical locations and scales, integrity (fragmentation due to reduction in ecosystem function), continuity (linkage with other habitats), biodiversity (noteworthy funa/flora, status of protection, etc.) and human impacts. Finally these habitats are scored based on a system with a weighting of 40% for habitat characteristics (area, integrity and continuity) and 60% for biodiversity, and three most representative habitats are suggested as potential sites for demonstration of biodiversity management.

Introduction

The Yellow Sea coast of China presents diverse habitats and host numerous marine organisms of which over one thousand species have been identified. However, many of these habitats are facing pressures from coastal development of human society and the biodiversity hereof is threatened. To abate such problems, UNDP/GEF has launched the project "Reducing Environmental Stress in the Yellow Sea Large Marine Ecosystem". The project thus has the transboundary analysis of the problems and is preparing for a series of activities to demonstrate the management effects in its five components including biodiversity. As part of the activities, this report is to prepare expertise and technical background to select the most representative habitat(s) for demonstration of biodiversity management.

Studies have been conducted in this region on description of marine/coastal wetlands (Bao et al. 1991; Wang et al. 1991; Xia et al. 1991; Chen et al. 1998; UNDP/GEF 2007) and identification of potential important/priority areas for biodiversity conservation (WWF et al. 2006). The book series Bays in China, first published seventeen years ago, focus on description of coastal bays and estuaries, but also information on other types of habitats that were included in or attached to the bays. The study by WWF et al. (2006) was based on species and provided important information, but the overlap of important areas for different biological groups present uncertainty and difficulty in practical application. This study attempted to use the community approach to identify representative habitats for the marine/coastal wetlands and was expected to further limit the priority areas for biodiversity conservation.

Materials and methods

The Yellow Sea coast of China was studied, spanning from West Bank of Yalu River Estuary on the north to North Bank of Changjiang (Yangtze) River Estuary on the south encompassing eight degrees of latitudes, consisting of the east coast of Liaoning Province, east and south coast of Shandong and the entire coast of Jiangsu.

Ramsar categories for marine/coastal wetlands were employed to classify the types of habitats. These categories include twelve types of wetlands:

A -- Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.

B -- Marine subtidal aquatic beds; includes kelp beds, sea-grass beds, tropical marine meadows.

C -- Coral reefs.

D -- Rocky marine shores; includes rocky offshore islands, sea cliffs.

E -- Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.

F -- Estuarine waters; permanent water of estuaries and estuarine systems of deltas.

G -- Intertidal mud, sand or salt flats.

H -- Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.

I -- Intertidal forested wetlands; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.

J -- Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.

K -- Coastal freshwater lagoons; includes freshwater delta lagoons.

Zk(a) – Karst and other subterranean hydrological systems, marine/coastal.

Only existing, public accessible information was used in this study. The book series Bays in China, first published seventeen years ago, focus on description of coastal bays and estuaries, but also contain information on other types of habitats that were included in or attached to the bays, therefore give thorough and systematic description of the marine/coastal wetlands and were used as the major reference material of this study.

The representative habitats for each suitable category were screened mainly according to their biodiversity (through literature review, site visit and expert consultancy) and availability of information needed.

To further select three most representative habitats from the above screened list, a scoring system out of 100 was used (Table 1). This system included indicators of area, integrity (fragmentation due to reduction in ecosystem function), continuity (linkage with other habitats) and biodiversity (noteworthy fauna/flora, status of protection, etc.), where biodiversity has a weight of 60% and the rest three (habitat characteristics) have a weight of 40%. The three most representative habitats were then defined based both on their score value and the significance of the wetland type represented.

Table 1. Criteria for scoring the representation of habitats

Area	Integrity	Continuity	Noteworthy fauna	Noteworthy flora	Protection status	Human impact
2, $<10^2$ha	5, Low	5, Low	5, with general significance	5, with general significance	2, with general awareness	0, High
4, $\geq10^2$ha	10, Moderate	10, Moderate	10, with supporting value	10, with supporting value	4, among local list of importance	5, Moderate
6, $\geq10^3$ha	15, High	15, High	15, with economic value	15, with economic value	6, among provincial list of importance	10, Low
8, $\geq10^4$ha			20, with international or national importance	20, with international or national importance	8, among national list of importance	
10, $\geq10^5$ha					10, among international list of importance	

Results

1. Classification of the wetland types in the Yellow Sea coast of China

A total of eight types of wetlands were identified. These include:

- Permanent shallow marine waters (in most cases less than six meters deep at low tide), includes sea bays and straits;
- Marine subtidal aquatic beds; includes kelp beds, sea-grass beds;
- Rocky marine shores; includes rocky offshore islands, sea cliffs;
- Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks;
- Estuarine waters; permanent water of estuaries and estuarine systems of deltas;
- Intertidal mud, sand or salt flats;
- Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes; and
- Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.

