IUCN situation analysis on East and Southeast Asian intertidal habitats, with particular reference to the Yellow Sea (including the Bohai Sea)

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Executive Summary

The IUCN Species Survival Commission and IUCN Asia Regional Office commissioned this independent report to assess the state and condition of intertidal habitats along the East Asian-Australasian Flyway (EAAF), in response to growing concerns expressed by IUCN members over observed declines in biodiversity, the loss of ecological services, and an increase in ecological disasters. This report is a situation analysis, and it seeks to gather in one place the relevant data and analyses, and to present as clear a picture of the status of the intertidal zone in the EAAF as the data allow. By intention, this report makes no recommendations, but it should serve as a resource for those stakeholders empowered to make or influence decisions and policies in the region.

This report makes use of the status and population trends of key species of waterbirds as indicators of the environmental health of intertidal habitats (including beaches, marshes, mudflats, mangroves and seagrass beds). It presents an analysis of ~390 coastal sites used by waterbirds along the EAAF and identifies 16 key areas. The findings presented show that there is cause for significant concern over the status of the intertidal zone along the EAAF. Fisheries and vital ecological services are collapsing and ecological disasters increasing, with concomitant implications for human livelihoods. Observed rates of declines of waterbird species of 5–9% per year (and up to 26% per year for Critically Endangered Spoon-billed Sandpiper *Eurynorhynchus pygmeus*) are among the highest of any ecological system on the planet. Breeding success among migrating species in their Arctic breeding grounds and survival on most wintering grounds (for northern breeding species) at the southern end of their migrations appears satisfactory, at least where hunting is sustainable. However, problems clearly are occurring along the EAAF during migration. Unless major steps are taken to reverse current trends, the EAAF is likely to experience extinctions and associated collapses of essential and valuable ecological services in the near future.

Although all sectors of the EAAF face a variety of threats, the Yellow Sea (including the Bohai Sea) emerges as the focus of greatest concern, with six of 16 key areas identified in this report in the region. Here, the fast pace of coastal land reclamation is the most pressing threat. Remote sensing and geographical information system (GIS) analyses show mean losses of 35% of intertidal habitat area across the six key areas of the Yellow Sea since the early 1980s. Losses of such magnitude are likely the key drivers of declines in biodiversity and ecosystem services in the intertidal zone of the region.

This report reviews the drivers that are leading to such environmental degradation. We evaluated the processes that should maintain or restore a balance between developmental needs and environmental needs (including legal instruments, financing, habitat and species conservation, awareness and knowledge), and found that these were usually weak, and were in some cases dysfunctional. Drivers are reviewed at both the national and site-specific level. The report highlights the risks to biodiversity, to the livelihoods of coastal communities, and to economic investments if the 'business as usual' scenario continues. The stakes are very high including financial loss to the fisheries sector and the potential financial damage and loss of coastal cities, towns and lands.

The countries along the EAAF have made commitments to global biodiversity targets under several key multilateral environmental agreements, but it will not be possible for the countries to meet these commitments without halting the declining trends in species populations and habitat availability and quality identified in this report. Each country's economic and environmental sustainability is being damaged by the actions of its neighbours. Various existing regional seas initiatives are failing to address these specific problems. The fast pace and nature of human developments affecting the EAAF jeopardizes species that depend on this zone as well as the valuable ecological services that intertidal zone ecosystems deliver to humans. Different species use different suites of sites during northbound and southbound migrations. Therefore, protection of only the best sites will not provide an adequate site network for all migratory species and broader protection of a comprehensive and complementary set of sites is necessary.

Although this is a situation analysis and does not include recommendations, we allow ourselves this comment. The birds and habitats of the EAAF are the shared natural heritage of 22 countries. Many of the steps that need to be taken to secure this resource in the long term will require international cooperation. Unless the fast economic development of this region can be balanced with adequate environmental safeguards, impressive-looking economic gains could be short-lived and undermined by the loss of valuable ecosystem services and a growing list of costly ecological disasters.

1. Introduction

Intertidal flats, the narrow band of habitat between the marine, freshwater and land environments, are characterized by regular tidal inundation, low slopes and muddy deposits (Healy *et al*. 2002). They provide ecosystem services such as food, shoreline stabilization, protection from storm events, maintenance of biodiversity and are often at the centre of social activities (Millennium Ecosystem Assessment 2005).

Globally, approximately 35% of mangroves were lost between 1980 and 2000 (Giri *et al*. 2011) and some 30% of seagrasses have been lost in the last ~100 years (Waycott *et al*. 2009). For intertidal flats, which are similarly heavily impacted by human influence, we have less certainty of their present distribution, status and trends (Healy *et al*. 2002, Millennium Ecosystem Assessment 2005, Keddy 2010). However, current estimates of the rate of intertidal habitat loss in Asia are equal to or greater than recorded losses of mangroves (Giri *et al*. 2011), tropical forest (Achard *et al*. 2002) and seagrasses (Waycott *et al*. 2009). For example, over the past 50 years, losses of up to 51% of coastal wetlands (including marshes) have occurred in China (An *et al*. 2007b), 40% in Japan, 60% in the Republic of Korea (ROK), and more than 70% in Singapore (Hilton & Manning 1995, Yee *et al*. 2010).

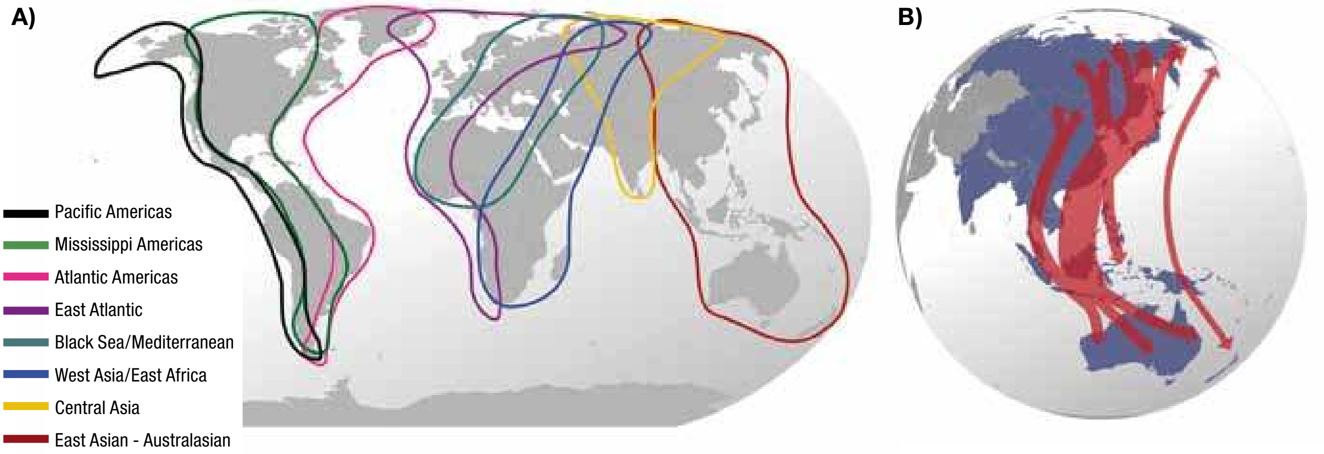
Birds serve as excellent indicators of environmental health and change. They occupy a wide range of niches, use many types of food and physical resources, and are sensitive to environmental changes. Just as nineteenth century miners looked to their caged canaries as an indication that it was safe to continue breathing the mine air, we use data on fluctuating bird populations (Rogers *et al*. 2006c) to alert us of modern environmental dangers. Birds are studied and monitored by considerable numbers of ornithologists and researchers, yielding unparalleled data on population trends over time. Like the canaries, the recent reports of major declines of waterbirds migrating through the East Asian-Australasian Flyway (EAAF, Figure 1) are an indication of significant environmental changes that require urgent investigation. A higher number and proportion of waterbirds are globally threatened in the EAAF than in any of the other seven major flyways of the world (Kirby 2010; see Figure 2). Most of these species are dependent on tidal flats, in particular 24 globally threatened or Near Threatened species of shorebirds, waterfowl, spoonbills, cranes, seabirds and pelicans (IUCN 2011), plus a further nine shorebird species currently under review which could be classified as threatened or Near Threatened in the near future.

The loss of intertidal areas along migratory pathways, especially staging sites (where birds must replenish their energy stores during migration for long, energetically expensive flights) can have extreme consequences for shorebird populations (Myers *et al*. 1987, Goss-Custard *et al*. 1995, Baker *et al*. 2004, Buehler & Piersma 2008, Warnock 2010, Rakhimberdiev *et al*. 2011). For the millions of shorebirds that migrate through the East Asian-Australasian Flyway, the intertidal areas of Asia are a crucial migratory bottleneck (Barter 2002, 2003, Bamford *et al*. 2008, Cao *et al*. 2009, Rogers *et al*. 2010, Yang *et al*. 2011a).

Apart from being vital habitat for the survival of millions of birds of more than a hundred species, intertidal habitat is critical as nesting beaches for sea turtles, breeding areas for Asia's seals, spawning grounds for important economic fisheries, and homes of thousands of species of invertebrates. Many species that rely on intertidal habitats in Asia are in trouble; for example, five species of intertidal sea grasses are globally threatened (Short *et al*. 2011) and the eastern Taiwan Strait population of the Indo-Pacific Humpback Dolphin *Sousa chinensis* is Critically Endangered (Ross *et al*. 2010).

This situation analysis was initiated by the IUCN to synthesize available information on status, trends and threats, identify areas most at risk of destruction and provide guidance to begin to conserve these important ecosystems. To complete the synthesis, a review focusing on three key inputs was undertaken: (i) an extensive review of published and unpublished literature; (ii) an analysis of published and unpublished data from a range of sources; and (iii) expert input from regional and local experts.

Figure 1. A) The eight broad flyways of waders / shorebirds. B) The East Asian-Australasian Flyway (EAAF). The arrows schematically show the many routes taken by migratory waterbirds travelling along this part of the globe (Boere & Stroud 2006, Bamford *et al*. 2008). In reality the migration routes of one species can cover large parts of the flyway as individual birds consistently take different routes on northbound and southbound trips (Minton *et al*. 2011, Battley *et al*. 2012). The journeys toward the breeding grounds largely converge on the Yellow Sea (including the Bohai Sea), which serve as a major refuelling station between March and May each year.



2. Methodology of study

Overview

This situation analysis is based on an extensive systematic literature review and supplemented with expert review and input from around the globe. A wide range of data on waterbirds and selected other taxa, habitat loss and threatening processes was compiled and analysed to identify which are the most important and vulnerable areas for biodiversity conservation. This analysis focuses on the drivers that are causing, or threaten to cause, the most severe losses of intertidal ecosystems and the services they provide, both in general across the entire EAAF and specifically in the most important sites. Information on past, current and future plans for land reclamation of intertidal habitats gives an indication of the sites most seriously at risk. Several case studies are presented, offering detailed information on the sites that are either most threatened or most important for waterbird migration.

Data and Databases

Expert elicitation

A request to solicit facts, views and opinions was sent by the Director General of the IUCN to relevant government agencies of all of the governments and non-government organizations associated with the countries and territories covered in this study. The responses received were incorporated in the study, and are available on request from the authors. Further, the authors attended the 6th Meeting of Partners of the East Asian-Australasian Flyway Partnership, where extensive discussions were held with experts and government officials.

Bird populations

On the basis of data availability and sensitivity of species to environmental change, we selected the waterbirds (including shorebirds such as sandpipers, plovers, snipes and allies) confined to intertidal zones and the intertidal habitats (see list in Appendix 1) as the most appropriate indicators in our analysis. Indeed, waterbird species that inhabit intertidal areas give us a convenient and powerful indication of ecosystem well-being, given that they are at the top of the food chain (Mallory *et al*. 2006) and we have good monitoring data for these species (e.g. Li *et al*. 2007, 2009b, Bamford *et al*. 2008). A database containing information on the abundance, distribution, conservation status and other pertinent details of 155 species of waterbirds that depend on East Asian intertidal and associated habitats was established. Of the 155 species, 24 are globally threatened (i.e., Critically

Endangered, Endangered or Vulnerable on the *IUCN Red List of Threatened Species*; www.iucnredlist.org) or Near Threatened (see Appendix 1); 71[1] are migratory shorebirds (including gulls and terns) (see Section 5). In addition, we present trend data on selected shorebird populations for the key areas identified in this analysis and the total EAAF (made possible through data provided by the University of Queensland and the Australasian Wader Studies Group).

Important sites and key areas

By collating information on Important Bird Areas (BirdLife International 2001), EAAF Migratory Waterbird partnership sites, Internationally Important Shorebird Sites (Bamford *et al*. 2008), and coastal protected areas, 388 coastal sites were identified for inclusion in this study (Appendix 11). From this group of sites, a subset of sites (Appendix 11; sites in bold) were determined to have high numbers of globally threatened or Near Threatened waterbirds, high shorebird diversity or large shorebird populations of at any time of year. Specifically, the subset included sites that had the greatest values for these three factors:

1. The number of globally threatened and Near Threatened shorebird species and other tidal waterbirds;
2. Number of shorebird species present with >1% of the total EAAF population (using peak high counts, any time of year);
3. Total abundance of shorebirds.

To analyse the final subset of sites, we pooled them into key areas, based on their geographic location. Sites that were situated closely along continuous stretches of intertidal habitats were considered as one key area. A total of 16 key areas were identified (Section 5, Appendix 2). Using information from the literature review, published and unpublished data sources, and from the expert consultation process, an analysis of each key area was completed. For each key area we determined:

1. Protected area coverage (Appendix 2);
2. Where possible, the conservation status of each key area, both national and international, and inclusion or potential inclusion on the Ramsar list of internationally important wetlands (BirdLife International 2005) (Appendix 2);
3. The biodiversity features according to the factors mentioned above (Appendix 2);
4. The area of intertidal wetlands pre-2000 and current (post 2010). Where possible, published sources were used. For areas where no information was available, we used an unpublished remote sensing dataset of tidal flats of East Asia by Murray *et al*. (unpubl. data). Extent of tidal areas was calculated using satellite images of known tide height from the Landsat Archive. High-tide and low-tide images were differentiated to determine the area of tidal flat lost between the two time periods (Appendix 2);
5. The proportion of intertidal wetlands affected by land reclamation (Table 4 and Appendix 2);
6. Drivers and threats to these sites (Appendix 2).

The study also presents case studies of some of the most threatened and most important sites for waterbirds (Appendix 9).

Policy analysis

Policy analysis involved identifying the major threats to coastal ecosystems and seeking the underlying causes behind those threats. It included a review of the policy, legislation, Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) processes, Protected Area (PA) coverage and management of each country against the background of the types of socio-economic development in those countries. We employed simple scaled rating scores dependent on expert opinion and review.

Public review

A one month period of public review was held, whereby officials of each country and other interested parties were given opportunity to comment on the draft of the entire report. All comments received were collated and considered for incorporation into the final report.

1 Not including Grey-headed Lapwing *Vanellus cinereus*, Australian Pratincole *Stiltia isabella*, Northern Lapwing *Vanellus vanellus*, and Long-billed Plover *Charadrius placidus*, which do not use tidal flats and/or are sedentary.

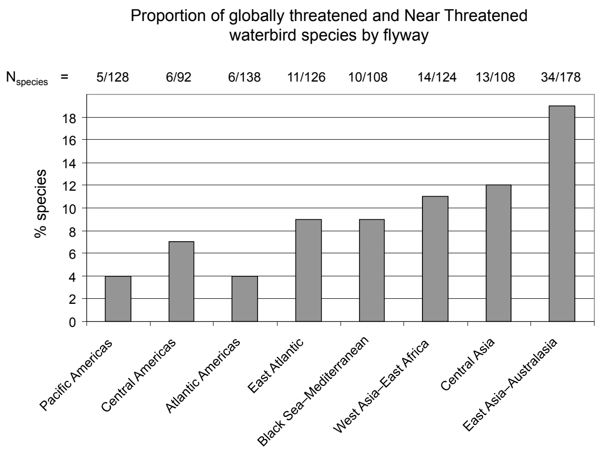
3. The intertidal zone of East and Southeast Asia

The intertidal zone of East and Southeast Asia extends for 34,000 km from China and the Koreas, down along the coasts of Vietnam, Cambodia, Thailand, Peninsular Malaysia and north around the coast of Myanmar to Bangladesh. An even greater length, 128,000 km, of coastline surrounds the islands of Japan, island states of the Association of Southeast Asian Nations (ASEAN) – Philippines, Malaysia (East), Indonesia, Brunei, and Singapore – and East Timor.

The coasts of Asia range from cold temperate to tropical and offer a range of habitats from mud to sand, marshes to mangroves. These habitats are biologically very productive, important for a wide range of biota, provide a range of very valuable ecosystem services and support the livelihoods of large human populations (see Section 4). Of particular value to wildlife are the tidal estuaries of some of Asia's great rivers, including the Yellow, Yangtze, Red, Mekong, Irrawaddy, Salween and Ganges. These tidally influenced river mouths emerge as the most important habitat for globally threatened waterbirds (see Appendix 2).

Asia's eastern coastline serves as a migration flyway for the many species that nest in north-eastern Russia and Alaska, but spend the non-breeding season in Asia, or head south to Australasia. Many species migrate annually through this Flyway, from the high Arctic to Indonesia (e.g. Battley *et al*. 2005, Crossland *et al*. 2010, Iqbal *et al*. 2010) and as far west as Bangladesh and as far south as New Zealand (e.g. Melville & Battley 2006) and Australia (e.g. Barrett *et al*. 2003, Gosbell & Clemens 2006). At least 33 globally threatened or Near Threatened waterbirds occur in the EAAF (of which 24 are heavily dependent on the intertidal zone) with as many as nine additional shorebirds that may be listed as globally threatened or Near Threatened soon (see Appendix 1). The EAAF is used by more waterbird species in total, and more globally threatened or Near Threatened species, than any of the world's other major migratory Flyways (Kirby 2010) (Figure 2).

Figure 2. Total number and proportion of globally threatened and Near Threatened waterbirds in the flyways of the world. Analysis and graphs reproduced from Kirby (2010).



Although not specifically covered within the scope of this study, it should be noted that, in addition to the threats identified in the Asian sectors of the Flyway, there is an additional 5,000–6,000 km of important coastline in Russia that constitutes the northern end of the Flyway. For now, this sector is not extensively developed but Russia is developing fast especially the southern coast between Vladivostok and Sakhalin with oil gas and port development and adequate protected areas are not yet in place.

4. Why mud matters – the importance and values of intertidal habitats

The intertidal zone has long provided a wealth of services to humans. Earliest human remains are often found in association with mounds of sea-shells indicative of the importance of this zone as a harvesting area. The human menu was broadened to include the fish, birds and reptiles that also found their own foods along the shoreline. According to government figures, China alone had 12.3 million people engaged in marine fishing in 2003 generating a catch valued at US$8 billion (Hanson & Martin 2006), with 70% of this figure realized in the coastal zone.

Shorelines function as physical collecting zones of sand, mud, pebbles and fringe vegetation that help slow and break the action of waves. Gentle beaches tame ocean waves providing safe places for villages, harbours and towns and the protection of adjacent agricultural areas. The binding of sand, mud and other sediments helps keep seas clean and productive and removes many pollutants from the air and water. Increasingly, these habitats are being recognized for their ability to store carbon (blue carbon) (Decho 2000).

