

Biological Assessment of Ecologically Important Areas for Fish and Invertebrate Taxonomic Group of the Yellow Sea Ecoregion

Korea Part

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Ecological sub-regions

Definition and Descriptions of sub-regions

Sub-regions were defined by unique bio-geographical, physical and topographical characteristics such as spawning, nursery, feeding and wintering grounds, and the cold water mass.

Sub-region 1: Areas of active spawning, nursery and feeding activities of fish and invertebrates in the Yellow Sea. Sub-region 1 is mostly coastal shallow areas that have sandy, muddy or rocky bottoms on the western or southern coast of Korea.

Sub-region 2: Sub-region 2 is defined as wintering grounds for fish and invertebrates, particularly the deep boundary area between the Yellow and East China seas, especially southwest of Jeju Island.

Sub-region 3: Sub-region 3 is the cold water mass which is consistently in the trough areas of the central Yellow Sea. Some cold water species isolated geographically from Pacific populations remain distributed in the center of the cold water mass all year around.

Common criteria for identification of Ecologically Important Areas of the Yellow Sea Ecoregion

The common criteria to identify ecologically important areas for fish and invertebrates in the Yellow Sea Ecoregion (YSE) are given in Table 1. For scientific and common names of species, the authors followed these references: Chyung (1977), NFRDI (2001) and Yamada et al. (1995).

Table 1. List of adopted common criteria for fish and invertebrate taxonomic groups			
Adopted common criteria	Proposed Indicator Species/groups	Habitat/biological characteristics or stock status of Indicator Species	Ecologically Important Areas
Criterion 1: Representative species/habitat types	<i>Gadus macrocephalus</i> , <i>Clupea pallasii</i> , <i>Raja pulchra</i> <i>Engraulis japonicus</i> <i>Sebastes koreanus</i> <i>Boleophthalmus pectinirostris</i> , <i>Periophthalmus modestus</i> , <i>Takifugu obscurus</i> <i>Larimichthys polyactis</i> <i>Penaeus chinensis</i> <i>Acetes japonicus</i> / <i>Acetes chinensis</i> <i>Gadus macrocephalus</i> , <i>Clupea pallasii</i> , <i>Raja pulchra</i> <i>Portunus trituberculatus</i>	Yellow Sea cold water mass	Trough area occupied by cold water mass and coastal spawning grounds
		Warm surface layer in coastal areas	Coastal spawning grounds
		Rocky beds	Spawning grounds on coastal rocky beds
		Mud flats	Spawning grounds in coastal mud flats
		Adjacent areas between fresh water and the ocean	Spawning and migration routes in brackish water of estuaries
		Deep trough area in the central Yellow Sea	Spawning grounds in coastal areas
		Sandy and muddy bottoms	Spawning and nursery grounds in the coastal areas of Chungcheongnam-do
		Sandy and muddy bottoms in coastal areas	Coastal spawning grounds
		Geographically isolated cold water mass in the central Yellow Sea	Trough area occupied by cold water mass and coastal spawning grounds
		Sandy and muddy bottoms	Coastal spawning grounds, Wintering grounds in the deep waters of the Yellow Sea and East China Sea
Criterion 2: Isolated stock or species, endemism and unique species assemblages	Not adopted <i>Raja pulchra</i> , <i>Gadus macrocephalus</i> , <i>Clupea pallasii</i> <i>Protosalanx chinensis</i> <i>Takifugu obscurus</i>	Not adopted	Not adopted
		Used to be abundant, but stocks have recently decreased significantly	Trough area occupied by cold water mass and coastal spawning grounds
Criterion 3: Species richness	Not adopted <i>Raja pulchra</i> , <i>Gadus macrocephalus</i> , <i>Clupea pallasii</i> <i>Protosalanx chinensis</i> <i>Takifugu obscurus</i> <i>Periophthalmus modestus</i> <i>Sebastes koreanus</i> <i>Scomberomorus nipponius</i> , <i>Lophius litulon</i> <i>Penaeus chinensis</i>	Not adopted	Not adopted
		Used to be abundant, but stocks have recently decreased significantly	Trough area occupied by cold water mass and coastal spawning grounds
			Spawning and nursery grounds in the estuary of Gyeonggi-do
			Spawning grounds and migration routes in brackish waters of estuaries
			Spawning ground in coastal mud flats
			Spawning grounds in coastal rocky beds
Criterion 4: Species of special concern 1 (threatened/depleted stocks and/or protected species)	Not adopted <i>Raja pulchra</i> , <i>Gadus macrocephalus</i> , <i>Clupea pallasii</i> <i>Protosalanx chinensis</i> <i>Takifugu obscurus</i> <i>Periophthalmus modestus</i> <i>Sebastes koreanus</i> <i>Scomberomorus nipponius</i> , <i>Lophius litulon</i> <i>Penaeus chinensis</i>	Not adopted	Not adopted
		Used to be abundant, but stocks have recently decreased significantly	Trough area occupied by cold water mass and coastal spawning grounds
			Spawning and nursery grounds in the estuary of Gyeonggi-do
			Spawning grounds and migration routes in brackish waters of estuaries
	Spawning ground in coastal mud flats	Spawning ground in coastal mud flats	
	Spawning grounds in coastal rocky beds	Spawning grounds in coastal rocky beds	
	Coastal spawning grounds	Coastal spawning grounds	
	Spawning and nursery grounds in the coastal area of Chungcheongnam-do	Spawning and nursery grounds in the coastal area of Chungcheongnam-do	

Criterion 5- A: Commercially important (Volume)	<i>Engraulis japonicus</i> , <i>Scomber japonicus</i> , <i>Trichiurus lepturus</i> , <i>Larimichthys polyactis</i> , <i>Collichthys niveatus</i> , <i>Cleisthenens pinetorum</i> , <i>Setipinna taty</i> , <i>Ammodytes personatus</i> , <i>Acetes japonicus</i> / <i>Acetes chinensis</i> , <i>Portunus trituberculatus</i> , <i>Pholis fangi</i> <i>Raja pulchra</i>	Maintains relatively good stock	Coastal spawning and wintering grounds Trough area occupied by cold water mass and coastal spawning grounds Not specified Coastal spawning grounds Spawning grounds in mud flats in coastal areas and river mouths Trough area occupied by cold water mass and coastal spawning grounds Spawning grounds and migration route in the brackish water of estuary Coastal spawning grounds, Wintering grounds in the deep waters of the Yellow Sea and the East China Sea Coastal spawning grounds of Chungcheongnam-do Not specified Not adopted Coastal spawning grounds Coastal spawning grounds in Chungcheongnam-do	
	<i>Todarodes pacificus</i> , <i>Pampus echinogaste</i> <i>Lophius litulon</i> , <i>Trichiurus lepturus</i> , <i>Larimichthys polyactis</i> , <i>Collichthys niveatus</i> , <i>Cleisthenens pinetorum</i> , <i>Engraulis japonicus</i> , <i>Setipinna taty</i> , <i>Scomber japonicus</i> , <i>Scomberomorus niphonius</i> , <i>Pholis fangi</i> <i>Boleophthalmus pectinirostris</i> / <i>Konosirus punctatus</i>			
	<i>Raja pulchra</i> , <i>Gadus macrocephalus</i> <i>Takifugu obscurus</i>			
	<i>Portunus trituberculatus</i>			
	<i>Penaeus chinensis</i> <i>Pampus echinogaste</i>			
	Not adopted			
	<i>Larimichthys polyactis</i> <i>Penaeus chinensis</i>			
	Criterion 6: Intact habitat/ecological processes			Not adopted
	Additional Criterion: Changes in biological characteristics			Reduced distribution areas