In the Yellow Sea coast of China, permanent shallow marine waters are the most abundant marine/coastal wetlands, intertidal flats and marshes make the next largest area, and seagrass beds are the most unique type of wetlands.

From the aspect of geographical distribution, Shandong Province has the highest variety

and quantity of marine/coastal wetlands, Liaoning the next, and Jiangsu the lowest with only one bay, one signicant estuary, one large sand/mud flat and one large coastal marsh.

2. Representative habitats

Twenty representative habitats were found for the eight types of the marine/coastal wetlands (Table 2 and Figure 1).

2.1. Permanent shallow marine waters

More than twenty bays (most in Shandong and only one in Jiangsu) in the Yellow Sea were included in the book series Bays in China. Among them, Haizhou Bay (Shandong, Rizhao and Jiangsu, Lianyungang) is the largest, but contains mainly intertidal flats and serves mainly as navigation industrial zone. Jiaozhou Bay (Shandong, Qingdao) and Sanggou Bay (Shangdong, Weihai) are next two largest bays, where the former is known as an important fisheries resource and the latter as the largest base for aquaculture in north China. Both Jiaozhou and Sanggou Bays have received extensive studies thus rich in biodiversity information and were screened as representative habitats of this type.

2.2. Marine subtidal aquatic beds

Seagrass beds were believed to widely exist along the coast of Liaoning and Shandong Peninsular and those of the Bohai Sea, where canopy coverage in many cases reached 75% and biomass amounted to above 1000 g/m^2 (Yang 1979; Yang & Wu 1981). However, these seagrass beds are difficult to find nowadays, except the seagrass/algal beds off Rongcheng (Shandong, Weihai), and they were screened.

2.3. Rocky marine shores

The rocky shores are mainly located in Liaoning and Shandong. Many of those in Liaoning have been modified/polluted due to human activities. Those in Shandong mainly occurs in Weihai and Qingdao and two significant zones those off Rongcheng (Shandong, Weihai) and Laoshan (Shandong, Qingdao) were screened.

2.4. Sand, shingle or pebble shores

These wetlands lack of biodiversity information and sand shores make the most of this type. The Stoneman Beach and Golden Beach (Shandong, Qingdao) are the most well known sand shores, and Jinshitan coastal landform (Liaoning, Dalian) is the known shingle shore,

therefore they were screened.

2.5. Estuarine waters

About twenty seasonal rivers (excluding Changjiang/Yangtze River) drain into Yellow Sea, of which only Yalu River (Liaoning) and Guan River (Jiangsu) present significant flows and estuaries and were included in the book series Bays in China. Dagu River (Shandong, running into Jiaozhou Bay) and Zhuang River (Liaoning) are another two with estuaries and known as important wetlands. Therefore, these four habitats were screened..

2.6. Intertidal mud, sand or salt flats

This type occurs with the largest area in Jiangsu and that near Batan Town is the largest. Qingdao also has large mud/sand flats. Three habitats, Batan intertidal flat (Jiangsu), Aoshanwei (Shandong, Qingdao) and Golden Beach (Shandong, Qingdao) were screened.

2.7. Intertidal marshes

The most famous intertidal marshes are those in the Yancheng Coast and Yalu River Estuary Wetland (Liaoning). The marsh in Rongcheng is the only urban wetland in China. Therefore, these three habitats were screened, respectively the Rongcheng Urban Marsh (Shandong), the Yalu River Estuary Wetland (Liaoning) and the Yancheng Coastal Marsh (Jiangsu).

2.8. Coastal brackish/saline lagoons

There are not many coastal brackish/saline lagoons. Chaoyanggang and Mashagang (both of Shandong, Weihai) are the largest and were screened.