Healthy strand vegetation, sea grass beds, algal beds and mangroves provide significant shelter in the face of typhoons and storms and against the tsunamis that are frequent in a zone prone to devastating earthquakes (Caldecott & Wickremasinghe 2005). Coastal damage seen after the great tsunami in Aceh, Indonesia in 2004 revealed that sites protected by intact healthy coral, mangrove or other coastal vegetation were dramatically less damaged than sites where these same habitats had been destroyed (Chang *et al*. 2006, Forbes & Broadhead 2007).

Intertidal habitats are amongst the most productive ecosystems on earth. Intertidal habitats, including tidal mudflats, tidal marshes and mangroves, provide safe spawning areas and nurseries for countless species of fish and crustaceans on which coastal fisheries depend (Yusoff *et al*. 2006). They also consolidate sediments into fertile new lands protecting offshore coral reefs from siltation and thereby enhance the productivity of reefs and coastal waters. Clean, beautiful shorelines offer wonderful and inspiring recreational opportunities, including for gastronomic tourism associated with seafood, and important local economies can develop as a result (Table 1).

Costanza *et al*. (1997) valued the ecosystem services of the coastal zone, mostly from coastal wetlands, globally at US$14.2 trillion per annum (or 43% of all global ecosystem services). More precise economic assessments of the values of these services need to be undertaken regionally. One preliminary study by the Korean Ocean Research and Development Institute (KORDI 2006) came up with the following estimates: annual value of a hectare of the ROK's intertidal habitats (US$32,660), which includes marine products (US$9,993), ecosystem preservation (US$8,548), habitat (US$7,533), water purification (US$3,702), recreation (US$1,443), and disaster prevention (US$1,442). Ecosystem service values for 170 km^2 of intertidal flats planned for reclamation in Xinghua Bay, Fujian, China, were estimated at US$0.65 billion/annum or US$38,235/ha/annum with an estimated loss of value of US$8,250/ha/annum if the land were reclaimed for agriculture or ponds (Yu *et al*. 2008). Given that there are more than 1 million ha of intertidal habitats in the Yellow Sea (including the Bohai Sea), these estimates point towards service values exceeding at least US$30 billion per annum. An *et al*. (2007b) estimate that the historical loss of 51% of China's coastal wetlands (not all intertidal) resulted in an annual loss of US$46 billion. The loss of ecosystem services caused by sea enclosures and land reclamation in China has been estimated at US$27.76 billion/annum (CCICED 2010b).

Bennett & Reynolds (1993) point out that mangroves not only deliver a huge boon of services, but that they also provide livelihood to large numbers of people. When intertidal habitat is converted there are high financial gains, through mariculture, infrastructure and related jobs, however other social and financial values are often not appreciated until they are lost (Wang *et al*. 2010b).

5. Identification of critical sites and species

Bird declines

The coastal intertidal zone is narrow. The total area involved is very small, fragile and is rapidly vanishing. Indeed, several countries have already lost between 40% and 55% of all intertidal habitat (Davidson 2011). The region of greatest habitat loss is the Yellow Sea (including the Bohai Sea) region (for details see Section 8), which is a critical convergence for many migration routes (Barter 2002, Heo 2000, Yi 2003, 2004).

Many birds that use intertidal habitats are migrants and travel annually along the EAAF. They connect continents and countries and are, therefore, excellent environmental indicators at both global and local scales (Battley *et al*. 2008). Of the 155 species of waterbirds that depend on East Asian intertidal and associated habitats, at least 50 species of migratory shorebirds and 21 migratory gulls and terns in the EAAF are strongly dependent on intertidal habitats (Table 2). Fifteen globally threatened or Near Threatened migratory intertidal species, including the Endangered Spotted Greenshank *Tringa guttifer* and the Critically Endangered Spoon-billed Sandpiper *Eurynorhynchus pygmeus* and Chinese Crested Tern *Sterna bernsteini* (Chan *et al*. 2010a), have more than 95% of their entire global population in the EAAF; at least one species entirely confined to the EAAF and currently listed as Least Concern, Grey-tailed Tattler *Heteroscelus brevipes*, is likely to be listed as threatened in the near future (Appendix I). A further six migratory shorebird species, currently listed as Least Concern, also have more than 95% of their entire global population in the EAAF (Sharp-tailed Sandpiper

Table 1. Summary of the main ecosystem services provided by mudflats and mangroves of the intertidal zone in East and Southeast Asia (following typology of Ranganathan *et al.* 2008).

Services/benefits provided	Notes	Vulnerability	References
Provisioning Services			
Sustainable fisheries	About 30 million fishermen in the entire study area depend on nets and fish traps in the tidal zone for their livelihood. A huge volume of shellfish and sea cucumbers is also harvested. The intertidal zone is also an important nursery area for many economically important deep-water species	Reclamation, overharvesting, alien species and pollution all threaten fisheries which are now in serious decline	Rönnbäck 1999, TEEB 2010
Biochemical	Extraction of medicines and other materials from biota (fish, molluscs, corals, jellyfish)	Loss of biota and habitats	Constanza *et al.* 1997
Genetic materials	For example, spread of genes for resistance to plant pathogens or hybridization with ornamental species	Loss of biota and habitats	Wilson *et al.* 2005
Harvest of non-timber forestry products	Honey, resins, tannins, edible nuts, seaweeds, shells	Loss of mangroves and beach forest	TEEB 2010
Silviculture/aquaculture	Intertidal zone used for rearing commercial species of plants and animals (crustaceans, fish, pearls, mangroves, algae)	Productivity threatened by pollution and loss of habitat. Over development of aquaculture can lead to spread of diseases, pollution and invasive alien species	Bennett & Reynolds 1993, Wilson *et al.* 2005
Regulating Services			
Detoxification and purification of water resources	Mud, gravel and their fauna of worms, molluscs and crustaceans remove pollutants from water	Loss of purification role leads to dangerous outbreaks of red and green algal blooms and dangerous toxins in seafood	Wilson *et al.* 2005
Climate regulation and carbon sequestration and fixation	Mudflats are important carbon sinks that help to regulate climate change through the process referred to as 'blue carbon'	Reclamation converts important carbon sinks into carbon sources	Decho 2000
Coastal protection/natural hazard protection	Mudflats and beaches disperse and break tidal action and safeguard shorelines from cyclones, tsunamis, erosion and salination. Mangoves protect coastal villages	Reclamation focuses and increases wave action and accelerates scouring at other parts of coastline increasing risk of storm damage and floods. Loss of coastal vegetation leaves coastline vulnerable to storms and sand storms	Caldecott & Wickremasinghe 2005, Chang *et al.* 2006, Forbes & Broadhead 2007
Water regulation (hydrological flows)	Groundwater recharge/discharge		Wilson *et al.* 2005
Cultural Services			
Educational	Opportunities for formal and informal education and training		Wilson *et al.* 2005
Coastal tourism, landscape diversity and scenic values including watching migrating birds, marine mammals etc. Eating fresh seafood, boating, surfing	Beauty and inspiration by the big swirling flocks of shorebirds and the science behind seasonal long-distance migration of birds and mammals adds to property values and supports large tourism industry that caters for more than 100 million tourists per year	Conversion, reclamation and development along the shoreline compromise aesthetic values. The amazing athletic physiology of birds covering 8,000 km or more in single flights, not sleeping or drinking for over a week	Wilson *et al.* 2005, Woodley 2009
Supporting Services			
Habitat for birds and other wildlife	Many charismatic, rare and important species depend on this zone. They are easily viewed on open flats and beaches adding to recreational and conservation values (see Cultural Services above)	Reclamation, cutting of mangroves, introduction of alien plants and pollution all destroy wildlife habitat	Bennett & Reynolds 1993, BirdLife International 2005
Nutrient recycling	Storage, recycling, processing, and acquisition of nutrients	Changes to seawater chemistry result in loss of many important species and negative changes in benthic communities. Shortage of oxygen destroys many economic species	Bennett & Reynolds 1993, Constanza *et al.* 1997
Nutrient export	Outwelling of organic nutrients and detritus increases productivity of local fisheries and nourishes plankton communities	Loss of biological productivity of intertidal zone due to pollution or habitat loss	Wolanski 2007
Soil formation	Sediment retention and accumulation of organic matter	Lost through coastal erosion	Wilson *et al.* 2005

Calidris acuminata, Red-necked Stint *C. ruficollis*, Long-toed Stint *C. subminuta*, Pacific Golden Plover *Pluvialis fulva*, Oriental Pratincole *Glareola maldivarum* and Swinhoe's Snipe *Gallinago megala*).

There are indications of serious declines in some bird populations along the EAAF. Of all monitored populations of Arctic breeding shorebirds in north-eastern Russia, 89% now show declines (E. Syroechkovskiy, pers. comm.). Monitoring on beaches of Australia reveals declines in the numbers of EAAF migrant shorebirds wintering there (Gosbell & Clemens 2006, Wilson *et al*. 2011, Szabo *et al*. 2012). Analysis of monitoring data of Japanese shorebirds between 1975 and 2008 evidenced declines in most species, especially those that stop at the Yellow Sea (including the Bohai Sea) (Amano *et al*. 2010). The fastest declining migratory shorebirds in the EAAF are the long-distance, Arctic-breeding migrants, such as the Spoon-billed Sandpiper (Amano *et al*. 2010, Zöckler *et al*. 2010b) (Figure 3) and the Red Knot *Calidris canutus* (Wilson *et al*. 2011, Garnett *et al*. 2011) (Figure 4). At the current rate of decline (26% per annum), Spoon-billed Sandpipers could be extinct within the decade despite ongoing conservation action (Pain *et al*. 2011) (Figure 3). Similarly, with the current rates of decline, for every 100 Red Knots migrating along the EAAF in 1992, only seven will be left in 2020 (Figure 4).

Identification of key areas

While migrating through the EAAF, shorebirds use areas with intertidal habitat. Throughout the EAAF around 390 internationally important sites for shorebirds have been identified (Appendix 11), here clustered into 16 key areas (Appendix 2). Six of these 16 key areas for shorebird biodiversity are in the Yellow Sea (including the Bohai Sea) (Figure 5). It was only in the 1990s that the ornithological importance of the Yellow Sea (including the Bohai Sea) became clear. It is possible that other key areas remain to be discovered in less accessible parts of the EAAF, such as the west coast of DPRK. Outside the Yellow Sea (including the Bohai Sea), ten areas in South and Southeast Asia with high intertidal biodiversity were identified. Some of the areas in the south are mainly non-breeding sites and are critical to the survival of particular species, such as the Spoon-billed Sandpiper (spending the non-breeding season largely on Sonadia Island in Bangladesh and in the Gulf of Martaban in Myanmar) and the Spotted Greenshank (dependent largely on the Malay Peninsula).

The six key shorebird areas in the Yellow Sea (including the Bohai Sea) support an overwhelming majority of shorebirds migrating through the EAAF. At least 36 shorebird species (Barter 2006) occur in internationally important numbers at 66 distinct shorebird sites (excluding the unknown sites in DPRK). As many as 22 shorebird species strongly depend on the Yellow Sea (including the Bohai Sea): 50–100% of the individuals use the Yellow Sea and Bohai Sea during northbound or

Figure 3. Population decline in Spoon-billed Sandpiper *Eurynorhynchus pygmeus* showing measured current rate of decline and the projected trajectory to extinction if no additional conservation measures are taken(after Zöckler *et al*. 2010b; but see Pain *et al*. 2011).

Figure 4. Population decline of Great Knots *Calidris tenuirostris* and of the EAAF populations of Red Knot *Calidris canutus* and Bar-tailed Godwit *Limosa lapponica* (for flyway routes see Figure 6). Shown are the measured current rates of decline and the projected trajectories if no further conservation measures are taken (after Amano *et al*. 2010 and Wilson *et al*. 2011).

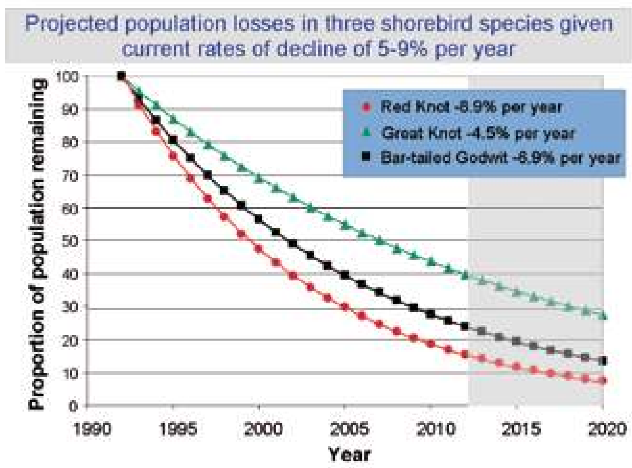


Table 2. Overview of the conservation status of waterbirds in general, and shorebirds (sandpipers, plovers, snipes and allies) in particular, in Asia and in the East-Asian Australasian Flyway.

Status of waterbirds in Asia and the EAAF, from a global perspective	Number of species	References
All waterbird species in Asia and the EAAF		
Total Asian waterbird species	349	Li *et al.* 2006
Total waterbird species dependent on intertidal flats in the EAAF	155	Li *et al.* 2009b
Globally threatened or Near Threatened waterbird species in the EAAF	24	Appendix 1
Shorebird, gulls and tern species in the EAAF		
Total migratory shorebird species (sandpipers, plovers, snipes and allies) in the EAAF	54*	Bamford *et al.* 2008
Total migratory gull and tern species depending on intertidal flats in the EAAF	21	Li *et al.* 2009b
Globally threatened or Near Threatened shorebird, gull and tern species in the EAAF	14	Appendix 1
Candidate EAAF shorebird species to be uplisted on IUCN Red List	9	Appendix 1
International comparison		
Globally threatened and Near Threatened intertidal species in the EAAF	33 of 155 (21%)	Appendix 1**
Globally threatened and Near Threatened waterbird species in Americas	18 of 202 (9%)	Kirby *et al.* 2008
Globally threatened and Near Threatened waterbird species in Europe, C Asia, Africa & Middle East	26 of 162 (16%)	Kirby *et al.* 2008
Globally threatened and Near Threatened waterbird species in Asia	46 of 201 (23%)	Kirby *et al.* 2008

* Note that number includes Grey-headed Lapwing, Australian Pratincole, Northern Lapwing, and Long-billed Plover, which do not use tidal flats and/or are sedentary.

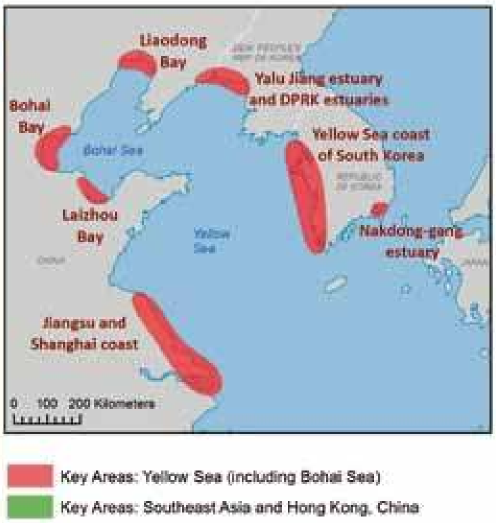
** Includes species currently listed as LC, eligible for uplisting to Near Threatened or Vulnerable.

southbound migrations (Barter 2002, Battley *et al*. 2012) (e.g. Figure 6). In eight species, as much as 70% of the population relies on the Yellow Sea (including the Bohai Sea) as a "fuel" stop (Barter 2002). All these species are declining: three species are Near Threatened (Great Knot *Calidiris tenuirostris*, Far Eastern Curlew *Numenius madagascariensis* and Eurasian Curlew *Numenius arquata*), two are globally declining (Bar-tailed Godwit *Limosa lapponica*) and Grey Plover *Pluvialis squatarola*), and three are regionally declining (Dunlin *Calidris alpina*, Kentish Plover *Charadrius alexandrinus* and Whimbrel *Numenius phaeopus*) (Amano *et al*. 2010, Battley *et al*. 2012).

6. Parallel declines in other taxa and services

Other taxa are undergoing declines parallel with birds (Table 3), further indicating the deteriorating productivity and health of the intertidal zone. Cascading declines are being recorded throughout the food web (WWF *et al*. 2006). In all areas of East and Southeast Asia, important stocks of economically important fish, crustaceans, shellfish and cephalopods are collapsing, causing livelihood losses for several million artisanal fishermen. In some countries, hunting for birds is increasing in response to collapse of fish stocks. Sea mammals and turtles are also undergoing rapid declines, and many are now threatened with extinction. The frequency of toxic algal blooms has increased dramatically; temperature, acidity and water levels have risen (Nicholls & Cazenave 2010); the frequency of catastrophic storms have increased (see Figure 8, Section 7), and the damage to coastlines from cyclones and tsunamis is becoming more serious, especially where the natural coastline has been destroyed (Caldecott & Wickremasinghe 2005).

Figure 5. The 16 key areas for intertidal waterbird biodiversity in the East Asian-Australasian Flyway. See Appendix 2 for detailed information on internationally important shorebird sites covered by the key areas and data on biodiversity values and threats.



Key intertidal areas as identified by biodiversity of waterbirds depending on tidal flats. Birds, top trophic predators, were used as a convenient indicator of tidal flat biodiversity given the relative availability of data on bird numbers.

To select key areas the ornithological importance of ~390 sites with significant tidal flats for all coastal East and Southeast Asian countries was assessed using three parameters:

a) globally threatened and Near Threatened wader species and other waterbirds using tidal flats at the site;
b) overall wader abundance;
c) wader populations of international importance (1% of their biogeographical population).

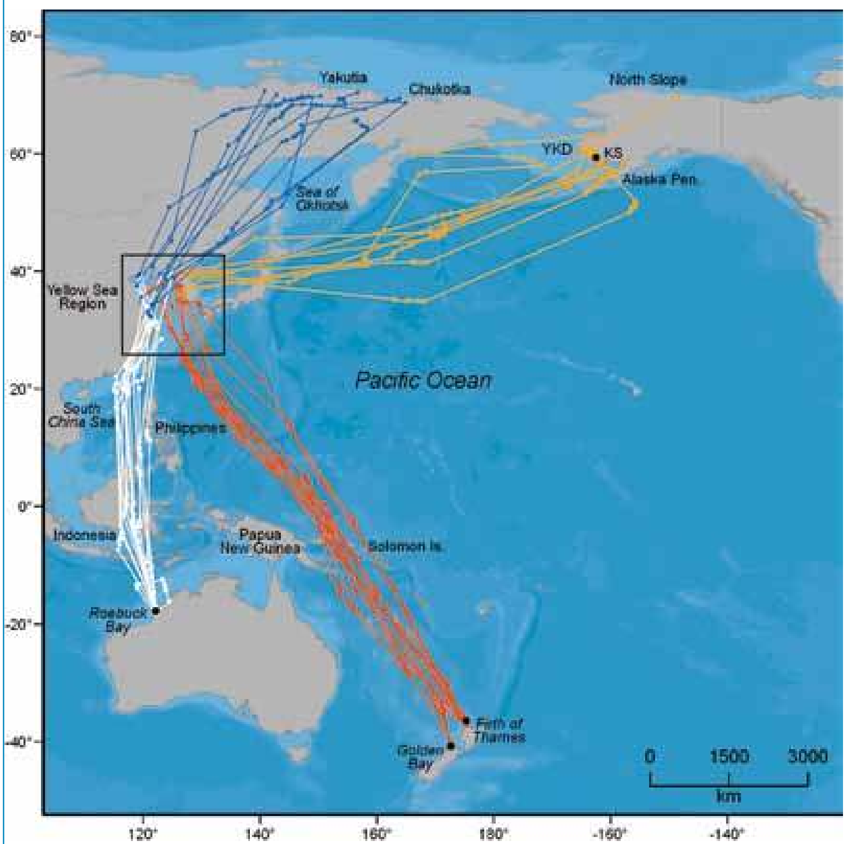


Figure 6. The migrations of many waterbirds converge in the Yellow Sea (including Bohai Sea) region. Tracks in figure are the routes of satellite-tagged Bar-tailed Godwits *Limosa lapponica* on northward migration. White/blue tracks represent the *menzbieri* population (white: north-west Australia to the Yellow Sea region; blue: Yellow and Bohai Sea to the breeding grounds in Siberia); red/gold tracks represent the *baueri* population (red: New Zealand to the Yellow and Bohai Sea; gold: Yellow Sea region to Alaska). Small circles along track lines represent positions calculated from Argos data. YKD: Yukon-Kuskokwim Delta, KS: Kuskokwim Shoals. Taken from Battley *et al.* (2012).