Proposed Indicator Species under Criterion 1: Representative species/habitat types

Definition of Indicator Species under Criterion 1:

Abundant or endemic species in the YSE that show habitat characteristics of bottom sediments or water masses.

Selected Indicator Species

- 1) [Pacific cod] [*Gadus macrocephalus*] [대구, Dae-gu]
- 2) [Pacific herring] [*Clupea pallasii*] [청어, Cheong-eo]
- 3) [Mottled skate] [*Raja pulchra*] [참홍어, Cham-hong-eo]

Reason For Selection: These three species are in the Yellow Sea cold water mass all year around. In the fall they migrate to coastal areas for spawning and in the spring they migrate back to the centre of the cold water mass. The spawning areas of Pacific cod is scattered along coastal areas and occurs late December to late February (Park et al., 2004; NFRDI, 1988 and 2000). The Pacific herring spawns in coastal areas near Chungcheongnam-do or Hwanghae-do when water temperature is less than 10°C. Mottled skate spawns near Hwanghae-do and Heuksan Island from fall to spring (Yeon et al., 1996; Yeon et al., 1997).

Ecologically Important Areas: For these species, EIAs include spawning and nursery grounds in coastal and trough areas occupied by the cold water mass in the central Yellow Sea.

- 4) [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]

Reason For Selection: This species is a small pelagic species widely distributed in the Yellow Sea, East China Sea and East Sea/Japan Sea. It seasonally migrates according to changes in surface water temperature. In the spring it migrates to coastal area along the Korean Peninsula where it spawns mainly in the mouth of Geum River from June to August, and in the autumn it migrates back to wintering grounds in the southern Yellow Sea. The optimum water temperature for this species ranges between 13 and 15°C (Kim, 1983; NFRDI, 1988 and 2000).

Ecologically Important Areas: Spawning grounds in coastal areas

- 5) [Mud hopper] [*Boleophthalmus pectinirostris*] [짱뚱어, Jjang-tung-eo]

Reason For Selection: This species is a representative species which lives in mud flats and is distributed on the coast of Jeollanam-do and Jeollabuk-do. Because of over-fishing, it needs protection and enhancement programs.

Ecologically Important Areas: Coastal spawning and nursery grounds

- 6) [Shuttles hoppers] [*Periophthalmus modestus*] [말뚝망둥어, Mal-tuk-mang-dung-eo]

Reason For Selection: This species is a representative species which lives in mud flats and is distributed at the coast of Chungcheongnam-do and Jeollabuk-do. Because of over-fishing, it needs stock and habitat protection.

Ecologically Important Areas: Coastal spawning and nursery grounds

- 7) [Korean rock fish] [*Sebastes koreanus*] [황해볼락, Hwang-hae-bol-lak]

Reason For Selection: The Korean rock fish is in the family Sebastidae and was recorded in the 1990's by Kim and Lee (1994). It is distributed on the coastal rocky beds of the Yellow Sea. The Korean rock fish is representative of species that live on coastal rocky beds.

Ecologically Important Areas: Coastal spawning and nursery grounds.

8) [River puffer] [*Takifugu obscurus*] [황복, Hwang-bok]

Reason For Selection: The river puffer is an anadromous species that has migration routes from the Yellow Sea to rivers such as the Han River, the Imjin River, the Mangyeong River and several other estuaries for spawning.

Ecologically Important Areas: Spawning and nursery grounds in the estuaries of the Han, Imjin and Mangyeong rivers.

9) [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]

Reason For Selection: The small yellow croaker, found widely in the Yellow and East China seas, can be divided into a number of subpopulations by their migration routes. One of them, the Korean subpopulation, moves toward the Korean coast in the spring, then migrates north along the west coast, and then spawns mainly near Chungcheongnam-do or Hwanghae-do from April to June. It then migrates offshore and back to its wintering area (Chung, 1970; Lee, 1977; Baik et al., 2004; Park, 1981; Yang and Cho, 1982; Hwang and Choi, 1980; NFRDI, 1988 and 2000).

Ecologically Important Areas: Spawning and nursery grounds on the coasts of Chungcheongnam-do and Gyeonggi-do

10) [Korean/Chinese shrimp] [*Penaeus chinensis*] [대하, Dae-ha]

Reason For Selection: This species is distributed mainly in sandy or muddy bottoms in the Yellow and Bohai seas. The shrimp population can be divided into two subpopulations based on their breeding areas and migration routes. One is the population on the western coast of the Yellow Sea, which hatches on the coast of the Bohai and the Yellow seas. The other is the population on the east coast of the Yellow Sea, which hatches on the west coast of Korea. In the spring, the Korean stock starts to migrate from their wintering ground in the southern part of the Yellow Sea to the Korean western coast where it spawns from April to June, mainly on the coast of Chungcheongnam-do, and then die. In the autumn the new hatchlings migrate to wintering grounds. Their life span is only one year (Kim, 1973; NFRDI, 1988, 2000 and 2001).

Ecologically Important Areas: Spawning and nursery grounds with sandy and muddy bottoms sediments in the coastal area of Chungcheongnam-do

11) [Acetes shrimps] [*Acetes japonicus/Acetes chinensis*] [젓새우, Jeot-sae-wu]

Reason For Selection: These species are distributed along the west coast of Korea all year round without a wide migration. They spawn from June to October. *Acetes japonicus* spawns on the coast of Chungcheongnam-do, and *Acetes chinensis* spawns on the coast of Gyeonggi-do (Oh and Jeong, 2002; NFRDI, 2001).

Ecologically Important Areas: Spawning and nursery grounds with sandy and muddy bottom sediments on the coast of of Chungcheongnam-do for *Acetes japonicus* and Gyeonggi-do for *Acetes chinensis*.