Table 2. Representative marine/coastal habitats in Yellow Sea coast of China.

Wetland type*	Habitat name	Location & Administration	Area (ha) & Integrity(High, Moderate,Low)	Continuity with other significant/ representative habitat(s)	Noteworthy fauna/flora	Status of protection	Human impact	Reference
A. Permanent shallow marine waters	A1. Jiaozhou Bay	36°01′N 120°16′E Qingdao City Shandong Province	25,000 H	(B), D, E, F, G	Manila clam & other commercial bivalves, shrimps, crabs, octopuses & cuttlefish, finfishes, seagulls, porpoise	Among the List of National Critical Wetlands	Moderate-high: ship navigation, fishing, marine engineering projects, pollution, aquaculture	1,2
	A2. Sanggou Bay	37°05′N 122°34′E Rongcheng (county)City Shandong Province	14,000 M (due to massive longline culture)	B, D, E, F, G, H, J	Numerous molluscs, sea cucumber, macroalgae, shrimps, crabs, finfishes, seagull, teal, swan, egret	County level	Moderate: aquaculture	3
B. Marine subtidal aquatic beds	B1. Seagrass/algal beds off Rongcheng	37°02-21′N 122°34′E Rongcheng (county)City Shandong Province	>1,000 H/M	A, D, E, F, G, H, J	*Zostera marina*, macroalgae, commercial species (mollusks, sea cucumber, crabs, sea horse/dragon), spawn-/nursing ground for finfishes, sea birds	Some within National Swan Nature Reserve, among provincial list of planned marine protected areas	Low/Moderate: aquaculture	3, 4
D. Rocky marine shores	D1. Rocky shore off Rongcheng	36°57-37°21′N 122°34′E Rongcheng (county)City Shandong Province	H/M	A, B, E, G, J	Macroalgae, commercial species (abalone, sea cucumber)	Some within Provincial Chengshantou Marine Ecosystem Reserve	Low/Moderate: coastal engineering porjects	5
	D2. Laoshan coast	36°06′N 120°35-42′E Qingdao City Shandong Province	H/M	A, B, E	Macroalgae, commercial species (abalone, sea cucumber)	Close to reserves of Qingdao	Low	5

Wetland type*	Habitat name	Location & Administration	Area (ha) & Integrity(High, Moderate,Low)	Continuity with other significant/ representative habitat(s)	Noteworthy fauna/flora	Status of protection	Human impact	Reference
E. Sand, shingle or pebble shores	E1. Stoneman Beach	36°05′N 120°28′E Qingdao City Shandong Province	800 H	A, D, G	N/A	N/A	Moderate: Human recreation activities	5
	E2. Golden Beach	35°58′N 120°15′E Qingdao City Shandong Province	105 H	A, D, G	N/A	N/A	Moderate: Human recreation activities	5
	E3. Dalian Jinshitan coastal landform	39°37.5′-39°41′N 122°57.7′-123°07′E Dalian City Liaoning Province	H	A	N/A (geological remains and fossils)	City level reserve	Low	6
F. Estuarine waters	F1. Yalu River Estuary	39°50′N 124°8′E Dandong City Liaoning Province	3,200 M/L (due to limited river flow)	A, G, H	Spawning ground for fishes, clams, shrimps See also H1	National Yalu River Estuary Wetland Reserve	High-Moderate: Coastal reclamation, reduced river flow, pollution	7
	F2. Guan River Estuary	34°28′N 119°48′E Lianyungang City Jiangsu Province	560 M	A, E, G, H	Some crustaceans, seagrass in salt pans	Close to National Yancheng Wetland Reserve	High-Moderate: Coastal reclamation, pollution	7
	F3. Zhuang River Estuary	39°37.5′-39°41′N 122°57.7′-123°07′E Dalian City Liaoning Province	100 M	A, G, H	Sea birds (egrets)	Among the List of National Critical Wetlands	High-Moderate: Coastal reclamation, pollution	2
	F4. Dagu River Estuary	36°11′N 120°08′E Qingdao City Shandong Province	70 M	A, G, H	Sea birds	Among the List of National Critical Wetlands	High-Moderate: Reduced water flow, pollution	2
G. Intertidal mud, sand or salt flats	G1. Batan Intertidal flat	34°24′N 119°50′-120°16′E Yancheng City Jiangsu Province	11,600 H	A, E, F, H	N/A	N/A	High-Moderate: Reclamation, pollution	5
	G2. Aoshanwei	36°17-28′N 120°42′E Qingdao City	6,000 H	A, D	Commericial spp. (sea cucumber, bivalves)	Among the planned area for National Ocean Research	Low-Moderate: Aquaculture	5, 8