Table 3. Some documented examples of parallel biodiversity declines in other taxa and increasing catastrophes.

Change observed	Comment	Cause	References
The output of prawns in the Bohai Sea fell from more than 40,000 tonnes in the 1970s to just 1,000 tonnes in 2004. A 1998 survey indicated that the total biomass of fisheries was reduced by 89% compared with 1992.	This is an important economic catch. 20% of all China's protein is marine-based. Fish farming production now exceeds wild catch, but may not be sustainable and is dependent on catch of threatened supply of wild larvae.	Excessive fishing, over-exploitation, disease and pollution have severely damaged this fishery resource. Legacy of habitat damage caused by historical trawling.	Qiao 2001
147,000 km² of Chinese seas classified as in serious eutrophic situation in 2009. Liaodong Bay, Bohai Bay, Laizhou bay, Yangtze Estuary, Hangzhou Bay and Zhujiang Estuary are the worst affected.	This constitutes maximum 3.7% of China's total marine area.	Pollution from land-based and marine sources, especially agricultural chemical run off.	SOA 2009, CCICED 2010b, Cao & Wong 2007
Shellfish population on the east coast of Jiaozhou Bay, Shandong, China, is at the brink of extinction.	154 species in 1960s reduced to 33 in 1980s and only 17 in 1980s with only one of the original 14 dominant species remaining.	Sustained land reclamation and urban encroachment.	Liu & Sun 2008
Sea horses and other fish are undergoing dramatic declines throughout the tropical region.	Fish species are taken as foods, as fish meal to use in aquaculture, for ornamental fish trade and as traditional medicines.	Loss of key nursery areas plus overharvesting, use of destructive trawls, fine nets, traps, explosives and poisons.	TEEB 2010
Serious declines in all marine mammals of Yellow Sea.	Spotted Seal *Phoca largha* breeding sites on winter ice flows of Bohai Sea and summer resting places on islands of Yellow Sea are all threatened.	Pollution leads to reproductive failure, loss of fish prey to starvation, habitat loss on summer beaches and accidental death in fishing nets.	Smith & Yan 2008, Ross *et al.* 2010
Serious loss of coastal vegetation throughout the region including major loss of mangroves (China has lost 73% since 1950s).	Many commercially important plants are declining – reed harvest, medicinal species, fodder species, plants used by fisheries and ecological and physical fixation of coastal sediments.	Habitat loss due to reclamation, fishponds, salt-pans combined with invasion by alien species such as *Spartina* cord grass.	Zhang *et al.* 2005
Important beds of seaweeds and sea grasses seriously damaged and declining throughout the region.	Many edible species of algae being lost; sea grasses important for wildlife (five species in the EAAF globally threatened); single celled algae important for fishery food chains, shorebirds and carbon fixation.	Pollution, changes in nitrogen levels and salinity caused by damming estuaries	WWF *et al.* 2006, Short *et al.* 2011
Dramatic increase in jellyfish blooms in the Yellow Sea (including the Bohai Sea).	Injury to humans, loss of tourism revenues, indirect reduction of fisheries.	Overfishing of jellyfish larval predators, litter provides habitat for jellyfish and jellyfish prey on fish larvae.	Xian *et al.* 2005, Kawahara *et al.* 2006, Titelman & Hansson 2006, Dong *et al.* 2010
Regional populations of Green Turtle *Chelonia mydas*, have declined dramatically in recent years. Presently only seven natural beaches in South China are utilized by nesting Green Turtles.	Previously distributed widely throughout the waters of China and commonly found on nesting beaches in South China. The only remaining mainland nesting beach is located in the Gangkou Sea Turtle National Nature Reserve (114°2'E, 22°3'N) in Guangdong.	Caught in fishnets, nest disturbance, ingestion of litter, loss of coastal habitat and impact of severe pollution.	Song *et al.* 2002, Wallace *et al.* 2011
Biotic community structure changed from crustacean to molluscs dominated in Yangtze Estuary.	In an effort to restore the large loss of biomass, 15 tons of benthic organisms were returned between 2002 and 2004, but the resultant community changed and is less valuable.	Biomass loss was caused by construction of deep water channel in Yangtze River Estuary.	Zhen *et al.* 2006.
Probability of lethally low oxygen levels (hypoxia) increased by 90% since 1990 around Yangtze Estuary.	This serious lack of oxygen leads to collapse of marine ecosystems and fisheries resulting in dead zones.	Pollution and loss of tidal cleansing functions increased by reclamations.	Wei *et al.* 2007
Overall changes in biotic composition in Bohai and Yellow Sea.	Less big carnivorous fish, more small low economic value fish, more jellyfish, less diatoms and more flagellates.	Overfishing, pollution, habitat loss and reduced river discharge (results in lowering of Si/N ratio).	Kim *et al.* 2007, UNDP/GEF 2009, Yang *et al.* 2011b
Frequency of harmful algal blooms (HAB) increased 3.4 times since 1990s, now affecting 16,300 km² in Yellow Sea.	Causes direct economic losses estimated at $285 million annually in China alone plus associated health risks.	Pollution and loss of tidal cleansing functions increased by reclamations.	Zhou *et al.* 2001, Song 2007

Change observed	Comment	Cause	References
Small Yellow Croaker *Larimichthys polyactis* has declined 80% since the 1960s in China and ROK.	This was formerly one of the most abundant economic species of the Yellow Sea accounting for 37% of total catch.	Overfishing combined with changing nature of the Yellow Sea. High trophic species replaced by low trophic anchovy and sandlance.	Zhou 2004, Tang 2006, Li *et al.* 2011
ROK has seen sharp declines in mollusc harvest.	50,000–90,000 tons of hard clams and 1000 tons of mud octopus were collected annually in the ROK, mostly in Saemangeum Estuary.	Saemangeum supply almost dried up since closing of the seawall gates in 2006.	WWF *et al.* 2006

7. Threats to the intertidal zone

A multitude of destructive processes and issues are negatively affecting shorelines and the intertidal zones of East and Southeast asia (Cheung *et al*. 2002). Questionnaires sent to managers of a number of sites of the Flyway Partners revealed a variety of perceived concerns in listing threats faced at individual sites (D. Watkins, pers. comm.; Figure 7). However, these sites are mostly protected areas with some security from other land claims. On the basis of the scale, timing of declines, irreversible nature of the threat, direct links to specific reclamations and measured bird losses, and the combination of direct and indirect impacts, this report suggests that by far the most serious and irreversible threat is the loss of habitat caused by reclamation of intertidal habitats for other uses such as agriculture, fish ponds, salt-pans and increasingly ports, industrial sites, tourism and new urban development. The following list, based on literature review and expert input lists the main threats to intertidal habitats and biota in approximate order of severity.

- **Loss and fragmentation of habitat**. According to the China National Wetland Conservation Action Plan (2000) some 1.19 million ha of coastal tidal flats have been lost and 1 million ha of coastal wetlands have been urbanized or used for mining. This constitutes a loss of 51% of all China's coastal wetlands (Chen *et al*. 2005, CCICED 2010b, Bi *et al*. 2011). Mangroves decreased from ~50,000 ha in 1950 to 22,700 ha in 2001 – a 44% loss (Chen *et al*. 2009). Loss of coastal

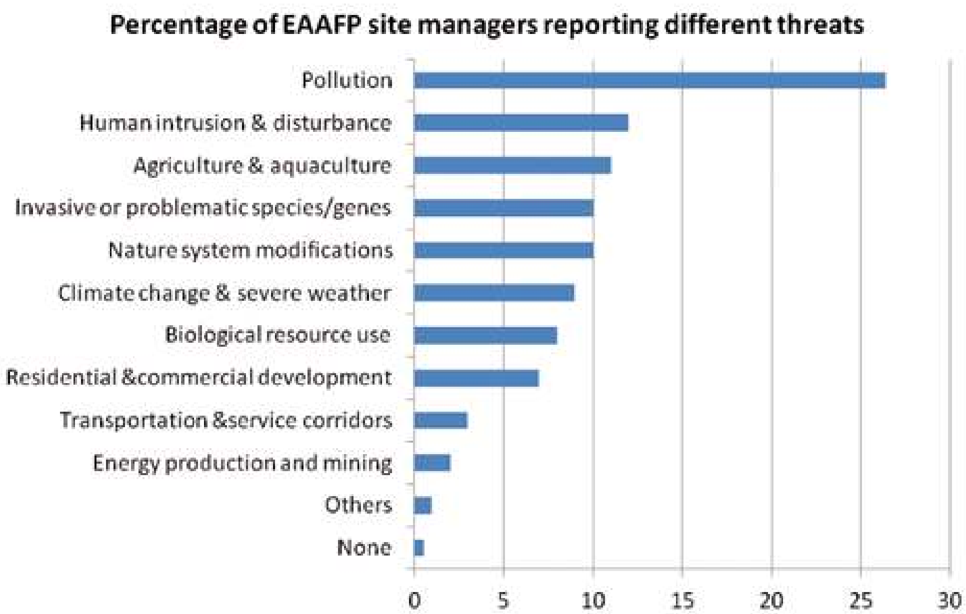


Figure 7. Proportional responses received from site managers of East Asian-Australasian Flyway sites to a questionnaire about perceived threats to each site. Courtesy D. Watkins, Wetlands International Oceania, 6th Meeting of Partners of the East Asian-Australasian Flyway Partnership, Palembang, March 2012.

wetlands continued and accelerated during the following decade. Much of the intertidal zone, especially in the Bohai Sea, is now occupied by aquaculture cage and salt farms. Incredibly, Asia accounts for 90% of the global aquaculture production with more than two-thirds occurring in China (Naylor *et al*. 2000). Intertidal habitat loss is a threat in all countries of the study (see Figure 9) (Bird Conservation Society of Thailand 2004, Trainor *et al*. 2008, Ardli & Wolff 2009, Choi *et al*. 2010, Toril *et al*. 2010, Murray *et al*. 2011, Wen 2012). Countries not yet facing much damage to habitat such as Myanmar (Naing 2007) are set to open up new developments, including reclamation for deep sea ports which could be very damaging unless the preliminary planning and zoning is sound. DPRK has also not yet reclaimed much of its coastline, but completed the 8,800-ha Taegyedo Tideland Reclamation project in 2010 and has plans for more reclamations (KCNA 2010).

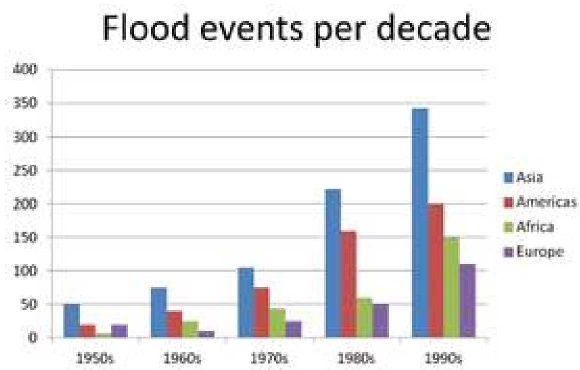
- **Damming of many major rivers** in the region has led to changes in silt discharge, seasonality and quality of freshwater discharge (Chen *et al*. 2005, Syvitski *et al*. 2009, Wang *et al*. 2010a, Yang *et al*. 2011b). Silt load of the Haihe River which flows into the Bohai Sea has reduced from an average of 0.75 kg/m3 to 0.1 kg/m3 as a result of damming and upstream water extraction (CCICED 2010b). Reduced discharge along the entire east coast of China has reversed the shoreline accretion process resulting in a now receding shoreline (almost 5 m per year along Hebei coast) which will impact recent coastal reclamations (CCICED 2010b) and reduce biological productivity (Ning *et al*. 2010).
- **Overuse of fertilizers, pesticides and herbicides in agriculture** results in agricultural runoff to the ocean, leading to excessive nitrogen loads and growing threats from harmful algal blooms in many coastal areas (Tang *et al*. 2006). Blooms in 2008 and 2009 caused direct economic losses of nearly US$300 million (CCICED 2010b). Antibiotics are also released from aquaculture, with unknown consequences on coastal ecosystems (Wang *et al*. 2008, Gräslund & Bengtsson 2001).
- **Pollution due to industrial emissions**, wastewater and sewage discharges both directly and indirectly (Li & Daler 2004) into the coastal zone (Sowana *et al*. 2011). Common pollutants include phosphate, hydrocarbons, pesticides (Hu *et al*. 2009), inorganic nitrogen, heavy metals and organic matter.
- **Oil spills** are an increasingly dangerous problem and are presently occurring with high frequency. The South China Sea to Yellow Sea passage is the busiest shipping lane in the world. Accidental leaks occur and oil rigs are becoming more common in the Bohai Sea and South China Sea. Major oil spills and blow outs have already impacted many coastal habitats in the ROK and the Bohai Sea of China, and there are hundreds of small leaks that are barely reported (CCICED 2010b).
- **Plastic litter,** on beaches and in the sea, is mildly toxic and occurs in ever greater volumes in all coastal areas of the globe. Being non-biodegradable, plastics are a serious threat to all marine wildlife. In the intertidal zone, plastics may be ingested by wildlife, contaminate feeding sites, ensnare animals, reduce access to feeding and roosting sites, and directly impact individual animals through entanglement. Seven shorebirds and a Chinese Egret *Egretta eulophotes* were found caught in a single net on a single day in Gomso Bay (South Korea) (D. Rogers, pers. comm.).
- **Tidal energy developments,** which involve the construction of sea walls and tidal barrages, lead to direct loss of tidal flats. These developments also change near-shore tidal flows, which leads to increased impacts to siltation dynamics and damage to near-shore areas (Gill 2005). A large tidal energy project is being developed at Incheon, ROK (see case study in Appendix 9).
- **Overharvesting** and overuse of intertidal resources, including fish, molluscs, sea-cucumber, sea-urchins and seaweeds. The recent industrialization of harvesting methods has resulted in even greater harvests of intertidal flora and fauna with less manual labour required, which is impacting ecosystem processes throughout the intertidal zone. In most areas, the intertidal zone is a maze of fishing platforms traps and nets that not only add to overfishing, but prevents adult fish from reaching spawning nurseries (CCICED 2010b).
- **Aquaculture/mariculture** has developed so fast in some areas that it brings stress to coastal and intertidal ecosystems, causing great changes to beaches, wetlands, seaweed beds and coral reef ecosystems. Mariculture directly destroys the spawning grounds and habitat of fishery resources, and further influences the regenerative capacity of fishery resources (CCICED 2010b). The potential for a disastrous collapse in mariculture production and wild fisheries becomes increasingly likely (see Section 10).
- **Hunting using** mist nets, fine fish nets, snares, egg collection, poison and guns is occurring on or adjacent to beaches throughout the EAAF. For instance, while there are only a few hundred Spoon-billed Sandpipers left globally, hunting of these birds continues at their major remaining non-breeding area in Myanmar (Zöckler *et al*. 2010a). Additionally, fishing nets accidentally kill significant shorebirds if left on flats at low tide.

Clearing after oil spill on the coast of the Republic of Korea

Plastic litter on a beach in the Republic of Korea

- **Exotic species are** negatively affecting native coastal habitat, causing local species to be displaced by species accidentally or deliberately introduced from other areas. With increase in global shipping trade the influx of such species is increasing, especially in the coastal zone. Examples include *Spartina* grass in China (An *et al*. 2007a, Li *et al*. 2009a), zebra mussels, and tilapia fish along most coasts and estuaries (Yu & Yan 2002) in the region.
- **Competition for food** by human fishermen together with associated disturbance by humans and boats has continued to put pressure on waterbirds along the EAAF.
- **Anthropogenic climate change** has led to raised temperatures, sea levels, acidity and reduced oxygen. Tropical cyclones and floods (Figure 8) are becoming more frequent (Chen 1997). These changes will result in loss of many beaches and intertidal habitats, including many valuable agricultural and mariculture developments, villages and even coastal towns. Such climate change may also lead to seasonal mismatch between migration times and habitat productivity (Maclean *et al*. 2007). This threat is likely to become much more significant as climate continues to change.
- **Windfarms** are being constructed on land, onshore and offshore, mostly on tidal flats, and present a risk to coastal birdlife if sited close to important species localities (RSPB 2009), primarily through collision with wind turbines and through environmental impact in the construction phase. For example, East Asia's largest wind farm, part of which has already been constructed, is at Rudong, where 50% of the global population of Spoon-billed Sandpiper was recorded in 2011 (Lee 2011) (see case study in Appendix 9).
- **Sinking of coastal areas due to groundwater abstraction** is exacerbating habitat loss due to reclamation (Syvitski *et al*. 2009) and sea level rise (Han *et al*. 1996). This weakens sea defences, can damage property and increases salt influx. Reclamation can result in increased sea levels – Saemangeum, for example, increased the level of the Yellow Sea (Lee *et al*. 2010).

Figure 8. Rising frequency of major flood events between 1950 and 2000 on four continents. Source: International Disaster Database, EM-DAT 2011.