Proposed indicator species under criterion 2: Isolated stock or species, endemism and unique species assemblages

Definition of indicator species under criterion 2:

Indicator species are those that are anadromous and whose habitats are mainly bottom sediments or cold water masses in the Yellow Sea Ecoregion. Species that are geographically isolated subpopulations in the East China Sea and/or East/Japan Sea.

Selected Indicator species

- 1) [Pacific cod] [*Gadus macrocephalus*] [대구, Dae-gu]
- 2) [Pacific herring] [*Clupea pallasii*] [청어, Cheong-eo]
- 3) [Mottled skate] [*Raja pulchra*] [참홍어, Cham-hong-eo]

Reason For Selection: These three species are geographically isolated from populations in the north Pacific or East/Japan Sea. They stay only in the Yellow Sea.

- 4) [Blue crab] [*Portunus trituberculatus*] [꽃게, Ggot-ge]

Reason For Selection: Blue crab in Korean waters is largely divided into two subpopulations. The first is distributed in the East China Sea during the winter time, migrates to the coastal areas off the southern coast of Korea or the eastern area off southern China in spring for spawning and then migrates back to the wintering grounds in autumn. The second spends winter time in the bottom in the deep waters of the Yellow Sea and migrates to the west coast of Korea and the east coast of China for spawning (Yeon et al., 1992; Yeon, 1997). They spawn in sandy and muddy bottoms in coastal areas from April to September, with most spawning occurring from May to July along the west coast of Korea (Yeon, 1999).

They are demersal crabs: during the day time they usually stay with their body (except eyes) buried in sandy or muddy bottoms, and at dawn and in the evening they come out to feed (NFRDI, 2001; Yeon, 1997).

Ecologically Important Areas: Spawning grounds with sandy and muddy bottom sediments in coastal areas and wintering grounds the deep areas of the Yellow and East China seas.

Proposed indicator species under criterion 4: Species of special concern 1 (Threatened, Depleted stocks and/or Protected stocks)

Definition of indicator species under criterion 4:

The stock of indicator species or groups used to be abundant but has recently decreased significantly to low levels.

Selected Indicator species

- 1) [Pacific cod] [*Gadus macrocephalus*] [대구, Dae-gu]

Reason For Selection: In the 1950s, this species was one of the most abundant in the region, but has recently been reduced to a very low level. It therefore needs protection and enhancement programs (NFRDI, 1988).

- 2) [Pacific herring] [*Clupea pallasii*] [청어, Cheong-eo]

Reason For Selection: The population has decreased significantly and needs protection and enhancement programs (NFRDI, 1988).

- 3) [Mottled skate] [*Raja pulchra*] [참홍어, Cham-hong-eo]

Reason For Selection: This species was relatively abundant until the early 1990s, but then reduced dramatically due to overfishing (Yeon et al., 1996).

- 4) [King ice-fish (whiting)] [*Protosalanx chinensis*] [붕통뱅어, Bung-tung-baeng-eo]

Reason For Selection: This species is distributed in the estuaries of the Han River and the Imjin River just like other ice fish. The stock size of this species is very small and needs protection.

Ecologically Important Areas: Spawning and nursery grounds in the estuaries of the Han and Imjin rivers

5) [River puffer] [*Takifugu obscurus*] [황복, Hwang-bok]

Reason For Selection: This species migrates to estuaries and spawns in upper fresh water streams (such as the Imjin River and the Han River). River puffers have been caught in estuaries and fresh-water habitats until 1980's, but have since diminished significantly.

6) [Shuttles hopfish] [*Periophthalmus modestus*] [말뚝망둥어, Mal-tuk-mang-dung-eo]

Reason For Selection: This species is in decline due to a reduction of their habitats, which are mud flats on the west coast of Korea.

7) [Korean rock fish] [*Sebastes koreanus*] [황해볼락, Hwang-hae-bol-lak]

Reason For Selection: This species is one of the family Sebastidae and was discovered in the 1990's by Kim and Lee (1994). It is distributed on the coastal rocky bed of the Yellow Sea. The Korean rock fish is representative of species living on the coastal rocky bed.

8) [Spanish mackerel] [*Scomberomorus niphonius*] [삼치, Sam-chi]

Reason For Selection: The catch of the fish has decreased significantly and is now at a very low level (NFRDI, 2000). The species stays near Jeju Island where it is near the warm current. During the winter time it begins to swim to coastal areas to prepare for spawning in the spring and spawns in the muddy bottoms of the relatively shallow coastal areas or in the Korean bays from May to July, and then migrates back to the wintering ground (Kim et al., 1977; NFRDI, 1988 and 2000).

Ecologically Important Areas: Coastal spawning grounds of Chungcheongnam-do and Jeollanam-do

9) [Goosefish/Yellow goosefish (main catch)] [*Lophius litulon*] [아귀류/아귀, A-gui-ryu/A-gui]

Reason For Selection: The stock used to be abundant in the Yellow Sea. However, it has decreased dramatically and is now at a low level. This species spends winter time in the southern part of the Yellow Sea, migrates to the coast in the spring and then swims back to the winter ground in the autumn. They spawn mainly from February to April. Their optimum habitat temperature is between 10 and 15°C (Cha et al., 1997; Park et al., 2000).

Ecologically Important Areas: Spawning ground in the western sea of Jeju Island

10) [Korean/Chinese shrimp] [*Penaeus chinensis*] [대하, Dae-ha]

Ecologically Important Areas: This species was one of the dominant shrimps on the west coast of Korea, but has decreased dramatically because of overfishing and diseases even though artificially grown seeds have been released since the late of 1970s (NFRDI, 1988, 2000).

Proposed indicator species under criterion 5A: Commercially important (Volume)

Definition of indicator species under criterion 5A:

The stock of commercially important species has been changing every year. Therefore, the authors selected the top five most abundant major species in the commercial aspects in the Korean fishery.