Wetland type*	Habitat name	Location & Administration	Area (ha) & Integrity(High, Moderate,Low)	Continuity with other significant/ representative habitat(s)	Noteworthy fauna/flora	Status of protection	Human impact	Reference
		Shandong Province				Center		
	G3. Golden Beach	35°58′N 120°15′E Qingdao City Shandong Province	105 H	A, D, G	Clams	N/A	High-Moderate: Reclamation, human recreation activities	N/A
H. Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.	H1. Rongcheng Urban Marsh	37°7.8′N 122°27′E Rongcheng (county)City Shandong Province	410 H	A, F, J	Reed as founding plant, with over 50 other plant species and 93 avian species	Established as National Urban Wetland Park, Among the National List of Important Wetlands	Moderate: Functioning as sewage treatment wetland	2, 9, 10
	H2. Yalu River Estuary Wetland	39°47′27″-39°49′41″ N, 120°30′50″-124°4′56 ″E Dandong City Liaoning Province	14, 642 H/M(outside of the core zone)	A, F, G	Reed & 288 plant species; Clams, feeding ground of marine organisms; Over 210,000 sea birds from 240 species including 8 first-class and 29 second-class national protected wildlives and over 10 internationally important species; Amphibians; Dotted seal	National Reserve, among the List of International Critical Wetlands & the Protection Network for East Asia-Australia Migrating Birds	High-Moderate: Reclamation & aquaculture activities outside of the core zone, pollution	2, 11, 12, 13
	H3. Yancheng Coastal Marsh	32°34′-34°28′N; 119°48′-120°56′E Yancheng City Jiangsu Province	453,000 H/M(outside of the core zone)	A, F, G	Reed and spartina as founder plants. 43 coelenterate species, 65 annelid species, 156 mollusk species, 139 carapace species, 310 insect species, 281 fishes, 45 amphibian and reptile species, 379 avian species and 47 mammal species. 12 species of the	National Reserve, among the List of International Critical Wetlands & the MAB (Man & Biosphere) Network	High-Moderate: Reclamation & aquaculture activities outside of the core zone, pollution	2, 14, 15, 16, 17, 18

Wetland type*	Habitat name	Location & Administration	Area (ha) & Integrity(High, Moderate,Low)	Continuity with other significant/ representative habitat(s)	Noteworthy fauna/flora	Status of protection	Human impact	Reference
					National First-class Protected Wildlives include 3 cranes, 2 storks, Chinese merganser, relicts gull, great bustard, 2 eagles, and paddlefish. 67 species of the National Second -class protected wildlives include water deer, black-faced spoonbill and whooper swan etc.			
J. Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.	J1. Chaoyanggang	37°24′N 122°28′E Rongcheng (county)City Shandong Province	108,00 H	A, B, D, E, G, H	Swan, sea cucumber, *Zostera marina* & *Ruppia maritima*, clams, shrimps and crabs, finfishes	Part of National Swan Reserve	Moderate: Reduced exchange of seawater, aquaculture	3, 19, 20
	J2. Mashangang (Moon Lake)	37°214′N 122°34′E Rongcheng (county)City Shandong Province	4,800 H	A, B, D, E, G, H	Swan, sea cucumber, *Zostera marina* & *Ruppia maritima*, clams, shrimps and crabs, finfishes	Part of National Swan Reserve	Moderate: Reduced exchange of seawater, aquaculture	3, 19, 20

* To keep accordance, same coding (A~J) is used here as those in the Ramsar list of marine/coastal wetland types.