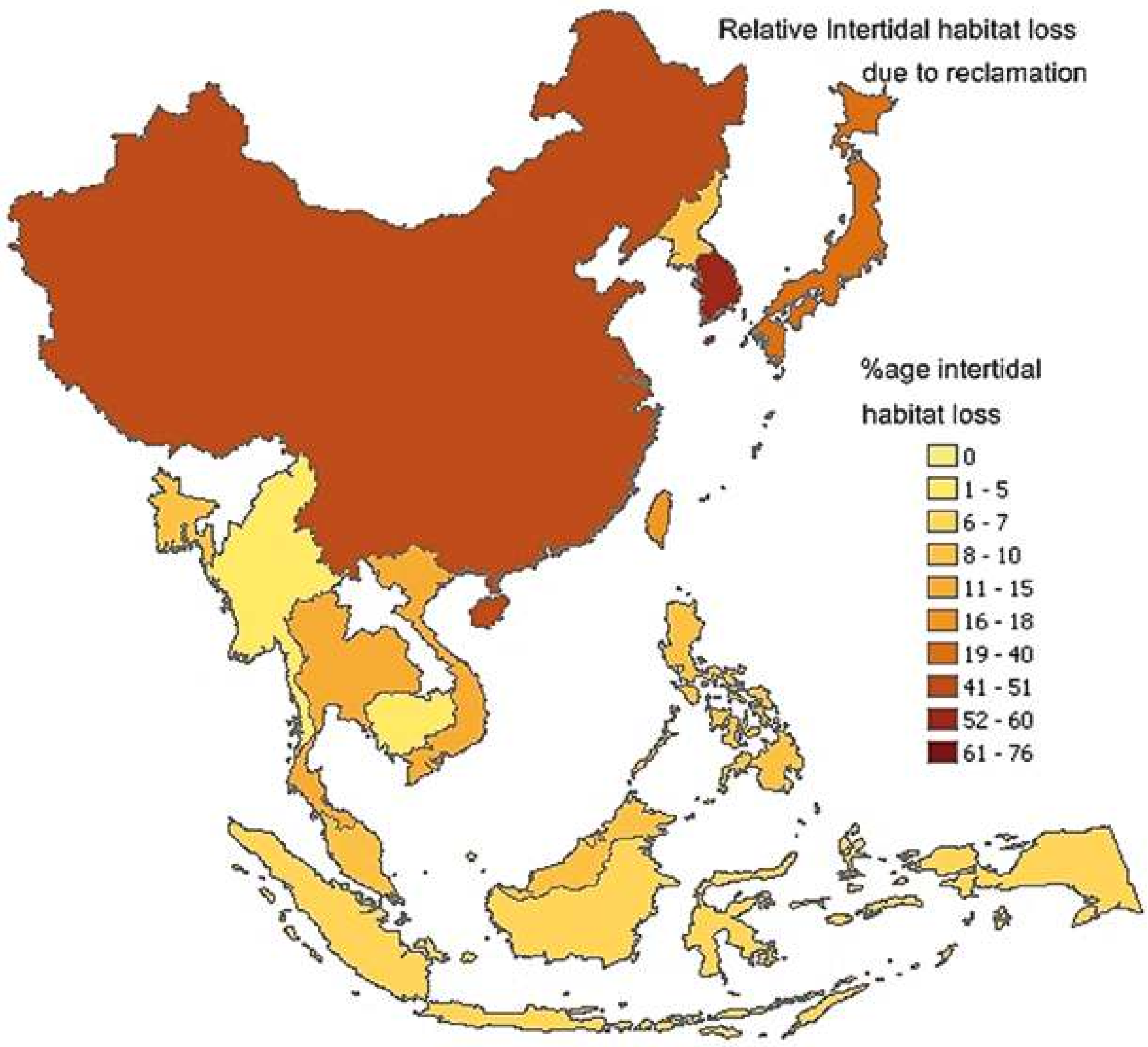
8. Vanishing intertidal habitats

The practice of converting the shallow intertidal flats into new land (commonly termed reclamation) is ancient and widespread. Early reclamations were incremental, advancing out onto the mudflats from the terrestrial coastline. Shorelines were continuously accreting and shorebirds fed mostly on the least affected lower tidal flats (Rogers *et al*. 2006b, Rosa *et al*. 2007). Reclamations were largely completed for new agricultural land for use as rice paddies or for salt-pans and during the past three decades for small-scale aquaculture.

However, the extent of habitat loss due to land reclamation (Figure 9) have accelerated with improving engineering techniques and faster paced infrastructure development. New industrial reclamations often involve constructing sea walls through deep water, from headland to headland, destroying all tidal flats. Habitat loss is thus more complete and sudden, leaving birds with little time to adjust. Moreover, reclamation of entire bays is likely to target habitats of greatest importance to shorebirds, which tend to occur in highest numbers on the largest tidal flats, often in estuaries (Table 4). Therefore, modern reclamation can be even more destructive to shorebirds than indicated by total tidal flat area lost.

In the Yellow Sea (including the Bohai Sea), the mean area of intertidal habitat lost from the six key areas since the early 1980s is 35% (Table 4; Appendix 2). This puts losses on a similar scale to tropical forests (Achard *et al*. 2002), sea-grasses (Waycott *et al*. 2009) and mangroves (Giri *et al*. 2011). In the Saemangeum area alone, the 40,100-ha development has resulted in massive intertidal destruction as part of the largest reclamation project to date (Birds Korea 2010), which resulted in a loss of 28,000 ha of intertidal flat (Moores 2012). Similarly, the reclamation of Caofeidian in the Bohai Sea plans to cover 31,000 ha by 2030 (CCICED 2010b), the largest reclamation project in the world. In China, the total area of planned reclamations yet to be initiated is more than 570,000 ha, which is extent the size of the intertidal flat reclamations in the last decade (Table 5).

Figure 9. Relative intertidal habitat loss due to land reclamation (by country/territory*), showing clumped percentiles of habitat loss by colour (see key). For data and references see Appendix 6.



* Data from Taiwan, Province of China, is represented separately because of the difference in intertidal habitat loss percentage.

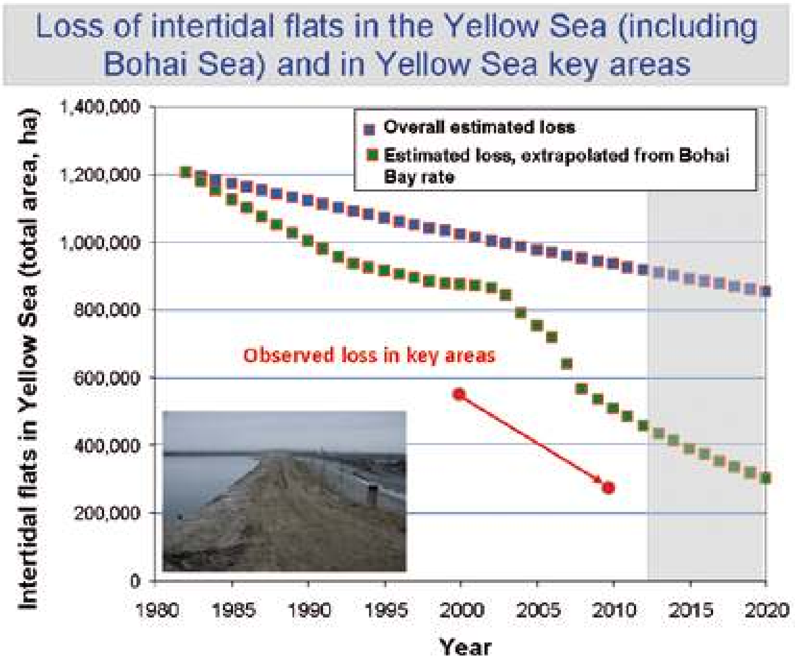


Figure 10. Loss of intertidal flats in the Yellow Sea (including Bohai Sea) as determined by analysis of images from the Landsat Archive (Murray *et al*. 2011, Yang *et al*. 2011). Region-wide rates are compared with the rates in Bohai Bay (Yang *et al*. 2011). The rate of loss in the key areas (in red) are given in Appendix 2. Future predictions (in grey shaded area) were generated using the estimates of rate of loss and extrapolating between years, and forward to 2020.

Table 4. National loss of coastal wetland (including marshes) and loss of intertidal flats in key areas (see Figure 5 for location) for intertidal waterbird biodiversity (in alphabetical order). Key areas were also identified in Bangladesh (1), Indonesia (1), Malaysia (2), Myanmar (1) and Vietnam (2), but no quantitative reclamation data were available (Appendix 2). Estimates of proportion coastal wetland reclaimed based on published sources.

Country	Coastal wetland ca.1980 ca.2010 (national, ha)	Proportion coastal wetland reclaimed (national) since 1980	Key area (see Appendix 2 and Figure 5)	Approximate intertidal flat area (ha) lost in key areas†	Proportion intertidal flat lost in key areas in last decade†
China (including Hong Kong, SAR China); DPR Korea		51%*	Bohai Bay – north-west Bohai Sea	53,100	59%
			Jiangsu and Shanghai coast, Yellow Sea	100,000	60% Jiangsu 15% Shanghai
			Laizhou Bay – south Bohai Sea	23,000	53%
			Liaodong Bay – north-east Bohai Sea	13,000	31%
			Mai Po and Inner Deep Bay (or Shenzhen Bay)	190	6%
			Yalu Jiang Estuary and DPRK estuaries	10,000	11%
Republic of Korea	312,000* 248,940*	60%**	eastern Yellow Sea coast	52,000	34%
			eastern Yellow Sea coast – Saemangeum only	28,000***	97%
			Nakdong-gang Estuary – Sea of Japan	300	20%
Thailand		–	Inner Gulf of Thailand	0	0%
Singapore		70%	internationally important EAAF site, but no key area with >20,000 shorebirds	–	–

* Data sources: An *et al*. 2007b, Hilton & Manning 1995, Moores 2012, ROK Ministry of Land Transportation and Maritime Affairs (MLTM) 2008, Yee *et al*. 2010.
** Total intertidal flat reclaimed in ROK is 60,800 ha (ROK Ministry of Land Transportation and Maritime Affairs (MLTM) 2008), which is 22% of total wetland area.
*** Total project including all wetlands covers 40,100 ha (Birds Korea 2010).
† For data sources see Appendix 2.

Table 5. Approved and ongoing large–scale reclamation plans of coastal provinces and cities in China and the Republic of Korea (sources: CCICED 2010b, Ko *et al.* 2011). Little published data were available for DPRK, but the 8,800–ha Taegyedo Tidal Reclamation project was completed in 2010 according to the Korean News Service (KCNA 2010) and extensive sea walls are visible on Google Map for extensive parts of the coastline.

Coastal provinces and towns	Time scale	Scale of reclamation plans relevant for intertidal flats (ha)	Purpose and data source
Hebei	~2020	45,200	Qinghuangdao harbor master plan; Tangshan harbor master plan; Huanghua harbor master plan; Caofeidian industrial park master plan
Tianjin	~2020	21,500	Tianjin coastal leisure tourism area masterplan; Tianjin harbor industrial area master plan
Shandong	2009 – 2020	42,000	Special plans of concentrated and intensive sea use in Shandong Peninsula blue sea economic zone (2009–2020)
Jiangsu	2009 – 2020	180,000	Jiangsu coastal development plan (2009–2020)
Shanghai	2011 – 2020	40,000	Shanghai municipal development and protection of beach resources planning revision
Zhejiang	2005 – 2020	174,670	Zhejiang beach reclamation master plan (2005–2020)
Fujian	2005 – 2020	55,100	Fujian province beach reclamation plan (2001–2020)
Hainan	–	unknown	
Guangxi	2008~2025	4,980	Guangxi Beihai city masterplan (2008–2025)
Guangdong	2005~2010	14,610	Guangdong province marine function zoning
Total China	**2005>**	**578,060**	
Ganghwa (west)	2012>	7,940	Ganghwa Tidal Power Station (Birds Korea 2010, Ko *et al*. 2011)
Incheon Bay	2012>	15,700 – 19,600	Incheon Tidal Power Station (MOMAF 2006, KHNP & Ecoeye 2010, Cho *et al*. 2011)
Songdo Tidal Flat	2009>	>1,000	Incheon Free Economic Zone (IFEZ) (Birds Korea 2010, Incheon Free Economic Zone 2011)
Garolim Bay*	2012>	9,000	Tidal Power Plant (Cho *et al*. 2011)
Total ROK	**2009>**	**>33,640**	

* The Garolim Bay development is currently halted (S. Millington, pers. comm.)

9. Direct links between species decline and habitat loss due to land reclamation

Studies of waterbirds linking habitat loss and population trends in Asia are badly needed. However, the urgency of the situation has become clear already. Several studies have indicated an unambiguous link between habitat losses and declines of birds (Box 1), such as when declines immediately follow habitat losses (Rogers *et al*. 2009), or when declines occur in migratory populations using the Yellow Sea (including Bohai Sea) but not in resident populations (Amano *et al*. 2010, Wilson *et al*. 2011). A common assumption made by land managers and governments is that birds will move to somewhere else following destruction of tidal habitats. This was shown not to be the case in both the Saemangeum studies for Great Knot (Moores 2012) and the Bohai studies where Red Knot are compressed into smaller and smaller remaining mudflats (Hassell *et al*. 2011), contributing at least to some of the observed declines in Red Knot. Moreover, the negative effects of reclamation on shorebird populations have been demonstrated in other flyways (Burton 2006, Burton *et al*. 2006).

Documenting the functional links between reclamation activities and biodiversity declines with detailed ecological research is incredibly important for the conservation case of intertidal wetlands.

For example, conservation organizations legally fighting the Wadden Sea shellfish-dredging permits issued by the Dutch Government won the case because they could refer to published research proving the causality between the activities and loss of biodiversity (van Gils *et al*. 2006, Kraan *et al*. 2007, 2009, 2010, 2011, Piersma 2009). Similar detailed research is now carried out in Bohai Bay by a consortium from Beijing Normal University, two Dutch institutions (University of Groningen and Royal Netherlands Institute for Sea Research - NIOZ) and the US Geological Survey (Anchorage) under the umbrella of the Global Flyway Network (GFN) and funded partially by WWF and BirdLife Netherlands (Yang *et al*. 2011a, Hassell 2011, T. Piersma, pers. comm.). Similarly, senior scientists and graduate students from Massey University, New Zealand, collaborate with volunteers from the New Zealand-based Miranda Naturalists Trust to document the migration patterns of shorebirds at Yalu Jiang and in the DPRK (Barter & Riegen 2004, A. Riegen, K. Woodley and D. Melville, pers. comm.).

In ROK, surveys of Saemangeum (Box 2) and nearby wetland systems were completed to assess whether birds were able to change to alternative flats when their original foraging habitat was reclaimed (Table 6). Following closure of the sea wall, there were strong declines recorded at Saemangeum and increases were recorded using two adjacent estuaries, Geum and Gomso, to the north and south (Moores *et al*. 2008). However, the increases in other Korean sites fell far short of the numbers of shorebirds lost from Saemangeum, and the total counts showed a large overall decline of shorebirds in the area (Figure 11).

Concurrent monitoring in non-breeding areas in Australia also showed declines in shorebird species affected by the Saemangeum reclamation, suggesting that a large proportion of the displaced birds perished (Rogers *et al*. 2009, Moores 2012, D. Rogers, pers. comm.). For example, on Eighty-mile Beach, a pristine site in north-western Australia which supports the largest non-breeding shorebird populations in the Flyway, most migratory shorebird species have declined appreciably in the past decade, while resident shorebird species have remained stable or increased (Table 7). Similarly, many species monitored elsewhere in Australia have undergone declines (for short review see Hansen (2011)). Although declines such as those on Eighty-mile Beach cannot be solely attributed to the loss of Saemangeum, several studies have indicated that threats are likely to occur at key migration sites rather than in non-breeding areas (Amano *et al*. 2010, Wilson *et al*. 2011, Szabo *et al*. 2012).

Box 1. Removing vital rungs of the ladder: why small habitat losses can have disproportional effect on populations of migrating birds

Not all migrating birds use exactly the same routes and stopover sites. Some species are very specialized and only use sites with specific resources (Piersma 2006), or staging sites where they can build up enough weight for long-distance journeys (Warnock 2010). Different species' bills are adapted to different types of mud or sand and to take different foods. Northward migration routes often differ from southward routes (Newton 2007, Gill *et al.* 2009, Minton *et al.* 2010, Lindström *et al.* 2011), for example due to seasonal differences in food availability (Yang *et al.* 2011a). The entire mixed species migration is dictated by specialization and constraints (Piersma 2007, Buehler & Piersma 2008, Batbayar *et al.* 2011). This leads to 45% of one population of Red Knots using only 20 km of coastline in Bohai Bay, China (Yang *et al.* 2008, Rogers *et al.* 2010), or more than 70% of the Flyway's Bar-tailed Godwit population depending on one other Yellow Sea site, namely Yalu Jiang (Barter and Riegen 2004).

A relatively small loss of key sites can result in big population declines (Wilcove & Wilkelski 2008). A classic example is the population crash of the Red Knot in the eastern United States caused by over-harvesting of Horseshoe Crabs *Limulus polyphemus* at a single stopover site, the one in Delaware Bay (Baker *et al.* 2004). Historically, the *rufa* subspecies of Red Knots have used Delaware Bay and its superabundant supply of Horseshoe Crab eggs to put on fuel reserves for their long flights to the Arctic (Niles *et al.* 2008).

As refuelling sites are lost or degraded this causes remaining sites to become migratory bottlenecks of heightened significance (Verkuil *et al.* 2012). Reclamation along much of the Tianjin coast has forced larger numbers of birds to remaining intertidal flats in Tangshan, Bohai (Yang *et al.* 2011a, Hassell *et al.* 2011) (now threatened by reclamation developments beyond the already completed Caofeidian reclamation plan). Loss of habitats along the south China coast has increased the importance of Mai Po and Inner Deep Bay (Anonymous 2009, Chan *et al.* 2009); damage to the entire eastern seaboard of Sumatra has funnelled populations to the Banyuasin Delta (Verheugt *et al.* 1993, Iqbal *et al.* 2010); and developments in the Red River, Vietnam have concentrated birds into the small site of Xuan Thuy (Tordoff 2002). The closure of Saemangeum (itself a hub for several species) diverted birds to adjacent wetlands in the Geum Estuary and Gomso Bay, also threatened by looming reclamation plans (Moores *et al.* 2008). However, the number of displaced birds found on Korean shores fell far short of the numbers lost from Saemangeum, suggesting that remaining tidal flats in Korea were not large enough to support so many displaced birds, and that many birds must have perished because of the Saemangeum reclamation (Moores 2012).

Recently, an application of the IUCN Red List categories and criteria at the national scale showed that shorebirds are the fastest declining bird group in Australia (Szabo *et al*. 2012). The authors attributed the declines in the status of shorebirds to threats operating outside of Australia, implicating loss of intertidal habitat to coastal development in migratory staging sites as the likely key cause of the declines. Indeed, population declines of migratory shorebirds have been recorded at several non-breeding sites in southern and eastern Australia. In general, concurrent declines have occurred at numerous independent non-breeding sites (Gosbell & Clemens 2006, Garnett *et al*. 2011). Further declines have been recorded in Queensland, with many migratory species in Moreton Bay showing evidence of declining local populations. Since all the species that were identified as declining are dependent on the Yellow Sea (including Bohai Sea) during migration, it is likely that habitat losses in that region are the principal drivers of declines. Also, numbers of Curlew Sandpiper *Calidris ferruginea* monitored on six discrete and independent sites in Australia all show the same rates of decline (D. Rogers, pers. comm.). The sites themselves are well protected so this appears to be further evidence that it is problems at the staging habitat, mostly in Bohai Bay that are responsible for these declines. Monitoring of some species at their Arctic breeding grounds indicates that indeed declines are likely caused by problems during their long migrations along the Flyway (Syroechkovskiy 2012) and not from losses on the breeding grounds.

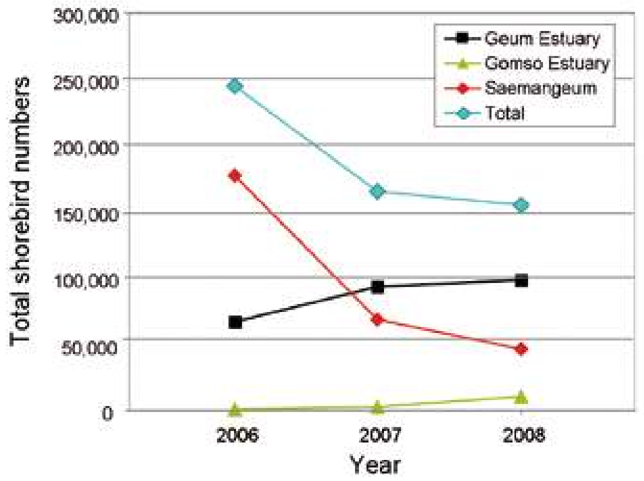


Figure 11. Changes in the population size and distribution of shorebirds in Saemangeum and adjacent intertidal areas after the closure of the Saemangeum sea wall in 2006 (data courtesy D. Rogers, N. Moores, P. Battley, C. Hassell & K. Gosbell). Research on tidal flat reclamations and the reducing of shorebird numbers in the East Asian-Australasian Flyway through Saemangeum Shorebird Monitoring Program (SSMP, Moores *et al*. 2008) and Monitoring Yellow Sea Migrants in Australia (MYSMA, Rogers *et al*. 2009).