Species or groups that ranked in the top 5 of mean annual landings in each decade:

1) 1960s

- [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 18,220 tons
- [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]: 16,874 tons
- [Flounders/ Pointhead flounder (main catch)] [*Cleisthenens pinetorum*] [가자미류, Ga-ja-mi-ryu]: 4,980 tons

- [Mottled skates/Mottles skates *Raja pulchra* (main catch)] [홍어류, Hong-eo-ryu]: 3,800 tons
- [Pomfrets, Silver pomfret (main catch)] [*Pampus echinogaste*] [병어류, Byeong-eo-ryu]: 2,141 tons

2) 1970s

- [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 36,634 tons
- [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]: 7,469 tons
- [Corvenias, Bighead croaker (main catch)] [*Collichthys niveatus*] [강달이류, Gang-dal-i-ryu]: 5,781 tons
- [Pomfrets, Silver pomfret (main catch)] [*Pampus echinogaste*] [병어류, Byeong-eo-ryu]: 5,732 tons
- [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]: 5,278 tons

3) 1980s

- [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 44,229 tons
- [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]: 9,608 tons
- [Corvenias, Bighead croaker (main catch)] [*Collichthys niveatus*] [강달이류, Gang-dal-i-ryu]: 8,869 tons
- [White gunnel] [*Pholis fangi*] [흰베도라치, Huin-be-do-ra-chi]: 7,239 tons
- [Scaly hairfin anchovy] [*Setipinna taty*] [반지, Ban-ji]: 6,229 tons

4) 1990s

- [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 11,863 tons
- [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]: 8,282 tons
- [Corvenias, Bighead croaker (main catch)] [*Collichthys niveatus*] [강달이류, Gang-dal-i-ryu]: 7,908 tons
- [White gunnel] [*Pholis fangi*] [흰베도라치, Huin-be-do-ra-chi]: 6,841 tons
- [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]: 4,591 tons

5) 2000s (2000 to 2003)

- [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]: 17,754 tons
- [White gunnel] [*Pholis fangi*] [흰베도라치, Huin-be-do-ra-chi]: 4,725 tons
- [Sand lance] [*Ammodytes personatus*] [까나리, Gga-na-ri]: 4,065 tons
- [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 1,882 tons
- [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]: 1,394 tons

Selected Indicator species

1) [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]

Reason For Selection: The Largehead hairtail is an abundant species in the Yellow Sea. The landing of this fish ranked first from the 1960s to 1990s, but dropped to fourth in the 2000s. The mean catch length has been decreasing.

Largehead hairtail in the Yellow Sea can be divided into two subpopulations based on wintering areas and migration routes. The first, called the Northern East China Sea population, spends winter in the northern part of the East China Sea. The second called the Yellow Sea population, overwinters in the waters just southwest of Jeju Island. Both subpopulations migrate to the coast of the Yellow Sea and the East China Sea in the spring, spawn in the coastal areas from May to August and then come back to wintering grounds in fall. The optimum water temperature for spawning is between 18 and 20°C. Fifty percent of the total spawning population is 25.6 cm in snout-anus length and two years in age (Hwang and Hong, 1985; Park and Hwang, 1978; NFRDI, 1988 and 2000).

Ecologically Important Areas: Spawning grounds in the western and southern coastal area of Jeollanam-do

2) [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]

Reason For Selection: Landing of small yellow croaker has been one of the top five in the Korean fishery since the 1960s with the exception of the 1980s.

3) [Flounders/ Pointhead flounder (main catch)] [*Cleisthenes pinetorum*] [가자미류, Ga-ja-mi-ryu]

Reason For Selection: Flounders (Pleuronectidae) are relatively abundant in coastal areas. Species identification, however, is very difficult due to their common shape. Therefore, “flounder” in Korean fishery statistics represent combined all kinds of flounders. Landing of these species ranked third in the 1960s, but since then has not been in the top five. However, it is still relatively abundant along the west coast of Korea.

Pointhead flounder, *Cleisthenes pinetorum*, is distributed in the Bohai, Yellow and East China seas. In the autumn the fish migrates from the Bohai Sea or northern Yellow Sea to the mid part of the Yellow Sea, around 35°N, and stays there until March. The fish spawns along the coast from winter to summer while overwintering or migrating northward. The spawning size of the fish is 25 cm (Choe et al., 1999).

Ecologically Important Areas: Spawning grounds along the west coast of Korea

4) [Mottled skates/Mottles skates *Raja pulcra* (main catch)] [홍어류, Hong-eo-ryu]

Reason For Selection: Was the fourth most abundant species in the Korean fishery in the 1960s, but has decreased very significantly.

5) [Pomfrets, Silver pomfret (main catch)] [*Pampus echinogaste*] [병어류, Byeong-eo-ryu]

Reason For Selection: Pomfrets landing ranked in the top five until the 1970s, afterward it has decreased and the mean catch length has become smaller.

This species stays in the East China Sea during winter time, begins migrating to the coast of Korea and China in spring, spawns in the coastal areas from May to July and migrates back to their wintering grounds (Cho et al., 1989; Lee et al., 1992; Kim and Lee, 1992; NFRDI, 1988 and 2000).

Ecologically Important Areas: EIAs not specified due to lack of information

6) [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]

Reason For Selection:

Anchovy is abundant in the Yellow Sea with the landing in the top five from the 1970s to 1980s. The landing of the fish in Korea fluctuates largely according to changes in water temperature.

7) [Corvenias, Bighead croaker (main catch)] [*Collichthys niveatus*] [강달이류, Gang-dal-i-ryu]

Reason For Selection: This species is small and looks like the small yellow croaker, but the price is much cheaper so most fishermen prefer to catch the small yellow croaker. Consequently when the stock of small yellow croaker is high, the landing of Corvenias is low and vice-versa. The stocks of Corvenias seem high according to the high landings and the results of trawl survey in the Yellow Sea.

Bighead croaker, *Collichthys niveatus*, lives mainly on muddy bottoms in coastal areas and in the mouth of big rivers in the Bohai, Yellow and East China seas. They spawn by schooling and croaking in coastal areas from May to July. Spawning length is 15 to 17 cm in total length (Kim et al., 2001).

Ecologically Important Areas: Spawning grounds in muddy bottoms along the west coast area of Gyeonggi-do and Jeollanam-do

8) [White gunnel] [*Pholis fangi*] [흰베도라치, Huin-be-do-ra-chi]

Reason For Selection: This fish is distributed in the Yellow Sea cold water mass. Its market price is low, so landings of the fish were not high before the 1970s when catches of high-priced stocks were high. As the high-priced stocks decreased, the landing of White gunnel has increased, so it has ranked second to fourth in the Korean fishery since the 1980s.

White gunnel, *Pholis fangi*, spawns mainly in the coastal area of Chungcheongnam-do and in the mouth of Geum River from November to February. The fish is caught during the juvenile period, from February to May, in the nursery grounds, which are the same as the spawning grounds (Park et al., 2004).

Ecologically Important Areas: Spawning and nursery grounds in the coastal area of Chungcheongnam-do and in the mouth of the Geum River

9) [Scaly hairfin anchovy] [*Setipinna taty*] [반지, Ban-ji]

Reason For Selection:

This species had the fifth most abundant landings in the 1980s in Korea, but has since decreased.

In the Yellow Sea, the fish winters in the south, starts to migrate north and then spends summer in the Bohai Sea and along the coasts of Shandong, China and the Korean peninsula. In the East China Sea, the fish winters south of Jeju Island; migrates to the coast of Jiangsu Province, China in spring; spends summer spawning and growing and then swims back to wintering grounds.

The fish spawns from May to June in the coastal areas of Korea and China. Fifty percent is 20 cm in total length at spawning (Kim et al., 2001).