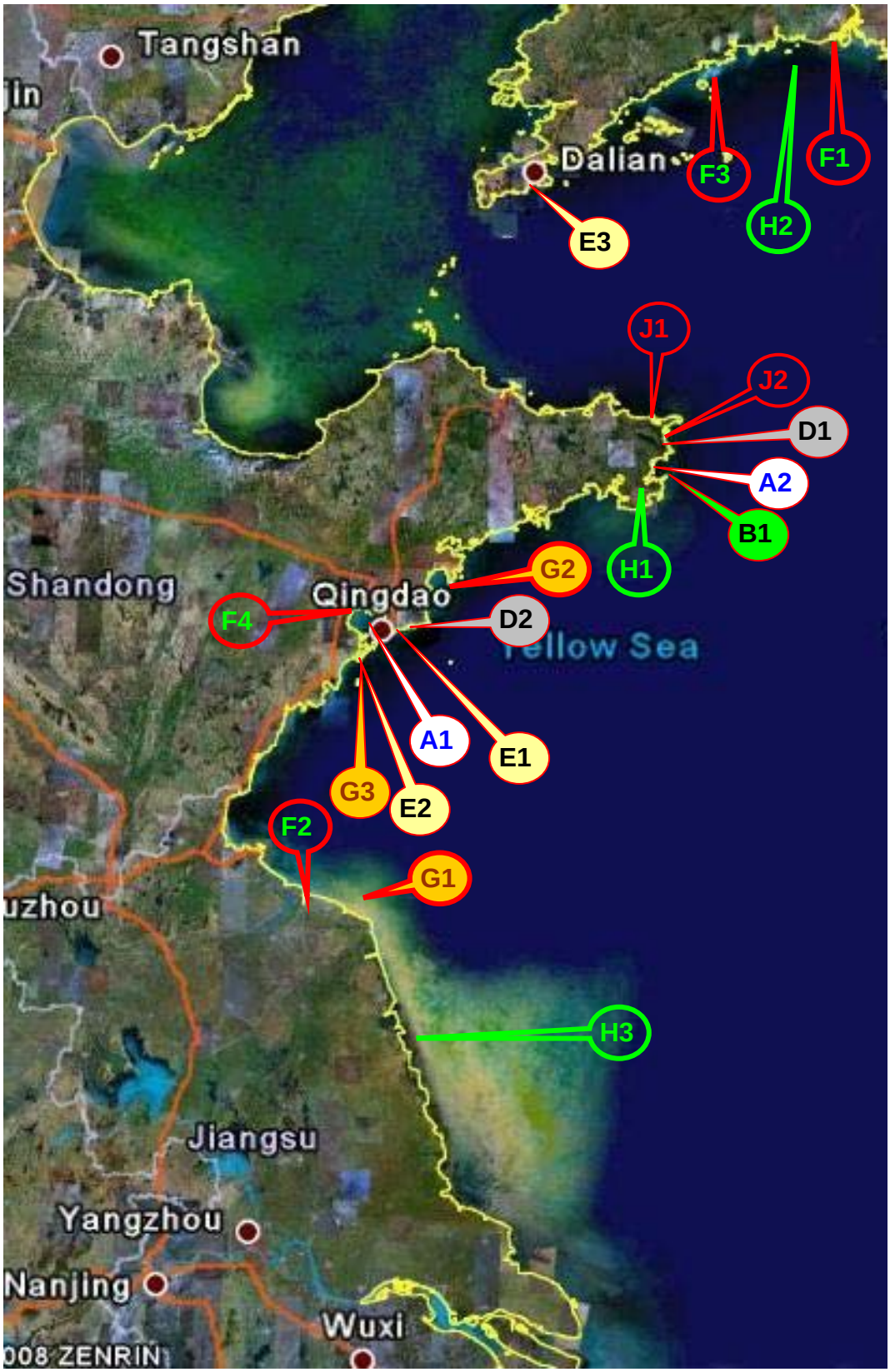

Figure 1. Locations of the representative coastal habitats (see Table 2 for coding).

3. Three most representative habitats

The above twenty representative habitats were scored (Table 3) using the 40:60 (characteristics: biodiversity) weighing method. According to the scores, ten habitats ranked to the first eighth, each with a score above or equal to 70. The seagrass/algal beds off Rongcheng (B1 in Figure 1; Shandong, Weihai) and Jiaozhou Bay (A1 in Figure 1; Shandong, Qingdao) ranked top two. They are the best of the seagrass/algal beds and coastal bays and were suggested as most representative.