Box 2. Saemangeum, Republic of Korea (Scott 1989, Moores *et al.* 2001, 2008, Moores 2012)

The Saemangeum mudflats at the mouths of the Dongjin and Mangyeong Rivers, on the coast of ROK has been recognised as one of the most important staging sites for migrating shorebirds in the world (Appendix 2). In the 1980s, well over 200,000 shorebirds depended on the Saemangeum estuarine habitats as an important feeding ground on the EAAF, including Spotted Greenshank and Spoon-billed Sandpiper. The entire estuary was dammed by the 33-km-long Saemangeum Seawall Project despite repeated criticism from environmentalists. It was closed off in April 2006 and officially completed in 2010 (work began in 1991). Reclamation within the wall continues and land is scheduled to be converted for agriculture or industrial development (see artists concept below). Shortly after closing the estuary to tidal influence, millions of molluscs perished and the populations of the birds depending on the estuaries as a staging site declined dramatically. Even though much is already lost, conservationists still think parts of the area are worth protective management and corrective actions. As recently as September 2011, the few remaining "living tidal-flats" in the Saemangeum reclamation area still have small numbers of shorebirds, including Critically Endangered Spoon-billed Sandpipers.

Photos show artists concept, sea wall completed and dead shellfish following closure.

Table 6. Results of the Saemangeum Shorebird Monitoring Program (SSMP), including surveys of the Saemangeum reclamation area and nearby wetland systems before and after closure of the sea wall (Moores *et al.* 2008, Rogers *et al.* 2009).

The three sites of the Saemangeum Shorebird Monitoring Program (SSMP)	Number of shorebird species that declined, 2006–2008	Number of shorebird species that increased, 2006–2008
Saemangeum	19	5
Geum Estuary	9	15
Gomso Bay	0	12
Total SSMP Region	**15**	**9**

Table 7. Overview of population changes of shorebird species spending the non-breeding season in Eighty-mile Beach, north-western Australia. Analysis of the counts by Australasian Wader Studies Group showed population changes in the 15 most abundant shorebird species (D. Rogers, pers. comm.).

Eighty-mile Beach non-breeding counts (Blue, resident species; Black, migratory species; Bold, migrants strongly dependent on intertidal flats)	December 2008	As % of 1999 and 2001 surveys
Greater Sand Plover	**22,885**	**35.4%**
Curlew Sandpiper	**3,292**	**41.0%**
Bar-tailed Godwit	**51,719**	**46.9%**
Grey-tailed Tattler	**7,950**	**54.3%**
Eastern Curlew	**423**	**59.7%**
Ruddy Turnstone	2,433	69.9%
Grey Plover	**1,146**	**72.3%**
Great Knot	**128,653**	**76.1%**
Red Knot	**23,123**	**77.9%**
Common Greenshank	2,534	104.0%
Sanderling	3,605	112.0%
Pied Oystercatcher	809	116.0%
Red-necked Stint	**28,443**	**118.5%**
Red-capped Plover	6,752	219.4%

10. Implications for fisheries

Fish and shellfish are a major food source for wildlife and form the major source of protein for the enormous human population of the coastal regions of East and Southeast Asia. Additionally, commercial and artisanal fishing industries are the main livelihood of many coastal communities. However, fisheries throughout the region are collapsing for a variety of reasons:

- **Overfishing:** Motorized fishing vessels in China increased from 10,000 in the late 1960s to 200,000 in the mid-1990s and have also increased in size, horsepower and modernized gear (China Fishery Yearbook 1998). Since 1989, China became the world's largest producer of fish (China Fishery Yearbook 2009) but catch per unit effort has decreased steadily with large bottom feeding and highly valued species being replaced in the catch by smaller pelagic, lower trophic, less valuable species. Much of the current catch is only used as feed for mariculture. Stocks of key species such as Large Yellow Croaker *Pseudosciaena crocea* are exhausted (Tang 1993) and many species breed prematurely (Li *et al.* 2011). Shellfish, being a very important component of the total harvest, are also overfished.
- **Use of unsustainable fishing or collection methods:** Even without mechanization, shellfish are often over-harvested by hand (Pedersen & Thang 1996) and industrialization of the shellfish industry has made matters worse. Increased use of explosives and poisons in coral reef areas is

causing terrible losses of complex species communities. Other unsustainable practices include the use of fine mesh nets and destructive trawl nets, harvesting of rare species of ornamental fish, molluscs and corals for tourist souvenirs, and dredging of entire reefs and beaches for lime and sand.

- **Decrease in fish, crustacean and shellfish population recruitment:** Stocks are failing to be replenished because vital spawning areas are being reclaimed, or scoured by increased sea action (itself increased by shoreline shortening of reclamations). Adult fish have reduced access to spawning areas due to a maze of traps, nets and other barriers (fish pens). Recruitment is hampered by distorted population demography (fewer reproducing adults) and increased harvest of wild larvae for mariculture use.
- **Pollution:** Fish and shellfish are dying and are rendered unsafe for human consumption as a result of increased pollution (Liu *et al*. 2007). The contaminants include heavy metals, persistent organic pollutants, toxic algal blooms and plankton. The reversal of coastal accretion, and increased scouring and coastal erosion, means that many pollutants that were removed from the ecosystem and held in deep mud are now being released back into food chains. Declines of marine fisheries due to reclamations, pollution and overfishing cause fishermen to seek new livelihoods in the damaging activities of mariculture (see below).
- **Growth of mariculture:** To meet growing demand for seafood products in face of collapsing marine supplies, mariculture has been stimulated into rapid growth in volume and technology. Mariculture production overtook wild capture in China since 1988. Today, 60% of commercial seafood products are from mariculture rather than offshore fisheries. However, mariculture waste feed and excrement introduces increasing pollution of nitrogen, phosphorous and organic matter (Cui *et al*. 2005), further degrading wild fisheries. Mariculture leads to increasing spread of diseases and easier transmission of diseases. It also results in an overall loss of the genetic resource base of the fisheries industry. The loss of genetic variation decreases adaptability in the face of changing climate and new diseases.

11. Threats to land and property

Continued coastal reclamation is leaving entire seaboards vulnerable to natural disasters from erosion, land subsidence, salination, flooding, cyclones and tsunamis. These dangers are amplified by the loss of silt discharge from major rivers, by rising sea levels and increasingly frequent extreme weather events (Figure 8) arising from climate change. All low-lying coastal lands and coastal cities are at risk.

By 2006, there were 90,048 dams constructed on the largest eight rivers flowing into the eastern seas of which 4,697 are greater than 30 m in height (CCICED 2010b). These dams, combined with reduced water flow, water diversion schemes and removal of gravel and sand for construction, have resulted in a huge reduction in silt load reaching the sea. Sediment flux from Liaohe, Haihe, Huanghe and Huaihe rivers of northern China have decreased by 99%, 99%, 87% and 66%, respectively. Measurements for Yangtze, Qiantangjiang, Minjiang and Zhujiang Rivers of southern China decreased by 67%, 42%, 41% and 65%, respectively (CCICED 2010b).

Land reclamation and construction of sea walls effectively shortens the coastline of bays and estuaries, which intensifies the scouring of sea waves. For instance, the Saemangeum seawall project reduced that shoreline to one-third of its original length. The result of intensified sea action in tandem with reduced silt deposition is that the former rate of coastal accretion has been reversed. Silt is removed by wave action leaving coarser gravel. As much as 70% of the coasts of China are now eroding (Wang 2010). Rates vary from 0.5 m/year to 14m/year, with most severe effects noticed in Bohai Sea around the Liaohe and Luanhe estuaries where erosion rates reach 2.5–5 m/year and 15–300 m/year, respectively, and Haikou area of Hainan with 5m/year (CCICED 2010b).

Land subsidence has occurred in many coastal cities such as Tianjin, Xiamen and Shanghai. As coastal regions subside, sea level rises and frequency of cyclones increases, and land losses and saltwater intrusion will accelerate (Nicholls & Cazenave 2010). Consequently, natural defences against storm damage and tsunamis are lost (Syvitski *et al*. 2009).

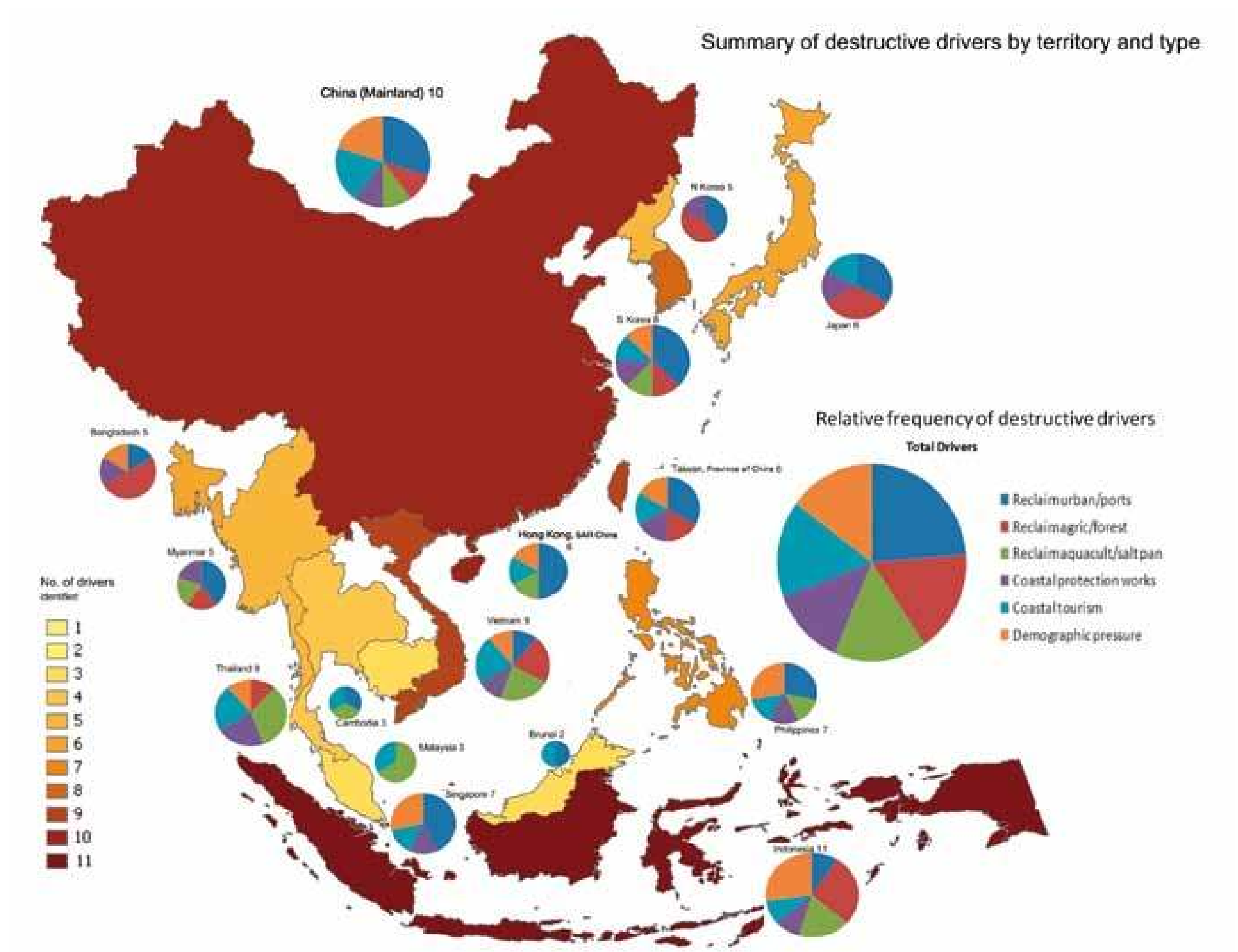
12. Review of drivers of coastal zone reclamation

Several different drivers encourage the reclamation of tidal flats (Figure 12). Appendix 3 presents a matrix of the observed threats, their drivers and possible solutions. Most are financial in nature and tend to dominate the weaker drivers for biodiversity conservation and protection of coastlines for their ecosystem services. More developed countries reclaim land for urban and infrastructure development. These are usually planned by central government or provincial development plans. Less developed countries face local drivers to undertake smaller reclamations for agricultural or aquacultural conversion when costs are low. In tropical countries this often involves pressures to extend clearing of intertidal mangroves, which also causes damage and siltation of adjacent coral reefs. The growth of threats appears to be accelerating. The following paragraphs review the main drivers involved.

Demographic

Almost one-third of the global human population currently lives along the seaboards of East and Southeast Asia. This number is rising at tremendous speed due to the labour force following work at population centres on the Asian coastlines. The pressures of expanding new developments and industries are unparalleled and are set to increase at a more rapid pace over the next three decades. Setting up of exclusive economic zones along the Chinese coast caused huge internal and international migration. China's migrant coastal population is estimated at more than 30 million.

Figure 12. Summary of the drivers of intertidal habitat loss by country or territory showing the number of drivers identified (indicated by number and size of circle) and the proportions of the various types of drivers (see pie chart legend). For source data and references see Appendix 5.



The total of 554 million people living in coastal areas of China is projected to grow to 700 million by 2020 and 840 million by 2030 (Jiang *et al*. 2006). ROK is also developing its coastal zone at a very high rate, involving large-scale demographic shifts to the urban areas of coastal cities. Overall population density of ROK is almost four times higher than China, but similar to China's eastern sea board. Demographic pressure is also very high in Indonesia and Bangladesh.

Low costs of land reclamation

Linham *et al*. (2010) found that the cost of tidal reclamation costs in East Asia is US$3–5 per cubic metre of material used (Table 8). For land reclamation in Hong Kong Harbour, Yim (1995) stated the costs of land reclamation per square metre of claim are US$3.9 when using marine fill and US$6.4 when using land-based fill material. Costs including subsequent construction on reclaimed lands can be far greater depending on the infrastructure required. Despite this, reclamation is far cheaper than land purchase or rental in most countries and certainly within urban areas, though reclamation costs are rising. The table below gives recent examples.

One of the reasons for apparent low costs of reclamation is that full environmental costs (such as loss of fisheries and other ecosystem services and externalities (TEEB 2010)) are generally omitted from project benefit evaluations. If full cost-benefit analyses are conducted, then reclamation projects may not be viable. For example, the cost of Saemangeum has been exceeded several fold and reclamation works are continuing after 22 years. Additionally, the costs of fill material used in reclamation is increasing (since Indonesia banned export of sand to Singapore in 2003, the cost has risen from $4 per tonne to $30–40).

Economic

Gross domestic production (GDP) of the 11 coastal administrations of China rose at an average 10% per annum between 2001 and 2009, reaching $US2.8 trillion or 57% of the national GDP. This GDP figure is projected to rise another 2.5 times to reach $US 6.7 trillion by 2020. Many heavy industries – for example, steel, automobile and petrochemical plants, have been relocated into coastal areas, and ports and storage quays have been developed to accommodate the huge increase in China's import and export sectors. The eight largest container ports in the world and 13 of the largest 20 are all located within the study area. The Chinese shoreline occupied by ports may increase from 600 km to 1,000 km. Together with other expansion of coastal industries and urban development, a further 5,000 km^2 of sea will likely be reclaimed by 2020 (CCICED 2010b).

GDP of marine industries (shipping, fishing, mining, tourism, salt production and exploration/ extraction for oil and gas) has grown even faster at an average of 15% per annum in China. New industries such as marine energy, marine engineering, biopharmaceuticals and marine sciences will help propel this growth even faster.

Ships and marine equipment exports from ROK in 2010 increased approximately 10% compared with the previous year, totalling US$49.8 billion, the largest performance ever. The production of marine equipment in ROK occurs in large industrial areas with direct access to the ocean. Such massive

Table 8. Costs of tidal reclamation in East Asia (Linham *et al.* 2010).

State/territory	Location	Area reclaimed (ha)	Total Cost (US$)	Unit cost (US$) per ha
Taiwan, Province of China	Kaohsiung Harbor	422.5	3.0 billion	7.1 million
Macao, SAR China	Zhuhai-Macao Port Artificial Island	208	0.37 billion	1.7 million
China (mainland)	Xiamen	3,933	3.4 billion	882,400*
Republic of Korea	Saemanguem (outer walls only)	28,300	2.1 billion	74,204
Bangladesh	Meghna	60,000	18 million	300

* From Peng *et al*. (2005)

industrial areas negatively impact coastal environments and expansion of the industry continues to threaten coastal ecosystems.

Socio-political

The strong socio-political push for rapid coastal development in China has been documented by CCICED (2010b). The development of marine resources has been identified as a special focus under China's 10th, 11th and 12th five-year plans (2001, 2006, 2011). This has ensured rapid approval for coastal constructions that are claimed to be positive for economic development: moving industry, establishing exclusive economic zones, new urban zones, port developments, oil exploration, refinery facilities, coastal roads and tidal reclamations. Implementation of Marine Development and Development of Marine Industries were respectively specified in the reports of the 16th (2002) and 17th (2007) National Congress of the Communist Party of China (CCICED 2010b). In 2008, the State Council of China published the 'Planning Outline of National Marine Program Development' placing even greater political emphasis on the economic development of the coastal zone and indirectly mounting more threats to intertidal habitats and biota. Similar forces have occurred in the ROK, with the government identifying areas that could be reclaimed in the 1980s and then systematically reclaiming them, often using the reclamations as an election banner (Moores 2006). Other countries of the region are pursuing similar socio-political policies.

Cultural and Religious

Many religious temples and cultural centres are found along the coasts of the Yellow (including the Bohai Sea) and South China seas. These are largely now developed as tourism sites and add additional pressure to the coastline. Some coastal regions have seen a huge increase in tourism development with disturbance to beaches and increased demand for sea-foods. Some sites now receive several million tourists per year (e.g. Sanya, Hainan 17 million, Phuket, Thailand 4.5 million, Kuta, Bali 2.7 million). Development of the Disneyland Resort in Hong Kong, SAR China, involved reclamation of 1.3 km^2 of sea.

Science and Technology

In theory, advances in science and technology should help reduce waste of marine resources and improve effectiveness of conservation. However, in general, advances in technology are driving further the levels of use of resources and damage to ecosystems. Advances in agriculture and mariculture have both brought added stress to the natural ecosystems. Advances in fishing technologies have contributed significantly to the depletion of marine fish stocks. Other advances are pushing the development of exploration for oil, gas and other submarine minerals, development of marine energy sources, exploitation of new marine food sources, development of additional mariculture systems, and use of new species in the biopharmaceuticals industry.

Advanced research and understanding of climate change may lead to greater awareness of the threats to the coastal zone from rising sea levels and increased and intensified storms and cyclones which may result in a slowing of investment into this threatened zone, but is more likely to result in the reliance on even greater physical constructions and sea defences.