Ecologically Important Areas: Coastal spawning grounds of Korea and China

10) [Sand lance] [*Ammodytes personatus*] [까나리, Gga-na-ri]

Reason For Selection:

Landing of this fish ranked 3rd from 2000 to 2002 in Korea, but it fluctuates significantly from year to year, and has decreased recently. Sand lance is a cold and coastal water species. It lives in sandy bottoms on the coastal areas or bays of Korea and Japan. They aestivate in sandy bottoms when the water temperature is over 15°C. The fish spawns at a depth of 20-30m on sandy bottoms or of the ones mixed with particles of clamshells from fall to early spring (Chun, 1974; Kim et al., 2000).

Ecologically Important Areas: Spawning ground in sandy bottom in the western sea of Korea.

11) [Chub mackerel] [*Scomber japonicus*] [고등어, Go-deung-eo]

Reason For Selection:

Chub mackerel is a relatively abundant species with a wide migration route in the Yellow Sea. The species in the Yellow Sea can be largely divided into two subpopulations based on their wintering grounds and migration routes. The East China Sea population winters in the northern part of the East China Sea, and the other, the Jeju Island offshore population, winters just south-east of Jeju Island. In the spring they migrate up to the middle of the Yellow sea and swim back to the wintering and spawning grounds in the autumn. They spawn from March to April in the East China Sea, and from April to May in the Jeju Island offshore (Choi, 1981; NFRDI, 1988 and 2000; Park and Choi, 1995; Park, 1977)

Ecologically Important Areas: Spawning and wintering grounds in the western Tsushima Island and eastern Jeju Island

12) [Common squid] [*Todarodes pacificus*] [오징어, O-jing-eo]

Reason For Selection: The common squid is an important species in the Yellow Sea. Landings of the species fluctuate greatly from year to year.

Common squid in the waters adjacent to Korea are divided into three stocks based on their birth seasons; one of them is called as a stock hatching in autumn from October to December, the second one hatching in winter from December to March, and the third one hatching in spring from May to August. Their spawning grounds seem to be the East Sea (Sea of Japan) or the East China Sea, but have not been exactly identified due to lack of information. Their optimum habitat temperature is from 10 to 20°C (Choi et al., 1997; Kim and Kang, 1995; NFRDI, 1988 and 2000).

Ecologically Important Areas: EIAs not specified due to lack of information

13) [Acetes shrimps] [*Acetes japonicus*/*Acetes chinensis*] [젓새우, Jeot-sae-wu]

Reason For Selection: Acetes shrimps are an important commercial species in the Korean Fishery and a dominant species in the coastal area in the Yellow Sea even though they have not been in the top five. The consumption of the shrimps in Korea has increased and they have recently been imported from China.

14) [Blue crab] [*Portunus trituberculatus*] [꽃게, Ggot-ge]

Reason For Selection: The blue crab was an abundant species until 2002 but catch has decreased dramatically since and now is very low. Some protection plans are necessary to rebuild the crab stocks.

Proposed indicator species under criterion 5B: Commercially important (Values)

Definition of indicator species under criterion 5B:

The stock status of commercially important species has been changing year by year. Because of this the authors selected species or groups whose total values of landings have been in the top five, and considered high price species in the Korean fishery since the 1960's.

Top Five Species and Group of the Landings Values by Decade:

1) 1960s

- a. [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]: 1,691 million won
- b. [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 666 million won
- c. [Mottled skates/Mottles skates *Raja pulchra* (main catch)] [홍어류, Hong-eo-ryu]: 207 million won
- d. [Flounders/ Pointhead flounder (main catch)] [*Cleisthenens pinetorum*] [가자미류, Ga-ja-mi-ryu]: 175 million won
- e. [Pomfrets, Silver pomfret (main catch)] [*Pampus echinogaste*] [병어류, Byeong-eo-ryu]: 162 million won

2) 1970s

- a. [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 4,567 million won
- b. [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]: 1,781 million won
- c. [Pomfrets, Silver pomfret (main catch)] [*Pampus echinogaste*] [병어류, Byeong-eo-ryu]: 932 million won
- d. [Corvenias, Bighead croaker (main catch)] [*Collichthys niveatus*] [강달이류, Gang-dal-i-ryu]: 738 million won
- e. [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]: 693 million won

3) 1980s

- a. [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 24,078 million won
- b. [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]: 3,782 million won
- c. [Corvenias, Bighead croaker (main catch)] [*Collichthys niveatus*] [강달이류, Gang-dal-i-ryu]: 2,564 million won
- d. [White gunnel] [*Pholis fangi*] [흰베도라치, Huin-be-do-ra-chi]: 2,115 million won
- e. [Scaly hairfin anchovy] [*Setipinna taty*] [반지, Ban-ji]: 1,097 million won

4) 1990s

- a. [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 21,340 million won
- b. [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]: 19,024 million won
- c. [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]: 8,542 million won
- d. [White gunnel] [*Pholis fangi*] [흰베도라치, Huin-be-do-ra-chi]: 4,003 million won
- a. c. [Corvenias, Bighead croaker (main catch)] [*Collichthys niveatus*] [강달이류, Gang-dal-i-ryu]: 2,479 million won

5) 2000s (from 2000 to 2003)

- a. [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]: 22,353 million won
- b. [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]: 11,943 million won
- c. [White gunnel] [*Pholis fangi*] [흰베도라치, Huin-be-do-ra-chi]: 6,660 million won
- d. [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]: 5,784 million won
- e. [Flounders/ Pointhead flounder (main catch)] [*Cleisthenens pinetorum*] [가자미류, Ga-ja-mi-ryu]: 4,161 million won

Selected Indicator species (proposed)

1) [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]

Reason For Selection: This is one of the most expensive fish species in Korea. Because of this, fishermen try harder and harder to catch it and it has been consistently in the top five landings.

2) [Largehead hairtail] [*Trichiurus lepturus*] [갈치, Gal-chi]

Reason For Selection: This species has a high value and has consistently been in the top five landings. The price per individual is very high in Korea. The main fisheries are trawl and stow net.

3) [Mottled skates/Mottles skates *Raja pulchra* (main catch)] [홍어류, Hong-eo-ryu]

Reason For Selection: This fish is a very expensive and a strong target species in Korea. The total value of the landing of the fish was third in the 1960s and since has not been in the top five.

4) [Flounders/ Pointhead flounder (main catch)] [*Cleisthenens pinetorum*] [가자미류, Ga-ja-mi-ryu]

Reason For Selection: Some of species among flounders are very expensive in the fish market, and the landings are high, so the total value was in the top five in 1960s and 2000s.