For another most representative habitat, additional criteria were used to assist selection. These include the significance of the wetland type and balance between geographical areas (trying to cover a wider scale from north to south). The Yellow Sea coast of China has the second largest coastal marshes in Asia, which mainly locates in the coast of Jiangsu and Liaoning (Yalu River Estuary Wetland). The other two that were suggested as most representative habitats both locate in Shandong Province. Therefore the Yalu River Estuary Wetland (H2 in Figure 1) was suggested as the third most representative habitats.

Table 3. Score and ordering of the twenty representative habitats in the Yellow Sea coast of China (next page).

Wetland type	Habitat name	Characteristics (out of 40)			Biodiversity (out of 60)				Total score	Order of score
		Area (10)	Integrity (15)	Continuity (15)	Noteworthy fauna (20)	Noteworthy flora (10)	Protection status (10)	Human impact (10)		
A. Permanent shallow marine waters	A1.Jiaozhou Bay	8	14	10	20	15	8	3	78	2
	A2.Sanggou Bay	8	10	15	15	15	8	5	76	4
B. Marine subtidal aquatic beds	B1.Seagrass/algal beds off Rongcheng	6	13	15	20	20	10	8	92	1
D. Rocky marine shores	D1.Rongcheng shore	6	13	11	15	10	6	8	69	8
	D2.Laoshan coast	6	13	7	15	10	8	10	69	8
E. Sand/shingle/ pebble shores	E1.Stoneman Beach	4	14	7	0	0	8	5	38	18
	E2.Golden Beach	4	14	7	0	0	8	5	38	18
	E3.Dalian Jinshitan coast	2	14	3	10	10	8	10	57	13
F. Estuarine waters	F1.Yalu River Estuary	6	8	7	10	10	8	3	52	16
	F2.Guan River Estuary	4	10	9	10	10	8	3	54	15
	F3.Zhuang River Estuary	4	10	7	20	10	8	3	62	11
	F4.Dagu River Estuary	2	10	7	15	10	8	3	55	14
G. Intertidal mud, sand or salt flats	G1.Batan Intertidal flat	8	14	9	5	5	5	3	49	17
	G2.Aoshanwei	6	14	5	15	5	8	8	61	12
	G3.Golden Beach	4	14	7	0	0	8	5	38	18
H. Intertidal marshes	H1.Rongcheng Urban Marsh	4	14	7	20	10	8	5	68	10
	H2.Yalu River Estuary Wetland	8	13	7	20	10	10	3	71	7
	H3.Yancheng Coastal Marsh	10	13	7	20	10	10	3	73	6
J. Coastal brackish/saline lagoons	J1.Chaoyanggang	8	14	13	20	10	8	5	78	2
	J2.Mashangang (Moon Lake)	6	14	13	20	10	8	5	76	4

Discussion

This study present an updated review of the representative habitats of marine/coastal wetlands in the Yellow Sea coast of China. The eight types of marine/coastal wetlands might not be a complete inventory of the Yellow Sea coast of China, due to shortage of available information. Nonetheless, these are the wetlands with most abundant and significant habitats. It is expected not to have significant change even with more information available. Therefore, the study results provide a technical basis for further applications such as prioritizing candidates for establishment of new protected areas or development of the existing ones.

Three habitats are suggested as most representative of those numerous belonging to the eight types of marine/coastal wetlands in the Yellow Sea coast of China. The seagrass/algal beds off Rongcheng (B1 in Figure 1; Shandong, Weihai) are unique: they are the only significant seagrass beds preserved to day, which were believed common in the north and east coasts of China decades ago. They are also the important representative seagrass beds in the temperate zone other than the subtropical ones in China. Jiaozhou Bay (A1 in Figure 1; Shandong, Qingdao) is the largest semi-enclosed bay of Yellow Sea. It is known historically as a centre of biodiversity, being an important wetland both for aquaculture and for capture fisheries by serving as spawning and nursing grounds of many commercial resource species (Wang 1991; Liu 1992). The Yalu River Estuary Wetland (H2 in Figure 1) represents the second largest coastal marshes in Asia, hosts numerous migratory seabirds periodically.

By conducting a few surveys on the biodiversity in these suggested habitats, information will be updated for a better understanding of their current status, therefore will further assist in choose of the habitat(s) to demonstrate good management measures on marine biodiversity.

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