13. Review of protective measures and tools available

Weakness of drivers for conservation of intertidal habitats

The challenges for conservation in the East Asian-Australasian Flyway are immense. Currently, conservation efforts for coastal areas are small, disparate and gaining little traction. Despite stated conservation policies of the territories concerned, several international agreements, an informal international partnership for the Flyway, and considerable conservation investments, the drivers for conservation that should be achieving a safer balance are failing to ensure environmental protection in intertidal habitats along the Flyway. The case studies presented in Appendix 9 give specific examples.

Awareness

Despite the tremendous efforts of international and domestic programmes and non-governmental organizations (NGOs), awareness of the importance of preserving functional natural ecosystems remains low within government, media, public and fishing communities affected (ECBP 2008). Statements promoting maintaining balance and harmony between ecosystems and human development, found in so many government policy documents, are not being reflected in results.

Awareness based on species, or habitat concerns, or appeals to conservation values are failing to halt governments and developers as land reclamation promises development and jobs. In each country, there is insufficient awareness of the international commitments that were made in 2010 when the CBD Strategic Plan for Biodiversity and its 20 "Aichi Targets" were agreed and adopted. Several of the Aichi Targets are especially pertinent to conservation of intertidal wetlands along the Flyway, most notably:

Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Target 11: By 2020, at least 17% of terrestrial and inland water, and 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

In order to meet these targets, it is clear that indiscriminate tidal reclamation along the Flyway cannot continue.

Lack of awareness is not limited to the international commitments that each country has made. There is also little understanding that the continued loss of ecosystem services leads to increasing threats and damage to life, health and property (Janekarnkij 2010). Economic valuations of the ecosystem services delivered by forests were effective in leading to the banning of logging over most of China, but only following catastrophic floods in 1997 (CCICED 2010c). Other areas of China's environmental policy have benefitted from joint international cooperative studies and reviews, especially the studies of special task forces organized under the China Council for International Cooperation in Environment and Development CCICED (Hanson & Martin 2006). Serious engagement of national and international celebrities, whether they are royalty, athletes, prominent businessmen, or artists can help highlight the importance of environmental issues and create a public turn-around.

Important studies and recommendations at the global level such as The Economics of Ecosystems and Biodiversity (TEEB) reports (TEEB 2010), or at national level such as the special ecosystem services task force report to the China Council for International Cooperation in Environment and

Development (CCICED 2010a), make a splash on publication, but such awareness is seldom sustained as governments' priorities keep diverting to deal with new challenges. Since there is rarely enough time for such awareness to be digested and relayed by media, educators and NGOs to the general public and local communities, who are usually the least empowered to effect development plans, it is often quicker to take awareness directly to local communities (Box 3).

Availability of information

Availability of good and trusted information on the ecology of wetlands or waterbirds should not be taken for granted by either NGOs or governments. Their collection needs a scientific infrastructure, continuous funding and cohorts of dedicated young researchers. In a few western countries, notably the UK, The Netherlands and the USA, long-term centres of academic study of wetlands and waterbirds have become established over the last 50 years. Often, work elsewhere in the world is linked to these 'source centres', a clear example being the Global Flyway Network rooted in academia in The Netherlands and Canada, employing scientists working in Australia and along the flyway, and now linking up with scientists from Beijing Normal University to document and study causalities of change on the mudflats and shorebirds using Bohai Bay (Rogers *et al*. 2010, Yang *et al*. 2011a, Battley *et al*. 2012). Within the EAAF, the development and funding of scientific centres of excellence clearly needs attention.

Lack of clear accurate, trusted and convincing information both in general terms and at specific sites weakens the potential to question developers plans or ensure that local government do not approve them without proper costing of environmental damages and losses. For instance, according to the statistics of China's State Oceanic Administration, the total approved coastal reclamation area in 2007 was 2,225 km^2. However, results gathered by the National Dynamic Monitoring and Management System show an actual reclaimed area of 13,380 km^2 in 2008 (Fu *et al*. 2010). In cases where the developer (often part of the government) is able to appoint both the assessor and the review board, EIA regulations can be easily circumvented, and EIA reports can lack the impartiality and rigour that they need. Strategic planning and EIA procedures can themselves be biased in favour of development at the expense of environment, especially if realistic environmental costs are not included in cost-benefit analyses. Even when good information exists it is often unavailable because of poor access, scientists refraining from releasing results before they are published in scientific journals (in turn delayed by slow review procedures), and because information is lost in technical jargon that non-specialists, such as planners and media, cannot understand. Outlets such as the books *Invisible Connections* (Battley *et al*. 2008) and *Godwits: Long Haul Champions* (Woodley 2009), if properly targeted, can help convey the transfer of information whilst illustrating the beauty of the fragile phenomena at the same time.

Distortion of data reporting can have disastrous management implications. Watson & Pauly (2001) demonstrated that over-reporting of catch by China (presumably to demonstrate production increases, which is important for local officials' performance appraisal) created a false perception of good health in world fisheries and delayed international action to conserve declining stocks.

Box 3. Examples of local community driven conservation

Apo Island, Philippines

Local fishermen at Apo Island were convinced by marine scientist, Dr Angel Alcala, to create a marine sanctuary instead of overfishing the area which would have led to the destruction of their reef system. Apo has since come to be known as one of the best examples of community-organized marine sanctuaries. It took three years of communicating with the local fishermen, but Dr Alcala was successful and with the help of the Silliman University Marine Laboratory and the village head (a woman), an area 450 meters along the shoreline and 500 meters out from shore was selected in 1982. This conservation model led the way for the creation of hundreds of marine sanctuaries in the Philippines and is proof that community-driven conservation efforts really do have an impact. Even though it takes some time to see that impact, fisheries around such sites continue to increase decades after establishment of the sanctuaries.

Yalu Jiang, China

Success is not guaranteed. An example is in Yalu Jiang where excellent outreach work by the Miranda Naturalists Trust, resulted in excellent local support and awareness. Volunteers were able to document large numbers of migrating shorebirds and establish the importance of the site as a migration stop-over. However, this was not enough to prevent the area becoming consumed by national and provincial plans and eventually being turned over to reclamation by the provincial government (Lee 2010).

Coastal management policy

All countries and territories of the Flyway have appropriate policy for biodiversity conservation in general and coastal management. Appendix 8 shows the various major international agreements they are party to, whose policies they share at international level and whose actions in terms of strategy and policy they are following. This existence and development of international conservation policy is an important component of international collaboration for conservation (Ministry of Environmental Protection 2011). For shorebirds migrating through the East Asian-Australasian Flyway, numerous shorebird specific policies and agreements apply (see Appendix 4). These agreements require all countries to manage their environment for the protection of an adequate network of sites for migrating birds. Furthermore, for migratory species several international policies apply, which require countries to conserve migratory birds flying throughout their region. However, despite many of these agreements and programmes being active for nearly three decades, shorebird declines are continuing.

Legislative framework

Governments of the region have been regularly introducing, revising and updating improved laws relating to coastal management and protection. Many international NGO's are also publicly advocating intertidal protection and are working to assist (see Appendix 4). Laws and decrees (together with guidelines, procedures and regulations for application and enforcement) for conservation fall into two main categories: 1) procedures for identifying, proposing and formal gazettement of priority sites for protection as nature reserves; and 2) application of EIAs in the process of development. Additional laws are gradually being developed to regulate strategic planning and Strategic Environmental Assessment (SEA) processes in the region. Laws need to be developed in parallel with assignment of governance mandates to different agencies.

Without clear management mandates, without integrated planning between upstream and coastal consequences, without a SEA or clear development zoning scheme, and with weak EIA process and a multitude of overlapping plans being pursued via national, local or private planners, there is the realization that many large-scale developments are carried forward at great damage to the environment.

Appendix 6 provides specific details for protected area (PA) legislation on a state-by-state basis along the Flyway. Legislative frameworks for protection of marine protected areas in Southeast Asia have also been reviewed by Cheung *et al*. (2002). Much of this legislation is outdated and preservationist, failing to cater for changing boundaries of dynamic wetlands, control of invasive species, habitat restoration needs, international or transfrontier parks, multiple use reserves or local community co-management (Cheung *et al*. 2002, Yan *et al*. 2004). In some countries, gazettement may not guarantee permanent protection and coastal PA degazettement has occurred, such as the loss of coastal reserves in Singapore (Pandan and Kranji Nature Reserves) and Malaysia (Klias Peninsula National Park).

Most countries have legal requirements for applying EIA and application to larger developments is fairly routine. The table in Appendix 7 compares legal approaches to EIA. A review of EIA application in Asia (World Bank 2006) also highlights the weaknesses of existing systems, such as weak enforcement, low penalties, limited public participation, and the lack of coordination between government bodies at local and central levels. Furthermore, as in many parts of the world, EIA is usually conducted by the developer, not by an independent assessor. Whilst EIA seems to be useful in assessing direct physical impacts such as pollution, noise and land disturbance, it appears that indirect assessments of impacts on biodiversity and ecosystem functions is not well practiced. Overall, EIA has not been effective in limiting the environmental damages caused by coastal developments and land reclamations.

Strategic Environmental Assessment (SEA)

Whilst EIA is applied to specific and relatively short-term projects and follows a narrowly defined format, SEA is applied to policies, plans and programmes with a broad and long-term strategic perspective. SEA considers a wider range of alternate scenarios and is conducted independently of project proponents and is less formally documented. SEA aims to balance environmental, social and economic objectives and inherently incorporates consideration of cumulative impacts (OECD 2006). A significant body of work on biodiversity and SEA/EIA including CBD guidance is relevant.

EIA is quite well developed and applied in South and Southeast Asia, but the application of SEA processes is still in a developing and experimental stage (World Bank 2006, Dusik & Xie 2009).

SEA is generally not a mandated planning process. However, China and Vietnam have established and implemented pioneer SEAs, including legal frameworks, specific guidance and increasing practice. In Indonesia, since 2007, the Ministry of the Environment, Ministry of Home Affairs and National Development Planning Board intensively developed a regulatory framework and an SEA Pilot Project aimed at mitigating climate change through protecting forests in Sumatra. Malaysia, Philippines, Thailand and Cambodia have developed basic proposals for SEA frameworks or initiated experimental projects with international donors (Dusik & Xie 2009).

Although SEA offers potential to achieve better balance in future developments in the region, it has not played a significant role yet. When planning the location or types of developments threatening the intertidal ecosystems of the region the instigation of SEA would be an excellent tool to evaluate potential large and long-term impacts on the ecosystem and ecosystem services, and can serve as a fruitful collaboration of national and local planning.

The 'Biodiversity Impact Assessment of China's Beibu Gulf Economic Zone Industrial Development Strategies and Plans' is an example of a regional level SEA undertaken by Beijing Normal University (2010) (Zhang *et al*. 2011) on behalf of the Ministry of Environment in China. The report reviews the impacts of existing and planned developments over a significant area of China's south coast and specifically identifies reclamation of mudflats and mangroves as the main reason for the decline in coastal biota and water birds and lists overharvesting of shrimps and other seafood products as a secondary threat. The plan sets objectives to increase PA coverage, protect typical ecosystems and restore key species, keep the length of natural coastline no less than 48% of the total coastline and limit the length of planned port industrial coastline to less than 12.1% of the total. It remains to be seen whether the report can be put into effect by the Ministry of Environment in the face of already planned local development interests, but if successful it could serve as a valuable model.

Mandates and governance

Even in the absence of mandatory SEA planning processes, governments of the region need to plan and manage coastal habitat in a coordinated and unified manner. Possible conflicts of interests between different ministries and sectors and decentralization of governments have to be overcome so that local economic interests are lined up with national policy, or more importantly to ensure that local dependence of habitats is taken care of. This is particularly important in the case of the intertidal zone where uses and interests of many different sectors overlap. Processes for resolving contradictory interests can be developed. For instance, Grumbine & Xu (2011) recognize that Chinese conservation values, policies and practices are not well integrated due to four systemic barriers: weak rule of law; unclear land tenure; top down government authority; and disconnects between scientific research and management implementation. They suggest combining traditional Chinese environmental values with contemporary science and international conservation practices, which will help to create a 'Conservation with Chinese Characteristics' (Grumbine & Xu 2011). Involvement of local residents and traditional values is needed to ensure that the environmental argument is fully respected.

Management of coastal developments in China has been labeled "zero management" (CCICED 2010b), with no coordination management framework in place to reconcile negative impacts of land-based activities with management of marine resources, estuaries and adjacent seas. There is no single agency providing a whole-of-government coordinated approach for the sustainable development of China's coastal and marine territory. The responsibilities of the various departments are governed by different uncoordinated legislation, resulting in many overlaps and conflicts of functions (CCICED 2010b). Similar overlaps of mandate are reported in several other countries in the region (see Appendix 7) leading to poor coordination and governance.

Integrated Coastal Zone Management (ICZM) and Ecosystem-Based Management (EBM)

Whilst EIA and SEA approaches operate for developing and approving plans, ICZM offers a way to undertake integration between different sectors at the management level. Almost all countries of the region profess to employ some forms of integrated planning and management of their coastal zones. The problem is that awareness of the importance of biodiversity is so weak that relevant experts are rarely engaged on the integrated planning teams and if involved can generally only offer generic platitudes in the lack of hard economic data. The result is that biodiversity is rarely well presented and under-protected in resultant plans.

Of many types of ICZM practiced to harmonize management of different sectors at various scales, EBM appears to be the most suitable to ensure that the continued delivery of vital ecosystem services is ensured. The EBM approach aims to ensure ecosystems are used in a sustainable way for improved human benefit and ecosystem services, in a monitored, integrated and participatory manner (Arkema *et al*. 2006).

Alder *et al*. (2010) assessed aggregate performance measures in managing marine ecosystems based on an evaluation of the national implementation of 14 indicators of EBM, including six biodiversity-related indicators, five value-related indicators and three job-related indicators, in survey of 53 maritime countries. Out of a maximum potential score of 10, the countries within our region scored at the lower end of the spread: Japan, 4.5; ROK, 4.2; Malaysia, 3.9; Philippines, 3.9; China, 3.7; Thailand, 3.6; Indonesia, 3.5; Myanmar, 3.3; DPRK, 2.8 and Bangladesh, 2.3 (Alder *et al*. 2010). There is evidently much room for improvement.

Conservation Planning

Recent selection of nature reserves and other protected areas has followed gradual identification of important sites and opportunities by respective management agencies to acquire land. Selection of some PAs and the types of development that have occurred in them has been sometimes motivated by local interests in developing potential tourism revenues rather than importance of sites for biodiversity (Yan *et al*. 2004). National PA systems have evolved rather than being based on comprehensive systems planning. However, a number of regional reviews have used gap analyses in an effort to help guide selection of potential sites to secure good representative PA systems (MacKinnon 1997, Cheung *et al*. 2002, MacKinnon *et al*. 2005, BirdLife International and IUCN 2007). In addition, conservation plans have been developed to protect specific habitat types, taxa or individual species.

As options for conservation are narrowed by growing land developments, there is a growing urgency to prioritize and zone areas for conservation protection and action. Conservation plans need to be integrated or mainstreamed into wider planning processes and protected areas planned from a broader landscape viewpoint (CCICED 2010d). Such approaches are being increasingly used in the development of National Biodiversity Strategies and Action Plans. Meanwhile, as awareness for a variety of environmental concerns grows, most governments of the region are striving to plan for a 'greener' type of development.

At the other extreme, conservationists with narrow target interests have been actively developing conservation plans to save individual species or closely related taxa. Examples on the EAAF include the International Single Species Action Plans under the CMS for Chinese Crested Tern (Chan *et al*. 2010a), and Black-faced Spoonbill (Chan *et al*. 2010b) and Spoon-billed Sandpiper (Zöckler *et al*. 2010b, Pain *et al*. 2011). There is a need to merge the two processes so that narrow target plans can fit neatly within broader plans. Moreover, synergy between many single species plans will generate overlaps and build up stronger justification for costly conservation actions. The same site that is important for shorebirds may also be important for marine turtles, rare plants or other priority conservation targets.

PA management

All countries of the region have well-developed protected area systems (MacKinnon 1997, MacKinnon *et al*. 2005, MacKinnon & Yan 2007) (Appendix 6). Even Democratic People's Republic of Korea (DPRK) has established 6% land coverage including a series of migratory bird reserves (Yun Son Suk & Kim Song Ok 2005. Most countries are well over the 10% protected area coverage target proposed by CBD in 1992, but considerable work remains to meet Target 11 of the CBD Strategic Plan for Biodiversity 2011–2020 (see above). Most of the countries are parties to the Ramsar Convention on Wetlands of International Importance (Appendix 8) and have established country focal points for the protection and monitoring of wetlands and especially of Ramsar Sites. Despite such progress, and in line with global patterns (Butchart *et al*. 2010), clearly the drivers of reclamation and other threats are much stronger than the drivers for conservation.

Furthermore, an analysis of the impressive protected areas of the region (Yan *et al*. 2004, MacKinnon *et al*. 2005, BirdLife International and IUCN 2007) reveals that there is a bias in establishment towards mountain reserves and inland wetlands, but a significant lack of representation of lowlands, coastal and marine areas. The reasons for this bias are that it is easier to designate large protected areas in the agriculturally less productive and more remote mountain areas (combined with high levels of awareness for the need to protect upstream water catchments in this region of high rainfall). In the coastal zone, awareness of conservation needs is low, probably due to reasons of demography and access, and competition for coastal lands is greatest. Conservation agencies have low financing and limited resources, resulting in weak protection and management of existing sites. Ministries or other agencies that are responsible for the establishment of protected areas or management of Ramsar Sites are generally low on the political hierarchy, not the agencies responsible for strategic planning or zoning of major developments in coastal regions, and at best only consulted during the EIA process of individual projects. The case studies in Appendix 9 illustrate these aspects in specific instances.

Where protected areas have been established in coastal areas, they have mostly been effective in conserving intertidal biota. For instance, despite big losses of habitat along the ROK coastline outside national parks, there has been no reclamation within any national park since the establishment of the Korea National Park Service.

The role of NGOs

NGOs play an important role in all countries of the region augmenting government conservation activities and providing a voice for local communities and public concern about environmental conditions. In many cases, they play an active role in ground-level conservation work, advocacy and promoting awareness (e.g. Birds Korea 2010). In Hong Kong, SAR China, WWF manages the Mai Po Marshes Ramsar Site on behalf of the government. Increasingly, NGOs are involved in a consultancy capacity in government planning and technical meetings and in the implementation of bilateral and international cooperative projects and programmes (e.g. Birds Korea 2010). Major international environmental NGOs have well-established programmes throughout the region (Appendix 4), but there has been an encouraging and rapid growth in number (several hundred), capacity and activity of national or local NGOs in all territories of the region. In the last decade, the China Coastal Waterbird Census, a monthly monitoring event started in 2005, was formed by volunteers from birdwatching and conservation NGOs in China.

Community co-management initiatives

Community-based conservation and management is poorly applied to coastal protected areas, despite the obvious interests of local fishing and seafood harvesting communities as stakeholders. There is much literature from other contexts (e.g. forest conservation) highlighting the enormous contribution community-based management can make to conservation while ensuring a sustainable flow of benefits to local communities, and this approach could also be of significant relevance in coastal habitats.

Territorial sovereignty

There are some regional overlaps in claims of territorial sovereignty that lead to disputes and certainly hinder aspects of cooperative protection for some islands and marine areas (Taek Hyun & Schreurs 2003). Hanson & Martin (2006) list ‘Impacts on fisheries and ecosystems arising from uncontrolled/unregulated exploitation in disputed areas of the South China Sea’ as one of seven security issues affecting the environment.