5) [Pomfrets, Silver pomfret (main catch)] [*Pampus echinogaste*] [병어류, Byeong-eo-ryu]

Reason For Selection: The price per individual is not very high but the total value of the landing was high until 1970s when it was one of the top five landings. Since then its value has decreased, but is still relatively high.

6) [Corvenias, Bighead croaker (main catch)] [*Collichthys niveatus*] [강달이류, Gang-dal-i-ryu]

Reason For Selection: The price per individual of this fish is low but the total value is very high. The total value was in the top five from the 1970s to the 1990s. This species is usually consumed instead of the small yellow croaker in Korea.

7) [Anchovy] [*Engraulis japonicus*] [멸치, Myeol-chi]

Reason For Selection: The price per individual of this fish is cheap, but the total value is high because of the large landings. It has been in the top five landings since the 1970s. Catch has increased recently.

8) [White gunnel] [*Pholis fangi*] [흰베도라치, Huin-be-do-ra-chi]

Reason For Selection: White gunnel is consumed dried. The price per individual is very cheap, but the total value of the landing is very high. It has been in the top five landings since the 1980s.

9) [Scaly hairfin anchovy] [*Setipinna taty*] [반지, Ban-ji]

Reason For Selection: The fish is very famous for being sliced and eaten raw and salted fish in the west coast of Korea. The price per individual is cheap, but the total value of the landing is high. It was ranked as the fifth biggest landing in the 1980s.

10) [Goosefish/Yellow goosefish (main catch)] [*Lophius litulon*] [아귀류/아귀, A-gui-ryu/A-gui]

Reason For Selection: The fish is very expensive in the fish market in Korea, but the total value of the landing is not very high.

11) [Gizzard shad] [*Konosirus punctatus*] [전어, Jeon-eo]

Reason For Selection: The fish is famous for sliced raw fish in the west coast, and the price of the fish is relatively expensive in the fish market. The taste of the flesh fish is the best in fall.

This species is spread across coastal areas of Korea and China. They migrate offshore from June to September and come back to the coastal areas from October to May. They spawn from March to June (mainly from April to May) in river mouths. The length of 50% of the spawning population is 18 cm, and the optimum water temperature for spawning is between 11 and 20°C (Kim and Lee, 1984; NFRDI, 1988 and 2000).

Ecologically Important Areas: Spawning grounds at river mouths.

12) [Mud hopper] [*Boleophthalmus pectinirostris*] [짱뚱어, Jjang-tung-eo]

This species is a representative species which lives at mud flats and is distributed in the coastal areas of Jeollanam-do and Jeollabuk-do. This species is used in traditional food and is often exported so it is relatively expensive.

13) [Pacific cod] [*Gadus macrocephalus*] [대구, Dae-gu]

Reason For Selection: The fish is very expensive in the fish market and is a target species in Korea. The stock has decreased dramatically. Therefore, some proper programs are needed to rebuild the stock.

14) [River puffer] [*Takifugu obscurus*] [황복, Hwang-bok]

This species migrates toward estuaries and spawns in upper fresh water streams (such as the Imjin River and Han River). The River puffer had been caught in estuaries and fresh-water areas until the 1980's, but the catch has diminished significantly since. This species has been a favorite food since ancient times. It has been the most valuable species in the local fish markets since the 1990s.

15) [Chub mackerel] [*Scomber japonicus*] [고등어, Go-deung-eo]

Reason For Selection: Price per individual and total value of landings are relatively high.

16) [Spanish mackerel] [*Scomberomorus niphonius*] [삼치, Sam-chi]

Reason For Selection: This fish is relatively expensive but landings are at a low level.

17) [Blue crab] [*Portunus trituberculatus*] [꽃게, Ggot-ge]

Reason For Selection: The crab is one of the most important species in the Korean commercial fishery since the individual price is very expensive, and the total value of the landing is high, but the percent of value in the total market has gone down as catch decreased.

18) [Korean/Chinese shrimp] [*Penaeus chinensis*] [대하, Dae-ha]

Reason For Selection: The Korean/Chinese shrimp is the most expensive shrimp species in Korea.

Proposed indicator species under additional criterion 6: Changes in biological characteristics

Definition of indicator species under additional criterion 6:

Species that show changes in biological characteristics such as advances in maturation period and reduction in distribution area

Selected Indicator Species:

1) [Small yellow croaker] [*Larimichthys polyactis*] [참조기, Cham-jo-gi]

Reason For Selection:

The mean catch length has become smaller and smaller (Park, 1981). Their distribution areas have also been reduced (Yeon and Park, 1991).

2) [Korean/Chinese shrimp] [*Penaeus chinensis*] [대하, Dae-ha]

Reason For Selection:

Their distribution areas have been reduced as stocks have become smaller

Table 2. List of proposed indicator species

Number	Selected indicator Species	Criterion 1 representative species/habitat types	Criterion 2 isolated stock or species, endemism and unique species assemblages	Criterion 4 Species of special concern 1 (threatened, depleted stocks and/or protected Species)	Criterion 5A commercially important (Volume)	Criterion 5B commercially important (Value)	Additional Criterion Changes in Biological characteristics
1	<i>Periophthalmus modestus</i>	X		X			
2	<i>Boleophthalmus pectinirostris</i>	X				X	
3	<i>Sebastes koreanus</i>	X		X			
4	<i>Takifugu obscurus</i>	X		X		X	
5	<i>Protosalanx chinensis</i>			X			
6	<i>Engraulis japonicus</i>	X			X	X	
7	<i>Lophius litulon</i>			X		X	
8	<i>Scomber japonicus</i>				X	X	
9	<i>Konosirus punctatus</i>					X	
10	<i>Trichiurus lepturus</i>				X	X	
11	<i>Raja pulchra</i>	X	X	X	X	X	
12	<i>Gadus macrocephalus</i>	X	X	X		X	
13	<i>Clupea pallasii</i>	X	X	X			
14	<i>Pampus echinogaste</i>				X	X	
15	<i>Larimichthys polyactis</i>	X			X	X	X

Number	Selected indicator Species	Criterion 1 representative species/habitat types	Criterion 2 isolated stock or species, endemism and unique species assemblages	Criterion 4 Species of special concern 1 (threatened, depleted stocks and/or protected Species)	Criterion 5A commercially important (Volume)	Criterion 5B commercially important (Value)	Additional Criterion Changes in Biological characteristics
16	<i>Scomberomorus niphonius</i>			X		X	
17	<i>Collichthys niveatus</i>				X	X	
18	<i>Cleisthenens pinetorum</i>				X	X	
19	<i>Ammodytes personatus</i>				X		
20	<i>Setipinna taty</i>				X	X	
21	<i>Pholis fangi</i>				X	X	
22	<i>Penaeus chinensis</i>	X		X		X	X
23	<i>Acetes japonicus / Acetes chinensis</i>	X			X		
24	<i>Portunus trituberculatus</i>		X		X	X	
25	<i>Todarodes pacificus</i>				X		

Note: X indicates that the species is proposed under the corresponding criterion.

Maps and description of ecologically important areas for fish and invertebrate taxonomic groups

Ecologically Important Areas for *Periophthalmus modestus* (Map 1)

Area name: the coastal area of Gyeonggi Bay

Description: Spawning and main distribution area, mud flats

Area name: the coastal area of Chungcheongnam-do

Description: Spawning and main distribution area, mud flats

Ecologically Important Areas for *Boleophthalmus pectinirostris* (Map 2)

Area name: the coastal area of Jeollanam-do

Description: Spawning and main distribution area, mud flats

Ecologically Important Areas for *Sebastes koreanus* (Map 3)

Area name: the western coastal area of Korea

Description: Spawning and main distribution area, coastal rocky beds

Ecologically Important Areas for *Takifugu obscurus* (Map 4)

Area name: estuaries of Han, Imjin and Mangyeong rivers

Description: spawning ground

Ecologically Important Areas for *Protosalanx chinensis* (Map 5)

Area name: estuaries of the Han and Imjin Rivers, Gyeonggi-do

Description: spawning and nursery ground

Ecologically Important Areas for *Engraulis japonicus* (Map 6)

Area name: the coastal area of Hwanghae-do, southwest coast area of Korea

Description: main coastal spawning grounds

Ecologically Important Areas for *Lophius litulon* (Map 7)

Area name: western sea of Jeju Island

Description: spawning ground

Ecologically Important Areas for *Scomber japonicus* (Map 8)

Area name: western sea of Tsushima Island, eastern sea of Jeju Island,

Description: spawning and wintering ground

Ecologically Important Areas for *Konosirus punctatus* (Map 9)

Area name: coastal areas of Korea

Description: spawning and nursery grounds in river mouths

Ecologically Important Areas for *Trichiurus lepturus* (Map 10)

Area name: the western and southern coast of Jeollanam-do

Description: spawning grounds

Ecologically Important Areas for *Raja pulchra* (Map 11)

Area name: coastal area of Hwanghae-do

Description: spawning grounds

Area name: Waters off of Heuksan Island

Description: spawning ground

Area name: the center of the Yellow Sea cold water mass

Description: distribution area

Ecologically Important Areas for *Gadus macrocephalus* (Map 12)

Area name: the Yellow Sea cold water mass

Description: distribution area

Area name: the coastal area of Jeollabuk-do
Description: spawning ground

Ecologically Important Areas for *Clupea pallasii* (Map 13)

Area name: the Yellow Sea cold water mass
Description: distribution area

Ecologically Important Areas for *Pampus echinogaste* (Map 14)

Area name: not specified
Description: specific studies needed

Ecologically Important Areas for *Larimichthys polyactis* (Map 15)

Area name: the coastal area of Gyeonggi-do and Chungcheongnam-do
Description: spawning ground

Ecologically Important Areas for *Scomberomorus niphonius* (Map 16)

Area name: the coastal area of Chungcheongnam-do
Description: spawning ground in shallow areas

Area name: West coast of Jeollanam-do
Description: spawning grounds in the shallow areas

Ecologically Important Areas for *Collichthys niveatus* (Map 17)

Area name: Coastal area of Gyeonggi-do
Description: spawning grounds in muddy bottoms

Area name: Western coastal area of Jeollanam-do
Description: spawning ground in muddy bottom

Ecologically Important Areas for *Cleisthenens pinetorum* (Map 18)

Area name: the western coastal area of Korea
Description: spawning ground

Ecologically Important Area for *Ammodytes personatus* (Map 19)

Area name: the western sea of Korea
Description: spawning and distribution area in sandy bottoms

Ecologically Important Area for *Setipinna taty* (Map 20)

Area name: Western coastal area of Korea
Description: spawning ground

Ecologically Important Area for *Pholis fangi* (Map 21)

Area name: Coastal area of Chungcheongnam-do and in the mouth of Geum River
Description: spawning and nursery ground

Ecologically Important Area for *Penaeus chinensis* (Map 22)

Area name: the coastal area of Chungcheongnam-do
Description: spawning grounds in sandy and muddy bottoms

Invertebrate Ecologically Important Area for *Acetes japonicus*/*Acetes chinensis* (Map 23)

Area name: the coastal area of Chungcheongnam-do and Gyeonggi-do
Description: spawning and distribution area in the sandy and muddy bottom

Invertebrate Ecologically Important Area for *Portunus trituberculatus* (Map 24)

Area name: western coastal areas of Korea
Description: spawning ground in sandy and muddy bottoms

Area name: the deep sea of the Yellow and East China seas

Description: wintering grounds in sandy and muddy bottoms

Invertebrate Ecologically Important Area for *Todarodes pacificus* (Map 25)

Area name: not specified

Description: specific studies needed

Table 3. List of Maps and Area Names for Fish Ecologically Important Area

Map No.	Indicator Species	Location of Ecologically Important Areas			
Map 1	<i>Periophthalmus modestus</i>	Gyeonggi bay	Coastal area of Chungcheongnam-do		
Map 2	<i>Boleophthalmus pectinirostris</i>	Coastal area of Jeollanam-do			
Map 3	<i>Sebastes koreanus</i>	West coast of Korea			
Map 4	<i>Takifugu obscurus</i>	Imjin and Han rivers estuaries	Mangyeong River's estuary		
Map 5	<i>Protosalanx chinensis</i>	Han and Imjin rivers estuaries			
Map 6	<i>Engraulis japonicus</i>	Coastal area of Hwanghae-do	Western and southern coastal areas of Korea		
Map 7	<i>Lophius litulon</i>	West of Jeju Island			
Map 8	<i>Scomber japonicus</i>	West of Tsushima Island	Off the eastern Jeju Island		
Map 9	<i>Konosirus punctatus</i>	West coast of Korea			
Map 10	<i>Trichiurus lepturus</i>	West coast of Jeollanam-do	Southern coastal area of Jeollanam-do		
Map 11	<i>Raja pulchra</i>	Coastal area of Hwanghae-do	Adjacent waters of Heuksan Island	Cold water area in the central Yellow Sea	
Map 12	<i>Gadus macrocephalus</i>	Yellow sea cold water mass	Coastal area of Jeollabuk-do		
Map 13	<i>Clupea pallasii</i>	Yellow sea cold water mass			
No Map	<i>Pampus echinogaste</i>	not specified			
Map 15	<i>Larimichthys polyactis</i>	Coastal area of Gyeonggi-do	Coastal area of Chungcheongnam-do		
Map 16	<i>Scomberomorus nipponius</i>	Coastal area of Chungcheongnam-do	Western coastal area of Jeollanam-do		
Map 17	<i>Collichthys niveatus</i>	Coast of Gyeonggi-do	West coast of Jeollanam-do		