14. Conclusions

This study reports on the loss of East Asian intertidal habitats, and especially tidal flats, a large and urgent problem of global concern from a biodiversity conservation viewpoint. The problem extends far beyond the crisis facing many intertidal shorebird species and encompasses other taxa, commercial fisheries, livelihoods and the ecological well-being of intertidal zones across the whole of East Asia, and in particular in the Yellow Sea (including the Bohai Sea). The rate of loss of intertidal habitat is greater than in any other flyway in the world. This degradation, and consequent rate of decline of dependent species, is undermining the conservation efforts and targets of countries elsewhere on the EAAF and cannot be ignored without severe consequences. A business as usual scenario has a high chance of leading to a variety of biodiversity loss. Furthermore, the international commitments made by all countries in the region, especially to the Aichi Biodiversity Targets, will not be met unless major changes are made to manage the coastal zone in a manner that secures biodiversity and ecosystem services.

The indicators of a well-developed nation are now merely economic, but must include environmental security including sustainable coastal zone planning that takes into account the importance of tidal flats.

The issue is multinational and national in nature, and its severity is not well recognized. Greater international cooperation would help address the many different threats and drivers of environmentally degrading processes. These processes are not all sea-based. Silt which is the lifeblood of the intertidal system is derived from inland sources. Actions are needed at inland point sources, the seas, and along the shoreline.

The lack of good and trusted information and the severity of ecosystem decline calls for a major shift in attitudes, policies and procedures by governments at national and local level, by planners and developers, by the funders of and investors in development, by the media, academia, general public and by local communities. It is not enough to strengthen, bolster and improve existing actions and programmes. A complete rethink could put intertidal mudflats at the core of coastal protection and any future coastal zone management. IUCN could play a stronger role in coordinating such actions, not by criticism or trying to push western values onto Asian countries, but by working through its national membership and partners to build on traditional belief and value systems, especially Buddhist and Daoist concepts of harmony with nature. IUCN could commission ecosystem studies, help develop an integrated action plan and work with governments to find solutions. A wide range of initiatives and partner programmes could be harmonized into a comprehensive action plan, but many of the actions are urgent and cannot wait for the completion of a full international plan.

The countries of the region would benefit greatly by drawing a red line on the destruction of the last estuarine intertidal habitats by following the precautionary principle, delaying approving new reclamations until better assessment of losses is completed, and even abandoning some environmentally damaging economic dreams by opening up some of the existing sea walls and reeling back excessive fishing and mariculture activities that are far beyond sustainable levels. Building on the supportive work of World Bank in promoting capacity in SEA procedures (World Bank 2006), countries could be assisted in strengthening coastal planning processes and strengthening the network of coastal protected areas.

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List of abbreviations and acronyms

ASEAN	Association of Southeast Asian Nations
CAMBA	China Australia Migratory Bird Agreement
CBD	Convention on Biological Diversity
CCICED	China Council for International Cooperation in Environment and Development
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CJMBA	China Japan Migratory Bird Agreement
CMS	Convention on Migratory Species
DG	Director General
DPRK	Democratic Peoples' Republic of Korea
EAAF	East Asian-Australasian Flyway
EAAFP	East Asian-Australasian Flyway Partnership
ECA	Ecologically Critical Area
EnCA	Environment Conservation Act
EI	Environmental Impact
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GIS	Geographical Information System
GISP	Global Invasive Species Programme
HAB	Harmful Algal Bloom
HK$	Hong Kong dollar
IBA	Important Bird Area
ICF	International Crane Foundation
IUCN	International Union for Conservation of Nature
KCNA	Korean Central News Agency
KEI	Korea Environment Institute
KORDI	Korea Ocean Research and Development Institute
MEA	Multilateral Environmental Agreement
MoE	Ministry of Environment
MOSTE	Ministry of Science Technology and Environment (Vietnam)
NBSAP	National Biodiversity Strategy and Action Plan
NGO	Non-governmental organization
NP	National Park
NR	Nature Reserve
NT	New Taiwan dollar
PA	Protected Area
PES	Payment for Ecological Services
POP	Persistent Organic Pollutant
PoWPA	Programme of Works on Protected Areas (of CBD)
REDD	Reducing Emissions from Deforestation and Forest Degradation
RM	Malaysia ringgit
ROK	Republic of Korea
RSPB	Royal Society for Protection of Birds
SEA	Strategic Environmental Assessment
Si/N	Silicon/Nitrogen
SSMP	Saemangeum Shorebird Monitoring Program
S$	Singapore dollar
TEEB	The Economics of Ecosystem and Biodiversity
TOR	Terms of reference
TRAFFIC	Wildlife Trade Monitoring Network
UN	United Nations
UNEP	United Nations Environment Programme
US$	United States dollar
WCA	Waterfowl Conservation Area
WCMC	World Conservation Monitoring Centre
WHO	World Health Organization
WI	Wetlands International
WWF	Worldwide Fund for Nature
WWT	Wildfowl and Wetlands Trust

National/territorial ISO3 codes:

BGD	Bangladesh
BRN	Brunei Darussalam
CHN	People's Republic of China
HKG	Hong Kong, Special Administrative Region of China
IDN	Indonesia
KHM	Cambodia
KOR	Republic of Korea
MMR	Myanmar/Burma
MYS	Malaysia
PHL	Philippines
PRK	Democratic Peoples' Republic of Korea
JPN	Japan
SGP	Singapore
THA	Thailand
TWN	Taiwan, Province of China
VNM	Vietnam

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Appendices

Appendix 1. List of globally threatened and Near Threatened waterbird species of intertidal habitats in East Asia. Species are listed in decreasing order of conservation urgency, and in alphabetical order. The relative importance of the EAAF for a species is expressed from a global perspective (% global population). For identification of key areas the biogeographical shorebird population sizes were used (Appendix 2). Shorebirds (sandpipers, plovers, snipes and allies) are indicate by bold Latin names.

Species	Common name	IUCN category	Group	IUCN Red List criteria	Population size*	% global population in EAAF**	% shorebird flyway population in Yellow Sea**	Reason for listing on the IUCN Red List
Sterna bernsteini	Chinese Crested Tern	CR	SN	C2a(ii);D	<50	100%		Tiny population which is declining owing to egg-collection, disturbance and the loss of coastal wetlands.
Eurynorhynchus pygmeus	Spoon-billed Sandpiper	CR	WS	A2abcd+3bcd+4abcd; C2a(i)	140–480	>95%	significant	Extremely small population, and an extremely rapid population reduction. Habitat loss in its breeding, passage and non-breeding grounds, which is compounded by disturbance, hunting and the effects of climate change. Fledging success and juvenile recruitment are very low, leading to fears that the population is ageing rapidly.
Platalea minor	Black-faced Spoonbill	EN	WS	C2a(i)	1,830–2,700	100%		Very small population, split into several small subpopulations, that is believed to be undergoing a continuing decline owing to loss of habitat to industrial development, **land reclamation** and pollution.
Heliopais personatus	Masked Finfoot	EN	WR	A2cd+3cd+4cd	2,500–10,000	100%		This elusive species has a very small, and very rapidly declining population as a result of the ongoing loss and degradation of wetlands and especially riverine lowland forest in Asia.
Ciconia boyciana	Oriental Stork	EN	WR	C2a(ii)	3,000	100%		Very small population, which has undergone a rapid decline that is projected to continue in the future, based on current levels of deforestation, **wetland reclamation for agriculture**, overfishing and disturbance.
Grus japonensis	Red-crowned Crane	EN	WR	C1	1,700	100%		Very small population. Population in Japan is stable but the mainland Asian population continues to decline owing to **loss and degradation of wetlands** through conversion to agriculture and industrial development.
Tringa guttifer	Spotted Greenshank	EN	WS	C2a(i)	400–600	>95%	significant	Very small population which is declining as a result of the **development of coastal wetlands** throughout its range, principally for industry, infrastructure projects and aquaculture.

Species	Common name	IUCN category	Group	IUCN Red List criteria	Population size*	% global population in EAAF**	% shorebird flyway population in Yellow Sea**	Reason for listing on the IUCN Red List
Egretta eulophotes	Chinese Egret	VU	WS	C2a(i)	2,600–3,400	100%		Small, declining population, principally as a result of the **reclamation of tidal mudflats and estuarine habitats** for industry, infrastructure development and aquaculture. These factors qualify it as Vulnerable.
Pelecanus crispus	Dalmatian Pelican	VU	WS	A2ce+3ce+4ce	10,000–13,900	<1%		Conservation measures have resulted in a population increase in Europe. However, rapid population declines in the remainder of its range are suspected to be continuing and therefore the species is listed as Vulnerable.
Numenius madagascariensis	Far Eastern Curlew	VU	WS	A4bcd	38,000	100%		Rapid population decline which is suspected to have been primarily driven by habitat loss and deterioration. Further proposed **reclamation projects** are predicted to cause additional declines in the future.
Calidris tenuirostris	Great Knot	VU	WS	A4bcd	290,000	>90%	significant	Rapid population decline caused by the reclamation of nonbreeding stopover grounds, and under the assumption that further proposed reclamation projects will cause additional declines in the future.
Rynchops albicollis	Indian Skimmer	VU	WR	A2cde+3cde+4cde	6,000–10,000	10%		Population is undergoing a rapid decline as a result of widespread degradation and disturbance of lowland rivers and lakes
Leptoptilos javanicus	Lesser Adjutant	VU	WR	A2cd+3cd+4cd	3,000–4,100	60%		Small population is rapidly declining, in particular as a result of hunting pressure.
Mycteria cinerea	Milky Stork	VU	WR	A2cd+3cd+4cd	5,000	100%		Rapid population decline owing to ongoing **loss of coastal habitat**, human disturbance, hunting and trade. However, further data are needed on rates of decline in Sumatra, its stronghold.
Anser cygnoides	Swan Goose	VU	WR	A2bcd+3bcd+4bcd	60,000–80,000	100%		Poor breeding success in recent years owing to drought, and considerable pressure from habitat loss, particularly owing to agricultural development, and unsustainable levels of hunting. Comprehensive surveys in the non-breeding range have failed to detect evidence of declines of the magnitude predicted.

Appendix 1 cont'd. List of globally threatened and Near Threatened waterbird species of intertidal habitats in East Asia.

Species	Common name	IUCN category	Group	IUCN Red List criteria	Population size*	% global population in EAAF**	% shorebird flyway population in Yellow Sea**	Reason for listing
Larus relictus	Relict Gull	VU	SN	D2	3,000–4,100	100%		Small, fluctuating population, breeding at a very small number of wetlands. Susceptible to stochastic effects and human impacts. Also thought to be declining as a result of **reclamation of coastal wetlands** for development.
Larus saundersi	Saunders's Gull	VU	SN	A3c	7,100–9,600	100%		Small, declining population. The rate of decline is likely to increase over the next three generations (18 years) as a result of **land reclamation on intertidal flats** and disturbance at colonies.
Limnodromus semipalmatus	Asian Dowitcher	NT	WS	–	23,000	90%	40%	Quite widespread, but moderately small population, thought to be in decline, owing primarily to **destruction of its non-breeding grounds**. An even more rapid population decline may take place in the future owing to climate change.
Esacus giganteus	Beach Thick-knee	NT	WS	–	6,000	80%	0%	This species qualifies as Near Threatened because it has a small population. If the population is found to be in decline it might qualify for uplisting to a higher threat category.
Limosa limosa	Black-tailed Godwit	NT	WS	–	630,000–805,000	20–25%	30%	Widespread and has a large global population, its numbers have declined rapidly in parts of its range owing to changes in agricultural practices. Overall, the global population is estimated to be declining.
Numenius arquata	Eurasian Curlew	NT	WS	–	770,000–1,065,000	40%	93%	Common in many parts of its range, and determining population trends is problematic. Nevertheless, declines have been recorded in several key populations and overall a moderately rapid global decline is estimated.
Charadrius peronii	Malaysian Plover	NT	WS	–	10,000–25,000	100%	0%	Likely to have a moderately small population which, owing to the **development pressures on the coastal areas** it inhabits, is likely to be undergoing a decline.
Charadrius javanicus	Javan Plover	NT	WR	–	unknown	100%	0%	Narrow range in which **development** and recreation are putting pressure on critical breeding habitats. It is likely to have a moderately small population, and this is thought to be declining.

Species	Common name	IUCN category	Group	IUCN Red List criteria	Population size*	% global population in EAAF**	% shorebird flyway population in Yellow Sea**	Reason for listing on the IUCN Red List
Gavia adamsii	Yellow-billed Loon	NT	SN	–	16,000–32,000	20%		Undergoing a moderately rapid population decline owing to unsustainable subsistence harvest. However, accurate data is lacking and further surveys need to be conducted to quantify the current rate of harvest.
Limosa lapponica	Bar-tailed Godwit	LC†	WS	–	1,100,000–1,200,000	28%	>95%†	Rapidly declining; 100% of the *baueri* and *menzbieri* populations are dependent on the Yellow Sea (Battley *et al.* 2012).
Calidris ferruginea	Curlew Sandpiper	LC†	WS	–	1,800,000–1,900,000	10%	10%	Rapidly declining.
Charadrius leschenaultii	Greater Sand Plover	LC†	WS	–	180,000–360,000	46%	50%	Rapidly declining.
Heteroscelus brevipes	Grey-tailed Tattler	LC†	WS	–	40,000	100%	4%	Rapidly declining.
Charadrius mongolus	Mongolian Plover	LC†	WS	–	310,000–390,000	41%	23%	Rapidly declining.
Calidris canutus	Red Knot	LC†	WS	–	1,100,000	15%	63%	Rapidly declining; *rogersi* and *piersmai* populations strongly dependent on the Yellow Sea (Battley *et al.* 2005, Yang *et al.* 2011).
Arenaria interpres	Ruddy Turnstone	LC†	WS	–	460,000–800,000	6%	13%	Rapidly declining.
Xenus cinereus	Terek Sandpiper	LC†	WS	–	160,000–1,200,000	18%	27%	Rapidly declining.
Pluvialis squatarola	Grey Plover	LC†	WS	–	692,000–692,000	18%	84%	Rapidly declining.

Key
*Source: BirdLife Data Zone (www.birdlife.org/datazone) and Waterbird Population Estimates (WPE; wpe.wetlands.org).
**Source: Barter 2002; †Battley *et al.* 2012
LC† = candidates to be uplisted to NT or VU on the 2013 IUCN Red List
WS = Waterbird-specialist intertidal
WR = Waterbird-regularly occurs in intertidal
WO = Waterbird-occasional visitor to intertidal
SN = Seabird neritic (coastal)

Appendix 2. List of key areas for waterbirds, and particularly shorebirds, in the EAAF, with specific threats. Key areas were identified with waterbird population data from 388 intertidal sites in all coastal East and Southeast Asian countries; birds as top trophic predators are indicators of intertidal flat biodiversity. For each key area is given: (green columns) Protected Areas, Ramsar Sites and Important Bird Areas (IBA); (orange columns) Biodiversity of waterbirds, for site

	Key area and protection status				Status of waterbirds dependent on intertidal#				Loss of tidal flats in last decade		
Country/Territory	**Key area**	Protected Sites within Key Area***	Protected area coverage (ha)	Important Bird Area (IBA)	Number of Near Threatened and threatened species	Shorebird populations meeting 1% criterion†	Minimum recorded population size of shorebirds$	Key season^	Tidal flat size ca. 1990–2000 (ha)	Tidal flat size current (ha)	Tidal flat lost (ha, %)
Bangladesh	**North Bay of Bengal Coast**	Sonadia Island ECA **– IBA candidate & Ramsar candidate;** Nijum Dweep NP; Sundarbans – **Ramsar Site**	601,700	BD010 BD011 BD012 BD016	**8** 9	**15** 16	**207,654** 210,770 (+40,000 in Sundarbans)	NB	~68,000	•••	•••
China (including Hong Kong, SAR China)	**Bohai Bay – north-west Bohai Sea, China**	no protected areas	0	CN311	**–** 8	**15** 21	**53,425** 148,791	N S	~90,000	37,000	-31,300 (to 1993) -21,800 (to 2010) (59% loss)
	Jiangsu and Shanghai coast, Yellow Sea, eastern China	Chongming Dongtan Nature Reserve; Yancheng National National Nature Reserve and Dafeng Milu National Nature Reserve – **Ramsar Sites;** Jiuduansha NNR	563,600	CN367 CN375	**8** 18	**35** 38	**164,243** «240,911	N=S NB	Yancheng ~100,000; Chongming Jiuduansha NNR 279,600 ha	Yancheng ~40,000; Chongming Jiuduansha NNR 236,851 ha (2007)	Total ~100,000 (60% and 15% loss)
	Laizhou Bay – south Bohai Sea, China	Yellow River (Huang He) Delta NR	153,000	CN327 CN328	**4** 7	**16** 19	**134,893** 196,404	N S	~43,000	~20,000	23,000 (53% loss)
	Liaodong Bay – north-east Bohai Sea, China	Shuangtaizihekou National Nature Reserve (Shuangtai Estuary) – **Ramsar Site**	(80,000) 128,000	CN052	**13** 13	**12** 12	**65,855** 97,793	N S	~42,000	~29,000	13,000 (31% loss)
	Mai Po and Inner Deep Bay (or Shenzhen Bay) – China, Hong Kong, SAR China	Mai Po Marshes & Inner Deep Bay – **Ramsar Site;** Futian Nature Reserve	1,513; 368	HK001 CN496	**20** 11	**14** 9	**54,457** 51,045	N NB S	3,150	2,960	190
	Yalu Jiang Estuary and associated areas – China, DPR Korea	Yalu Jiang National Nature Reserve	108,057	CN062	**13**	**10**	**174,179**	N	~90,000	~80,000	10,000 (10.5% loss)

with highest biodiversity (first row, **bold**) and for total area (second row); (yellow columns) Loss of tidal flat in last decades, which is size ca. 1990–2000 minus current size; (grey columns) Habitat change, land threats, and other threats (in grey); (blue columns) Names of specifically named sites in key area, and associated sites (sites in **bold** are sites with highest biodiversity value).