Map No.	Indicator Species	Location of Ecologically Important Areas				
Map 18	<i>Cleisthenens pinetorum</i>	Western coastal area of Korea				
Map 19	<i>Ammodytes personatus</i>	Western area off the Korean Peninsula				
Map 20	<i>Setipinna taty</i>	Western coastal area of Korea				
Map 21	<i>Pholis fangi</i>	Coastal area of Chungcheong nam-do and in the mouth of Geum River				
Map 22	<i>Penaeus chinensis</i>	Coastal area of Chungcheong nam-do				
Map 23	<i>Acetes japonicus / Acetes chinensis</i>	Coastal area of Gyeonggi-do	Coastal area of Chungcheongnam-do			
Map 24	<i>Portunus trituberculatus</i>	Western coastal area of Korea	Middle part of the deep area of the Yellow Sea	Northern part of the deep area of the East China Sea		
No Map	<i>Todarodes pacificus</i>	not specified				

Knowledge gaps and specific studies needed for fish and invertebrates for considering the important ecoregions in the Yellow Sea

Knowledge gaps for fish and invertebrates

To consider appropriate strategies for conservation of the biologically and ecologically important areas for fish and invertebrate in the Yellow Sea, it is necessary to comprehensively understand the Yellow Sea ecosystem, especially the dominant and important species, both ecologically and commercially, for scientists from the countries sharing the resources in the Yellow Sea. However, until now there have not been any opportunities to carry out necessary comprehensive and cooperative investigations. Therefore, it is necessary first to collect data and information on the taxonomy of organisms in the Yellow Sea. While we were collecting data and information under the YSE Project Program, we found there are some data and information gaps on scale and accuracy between countries sharing the Yellow Sea, due to the fact that each country has its own ways to protect the plants and animals. The quality of data in each country varied from species to species. For example, for some species covered in this report, there was relatively lots of data and information to consider biologically and ecologically important areas to be conserved even though the data and information in each country had different levels of quality. For some species there was only a little data, but on others, such as the Pacific squid and Pomfrets were little data and information to think about their important ecoregion areas, even though they are commercially important species in the Yellow Sea, and then often when one country has the data and information of a species, the other countries do not have it. Therefore, calibration of data and information between countries may be needed, and some cooperative surveys need to be conducted to get more accurate data and information to understand how to conserve important areas for all species in the Yellow Sea Ecoregion.

Studies needed

To analyse the biologically and ecologically important areas for each species, it is necessary to understand

each species' migration routes and seasonal and special distributional areas and density. However, it was very difficult to get combined assessments among the scientists from countries sharing the Yellow Sea. Because of this, it is necessary to set up a cooperative survey among South Korea, North Korea, China and Japan on Archival Tagging, Proper Fishing Report Systems by fishermen and Seasonal and Special Cooperative Trawl Survey Systems.

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Map 1 *Periophthalmus modestus*



Map 2 *Boleophthalmus pectinirostris*



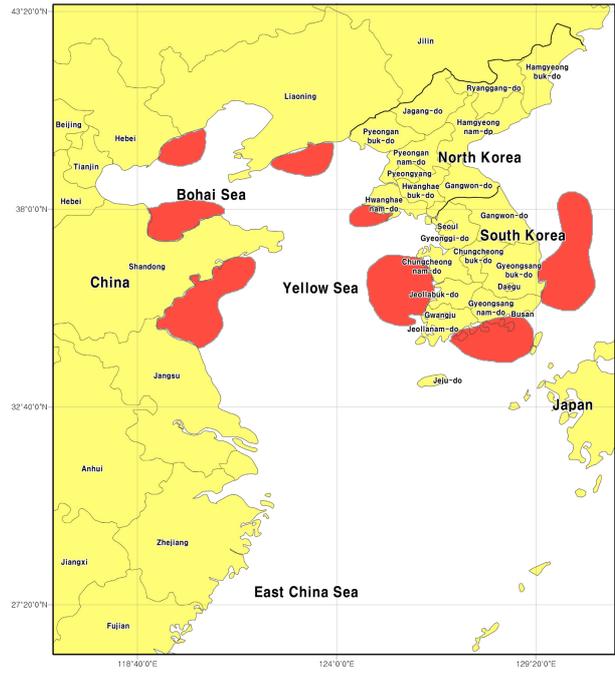
Map 3 *Sebastes koreanus*



Map 4 *Takifugu obscurus*



Map 5 *Protosalanx chinensis*



Map 6 *Engraulis japonicus*



Map 7 *Lophius litulon*



Map 8 *Scomber japonicus*



Map 9 *Konosirus punctatus*



Map 10 *Trichiurus lepturus*



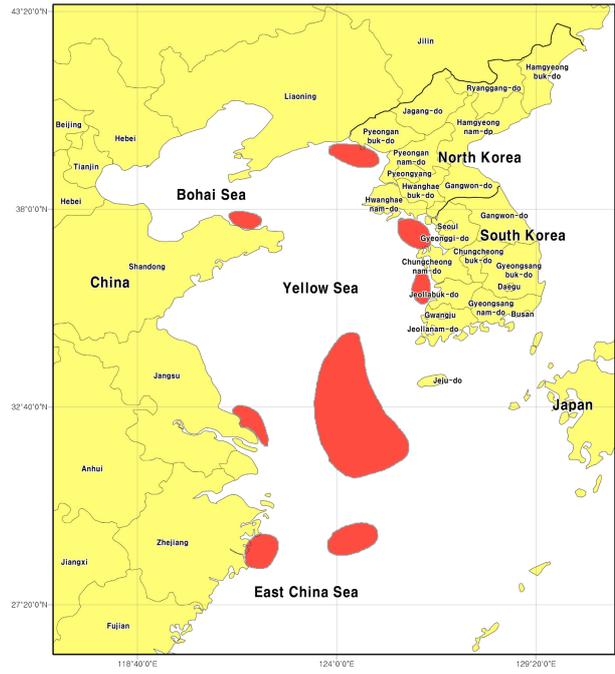
Map 11 *Raja pulchra*



Map 12 *Gadus macrocephalus*



Map 13 *Clupea pallasii*



Map 15 *Larimichthys polyactis*



Map 16 *Scomberomorus nipponius*



Map 17 *Collichthys niveatus*



Map 18 *Cleisthenens pinetorum*



Map 19 *Ammodytes personatus*



Map 20 *Setipinna taty*



Map 21 *Pholis fangi*



Map 22 *Penaeus chinensis*



Map 23 *Acetes japonicus* / *Acetes chinensis*



Map 24 *Portunus trituberculatus*