Habitat change and land threats*			**Other threats**	**Other information**	
Land reclamation	Erosion/accretion	Changes of habitat nature	See Key^^	Data references**	Specifically named sites and associated areas
Tidal flat lost through Coastal Embankment Project (CEP) (Kabir & Hossain 2007). Hatiya and Sonadia Island (Chowdhury *et al.* 2011) have been proposed as seaport site.	Sediment transport and replacememt create new islands and change channels and flow of delta arms (Zöckler & Bunting 2006).	Mudflats converted to shrimp ponds, saltpans and mangrove plantations. Urgent action is required to mitigate shorebird hunting (Chowdhury *et al.* 2011). Pollution on Patenga beach due to port and ship breaking (S. Chowdhury, pers. comm.).	H P D	Islam 2001, Zöckler *et al.* 2005, Zöckler & Bunting 2006, Kabir & Hossain 2007, Zöckler *et al.* 2010b, Chowdhury *et al.* 2011	**Ganges-Brahmaputra-Meghna Delta: Damar Char**, Hatiya Island, Nijum Dweep, Patenga Beach, Char Shahajalal, Char Kukri mukri, Sonar Char. Associated areas: Sonodia Island (Cox's Bazar), Sundarbans, shared with Sundarbans, India
Further land reclamation plans for 34,700 ha of tidal flat would affect 62% of global populations of red knots and 56% of the global population of Relict Gulls (Yang *et al.* 2011a).	•••	•••	P D	Barter *et al.* 2003, Bamford *et al.* 2008, Rogers *et al.* 2010, Yang *et al.* 2008, 2011a	Beidaihe, North Bo Hai Wan, Northwest Bo Hai Wan, **Shi Jiu Tuo/Daqing He**, Tianjin/Tangshan/Caofeidian
Chongming: 2.19 million ha (50% wetland) enclosed by seawall; >15,000 ha intertidal has been developed, before 1990s in agriculture, after 1990s in aquaculture (Ma *et al.* 2009). Yancheng: from 1988 salt flats from >40% to <20% of reserve (Ke *et al.* 2011)). Rudong: wind farms and reclamation plans (China Coastal Waterbird Census Team 2011).	Reductions of sediment contributions of Yangtze River impacts extent of tidal flats (Cao *et al.* 2009).	Chongming: reclaimed land for farmland, fishponds, road systems more than doubled; 30% of intertidal planted with invasive *Spartina* (Ma *et al.* 2009). Yancheng: shellfish harvest (Barter *et al.* 2001); managed for Red-crowned Cranes. Rudong: pollution from chemical industry; invasive *Spartina*; restricted roost areas (China Coastal Waterbird Census Team 2011).	P D	Barter *et al.* 1997, Barter *et al.* 2001, 2005b, Bamford *et al.* 2008, Ma *et al.* 2009, Cao *et al.* 2009, China Coastal Waterbird Census Team 2011, Ke *et al.* 2011	Chongming Dongtan Nature Reserve, Dongsha Islands, Jiuduansha Nature Reserve, Rudong, **Yancheng Nature Reserve.**
Since 1980s, major reductions in tidal flat area and rates of loss are accelerating (Cao *et al.* 2009).	Sediment contributions of Yellow River declined by 70% leading to erosion of the delta and tidal flats (Cao *et al.* 2009).	•••	P D	Zhu *et al.* 2001, Barter & Xu 2004, Barter *et al.* 1998, 2005a, Bamford *et al.* 2008, Cao *et al.* 2009	Laizhou Wan, South Bo Hai Wan, **Yellow River (Huang He Delta) Nature Reserve**
Tidal flat claimed to grow Cordgrass (Spartina sp.) (D. Melville, pers. comm.).	Sedimentation rates insufficient for new saltmarsh generation (D. Melville, pers. comm.).	Reclamation to grow Cordgrass. Shuangtaizihekou NNR managed for Red-crowned Crane breeding grounds (D . Melville, pers. comm.). Intensive reed harvesting, aquaculture and oil extraction.	P D	Barter *et al.* 2000a, Bamford *et al.* 2008	Linghekou, **Shuangtaizihekou NNR and Inner Golf of Liaodong**
No land reclamation. Intertidal mudflats and mangroves in Ramsar Site are listed as Restricted Area under the Wild Animals Protection Ordinance (Lee 1999).	•••	Ponds function as de facto nature reserves yet allow for resource harvest and subsistence use by local people (http://www.ecf.gov.hk/en/approved/ncmap.html).	–	Lee 1999, Bamford *et al.* 2008, Anon. 2009, 2011, China Coastal Waterbird Census Team 2011	Futian Nature Reserve, Inner Deep Bay, Shenzhen River catchment area. Associated area (at 50 km): Taipa-Coloane Wetland (IBA:MO001)
Extensive past reclamation (Barter *et al.* 2000b) and ongoing (D. Melville, pers. comm.). Used by 70% of flyway's Bar-tailed Godwits (Barter & Riegen 2003).	•••	Roost sites in fish ponds are critical (Barter *et al.* 2000b)	P D	Barter *et al.* 2000b, Barter & Riegen 2003, Bamford *et al.* 2008	**Yalu Jiang Estuary (Dandong)**, Ryonghung Gang Estuary?

Appendix 2 cont'd. List of key areas for waterbirds, and particularly shorebirds, in the EAAF, with specific threats.

	Key area and protection status				Status of waterbirds dependent on intertidal#				Loss of tidal flats in last decade		
Country/Territory	Key area	Protected Sites within Key Area***	Protected area coverage (ha)	Important Bird Area (IBA)	Number of Near Threatened and threatened species	Shorebird populations meeting 1% criterion†	Minimum recorded population size of shorebirds§	Key season^	Tidal flat size ca. 1990–2000 (ha)	Tidal flat size current (ha)	Tidal flat lost (ha, %)
Indonesia	**Sumatra coast – Banyuasin Delta & Deli Serdang district**	Sembilang NP – **Ramsar Site;** Coast of North Sumatra **– potential Ramsar Site**	202,896 (core 83,361)	ID007 ID031 ID032 ID033	**10**	**12**	**86,661**	S N NB	>40,000	•••	•••
					11	13	114,530				
Malaysia	**north-central Selangor coast**	Kuala Selangor Nature Park; Klang Islands Mangrove Forest Reserve – **potential Ramsar sites**	260 (incl. high tide roost); 11,000	MY011	**9**	**6**	**17,408**	NB S N	~14,000–25,000	•••	•••
					13	11	«36,899 >27,434				
Malaysia	**western Sarawak coast**	Pulau Bruit NP	40,000	MY034 MY042 MY041	**5**	**8**	**17,991**	NB=N=S	~30,000	•••	•••
					17	•••	«24,340				
Myanmar	**Gulf of Martaban and River mouth area of Sittaung River**	no protected areas – potential Ramsar site	0		**8**	**13**	**65,246**	•••	~15,000	~2,500	•••
Republic of Korea	**eastern Yellow Sea coast**	Natural Monument, Wildlife Reserve, Protected Waterfowl Habitat (*sites in italic;* see ROK MPA/ MLTM News Report (2012.2.17))	21,896	KR004 KR005 KR006 KR010 KR017 KR018 KR019	**9**	**12>14¶**	**«82,993> 103,271¶**	N S	155,000	103,000	52,000 (34% loss)
					19	18	«339,903				
		Saemangeum reclamation project – seawall closed in 2006	0	KR021 KR022	**14**	**15>10¶**	**«198,031> 54,393¶**	N=S	29,000	<1,000	28,000 (97% loss)
	Nakdong-gang Estuary - Sea of Japan	Nakdong Estuary Natural Monument	9,560	KR035	**10**	**5**	**33,109**	S N	1,500	1,200	~300 (in 1980s) (20% loss)

Habitat change and land threats*			Other threats	Other information	
Land reclamation	Erosion/accretion	Changes of habitat nature	See Key^^	Data references**	Specifically named sites and associated areas
Banyuasin Delta: heavy pressure from reclamation activities for aquaculture.	Banyuasin Delta: long-term average coastal accretion rate is estimated at about 100 m per year.	Banyuasin Delta: local fishing industry thrives largely on shrimps and prawns.	H P D	Verheugt *et al.* 1993, Bamford *et al.* 2008, Iqbal *et al.* 2010,	**Banyuasin Delta**, Bangan Percut, Pantai Ancol, Sembilang NP, Tanjung Bala, Tanjung Selokan, Tanjung Koyan
Up to 1997, 76 reclamation projects involving 384,000 ha of land (Yusoff *et al.* 2006). Mud and sandflats are not protected under the law; sand mining; reclamation of mangroves**.	Longshore-moving cycles of erosion and accretion, and changes in the location of the seaward edge of mangrove forest in modern times affected by increases of silt discharge by the larger rivers (D.R. Wells, pers. comm.).	Reclamation for housing estates, tourism, industry, agriculture, and aquaculture reduced the number of feeding and roosting areas. Port development Klang Islands (Li *et al.* 2007, Bakewell 2009) and illegal mangrove logging**.	P D	Yeap *et al.* 2007, Li *et al.* 2007, Bamford *et al.* 2008, Bakewell 2009	**Kapar Power Station**, Klang Islands, Pantai Rasa Sayang, Pantai Tanjong Karang
Bako-Buntal: high human pressure in the bay. Pulau Bruit: increased utilization of land for agricultural purposes.	Pulau Bruit: drainage for cultivation affects may lead to decreased accretion or coastal erosion.	Bako-Buntal: restaurants line the sandbar, which is also the high tide roost for shorebirds. Pulau Bruit: migrant populations of waders have decreased due to several factors including severe erosions by storms and destructive waves.	H D	Yeap *et al.* 2007	Bako-Buntal Bay, coast from Kuala Samarahan to Kuala Sadong, **Pulau Bruit NP**, Sadong-Saribas coast. Associated area: Tanjung Datu-Samunsam Protected Area
Moulamein Deep Sea Port. Further south: Dawei Industrial Zone is undergoing large coastal development (Zau Lunn, pers. comm.).	Highly dynamic.	Area is too dynamic for aquaculture. Unsustainable fisheries with fine-mess nets. Oil and gas exploitation.	H (mistnets/ snares/ poison)	Naing 2007, Bamford *et al.* 2008, Zöckler *et al.* 2010a, H. Hla & N. Clark, pers. comm.	Associated area: Dawei River mouth in the Tanintharyi coastal zone. Other areas: Nanthar Island in the Rakhine coastal zone, Irrawaddy Delta (Labutta), Letkok Kon
Of Asan Bay >30,000 ha reclaimed. Much of Cheonsu reclaimed in 1980s. Large-scale ongoing reclamation in Geum. Namyang now largely reclaimed. Small-scale reclamation in Ganghwa and Yeonjong, after large-scale in 1990s.	Accretion is very slow (Lee & Chough 1989).	Geum smothered in silts: lagging effect of Saemangeum project, leads to die-off of shellfish (Kim & Choi 2006). Benthic habitat quality change after reclamation (Choi *et al.* 2010). No undisturbed high-tide roost sites available for shorebirds at several sites.	P D	Barter 2002, Rogers *et al.* 2006a, Bamford *et al.* 2008, Moores *et al.* 2008, Moores 2012	Asan Bay (Asan-ho lake and Sapgyo-ho lake), *Cheonsu Bay*, ***Geum-gang Estuary***, *Han-gang Estuary*, Incheon Bay, Namyang Bay, *Songdo Tidal Flat*, Ganghwa-do Island, Yeongjong-do Island.
Seawall closed in 2006, 5,000 ha flats remains but without tidal exchange (Moores 2012). Had Yellow Sea's largest concentration of Spoon-billed Sandpiper (Moores 2012).	•••	Reclamation affected 30% of flyway's Great Knots (Rogers *et al.* 2009). From 1997–2001, ca. 316,000 shorebirds during northward migration, ca. 257,000 on southward migration (Yi 2003, 2004). In 2010, fewer shorebirds during southbound migration (Korean Shorebird Network 2011).	P	Yi 2003, 2004, Rogers *et al.* 2006a, 2009, Moores *et al.* 2008, Korean Shorebird Network 2011	Dongjin Estuary, Mangyeong Estuary
Busan City wants to built airport in estuary. Various reclamation projects ongoing.	•••	•••	P D	Doornbos *et al.* 1986, Barter 2002, Bamford *et al.* 2008, Moores 2012	**Nakdong-gang Estuary**

Appendix 2 cont'd. List of key areas for waterbirds, and particularly shorebirds, in the EAAF, with specific threats.

	Key area and protection status				Status of waterbirds dependent on intertidal#				Loss of tidal flats in last decade		
Country/Territory	Key area	Protected Sites within Key Area***	Protected area coverage (ha)	Important Bird Area (IBA)	Number of Near Threatened and threatened species	Shorebird populations meeting 1% criterion†	Minimum recorded population size of shorebirds§	Key season^	Tidal flat size ca. 1990–2000 (ha)	Tidal flat size current (ha)	Tidal flat lost (ha, %)
Thailand	**Inner Gulf of Thailand**	Don Loi Hot - **Ramsar Site;** Khok Kham and Pak Thale **- Ramsar candidate**	87,500	TH032	5	10	117,500	NB N	23,000	23,000	0
Vietnam	**Red River Delta**	Xuan Thuy Natural Wetland Reserve - **Ramsar Site**	12,000	VN012 VN013 VN014 VN015 VN016 VN017 VN060 VN061	**8**	**2**	**7,801**	N S	~31,000-58,000	•••	•••
					9	4	10,899				
Vietnam	**Mekong and Saigon Delta**	Gan Gio Mangrove Protected Area; Tan Thanh intertidal area & Ngang Island - **potential Ramsar site**	223,213	VN001 VN002 VN051 VN062 VN063	**5**	**1**	**20,083**	NB N S	~273,800	•••	•••
					8	4	34,373				

* Information without reference is taken from Asian Wetlands Directory 1989 and EAAF Shorebird Network Site

** Information on Important Bird Areas (IBA) and globally threatened birds taken from BirdLife Data Zone (www.birdlife.org/datazone)

*** NP = National Park; WCA = Waterfowl Conservation Area; ECA = Ecologically Critical Areas

••• No quantitative data available

Number of GTBs given for all intertidal waterbirds (see Appendix 1). Other data only for extreme intertidal specialists: shorebirds (sandpipers, plovers, snipes and allies). First row: site with highest biodiversity. Second row: cumulative data for total area.

† 1% citerion: species present with 1% or more of the total EAAF population

§ Given are highest count (from data reference), or sum of count of species meeting 1% criterion (Bamford *et al.* 2008), either non-breeding, or during northbound or southbound migration

¶ Changes from 2006 to 2008 after closure of seawall in Saemangeum

« Indicates that a decline in shorebird population has been recorded

^ Key season: NB = nonbreeding NB, N = northbound S = southbound; based on number of present species meeting 1% criterion

^^ Other threats: H = hunting, P = pollution, D = human disturbance

Habitat change and land threats*			Other threats	Other information	
Land reclamation	Erosion/accretion	Changes of habitat nature	See Key^^	Data references**	Specifically named sites and associated areas
No reclamation on any significant scale has taken place (Round 2006), but election campaign proposed land reclamation of 10 km of coast (30.000 ha tidal flats; P. Round, pers. comm.).	Recession rate of 1.2–4.6 m/year; ca. 1 km tidal flat lost in last 30 years, especially from Bang Pakong River to the Thachin River (Sripanomyom *et al.* 2011).	Don Hoi Lot has razorshell fishery and is the single most disturbed stretch of shoreline for waterfowl in the entire gulf (Manopawitr & Round 2004).	H	BCS 2004, Manopawitr & Round 2004, Round 2006, Sripanomyom *et al.* 2011	Inner Gulf of Thailand
Entire delta areas reclaimed for agricultural land, aquaculture ponds, forestry and urban development.	•••	•••	H	Tordoff 2002, Bamford *et al.* 2008	An Hai, Ha Nam, Nghia Hung (Day and Ninh Co Estuary), Thai Thuy, Tien Hai, Tien Lang, Tra Co, **Xuan Thuy**
Mangrove planting on accreting mudflats reduces habitat for migratory waterbirds (Buckton *et al.* 1999).	Tidal flats dynamic due to erosion and accretion (Sourcebook 2012). Accretion rates along the coastline of up to 50 m per year (Buckton *et al.* 1999).	Mainly shrimps ponds and agricultural (rice) fields, some salt ponds. Disused agricultural land also provides habitat (Buckton *et al.* 1999). Mangrove forests protected now.	H (small scale)	Buckton *et al.* 1999, Tordoff 2002, Bamford *et al.* 2008, Sourcebook 2012, V. Morozov, pers. comm.	Bai Boi, Binh Dai & Ba Tri, Gan Gio,**Tan Thanh intertidal area & Ngang Island**. Associated area: Dat Mui National Park (Ca Mau Province)

Appendix 3. Major problems, drivers and possible solutions to reduce loss of intertidal habitats and biota (based on literature review and expert input).

Root causes/ drivers	Perverse processes	Resultant threats to intertidal zone	Ultimate problems	Domestic solutions	International solutions
Short-sighted agricultural policy, perverse subsidies, low awareness, weak agro-practice controls.	Over-use of chemical fertilizers. Release of excess nitrogen into water system.	Dangerous algal blooms, red tides; reduced water transparency; reduced silicates; eutrophic conditions.	Health dangers, blockage of waterways, toxic to some fish, loss of diatoms basic to many foodchains; increased toxic dinoflagellates; reduced oxygen in water.	Review agricultural policies; reverse perverse subsidies; promote more sustainable practices; strengthen agro-biodiversity protection.	FAO and other international programmes available to help countries develop sound agricultural policies and practices. Sharing of best practices.
Weak regulations and law enforcement or lack of budget for sewage treatment.	Release of untreated sewage into water system.	Algal blooms and dangerous bacteria.	Severe health dangers; loss of tourism potential; loss of biodiversity.	Ensure both regulations and enforcements maintain high sewage treatment standards. This must cover domestic sewage and farm animal wastes.	WHO and other international programmes can help countries achieve higher standards of waste treatment.
Weak EIA, weak pollution legislation, weak law enforcement drive industries to take economic shortcuts. Vietnam War defoliation (historical residues).	Release of toxic metals and Persistent Organic Pollutants (POPs) into water system from industrial activities.	Toxic materials enter food chains and mud.	Human health hazard including carcinogenic threat; kills many wild creatures and targets vulnerable species; pollutants can persist in mud and living creatures for many years; fisheries decline.	Improve environmental legislation, law enforcement and monitoring. Better zoning into development and non-development areas and siting of pollution sources. Establish strict food and health standards; develop treatment facilities.	Stockholm Convention and other programmes available to share information on ways to achieve sound management of chemicals and wastes.
Failure to collect and treat garbage. Excessive use of plastic containers and wrappings.	Dumping of untreated garbage into waterways.	Massive unsightly and hazardous flotsam littering beaches.	Plastic waste covers beaches and mudflats; disturbs wildlife and can be hazardous to animals especially if ingested; slightly toxic	Campaigns and taxes to discourage use of plastic bags and other unnecessary packaging. Improve recycling and garbage treatment.	Waste often comes from distant countries. Issue needs to be tackled on a global basis.
Inadequate controls and enforcement of standards. Inadequate equipment to clean up spills.	Leaks from drilling platforms, tankers and cleaning bilges.	Oil spill washed up on shoreline.	Oil kills many birds, fish and invertebrates.	Tighten national standards and controls; improve response capability; ensure bird treatment capacity available.	Law of Sea and other programmes can be applied.
Few livelihood alternatives, growing demand from tourism industry and for export, lack of adequate quotas and controls.	Overharvesting of seafoods – fish, crustaceans, molluscs, worms.	Cutting of mangroves, erection of net systems and traps; raking of mudflats.	Loss of fish stocks, loss of invertebrates, disturbance to shorebirds that need undisturbed roosts.	Include more habitat in PA system; strengthen protective management and law enforcement; provide livelihood alternatives; use payment for ecosystem services (PES) to pay for good ecosystem co-management.	Certification for sustainable harvested products; bilateral programmes can help provide alternative livelihoods.
Low awareness of ecology by foresters. Trees are not always 'good'.	Budgets are available for tree planting, open wetlands offer cheap, open areas for planting.	Damaging important wetlands by inappropriate tree planting.	Loss of wetlands; introduction of alien species; changes to water table; shorebirds favour wide open spaces where they feel safe from predators.	Scientific community should advise managers on when and which species of tree planting are not appropriate.	Ramsar, Wetland International and other organizations and programmes should highlight this threat to wetlands and provide guidelines on 'When and what not to plant'.
Lack of SEA; weak planning, weak PA legislation, failure to mainstream biodiversity, low awareness and short-sighted economic policies.	Urban, touristic or aquaculture encroachment.	Loss of vegetation above the high-tide line.	Loss of nesting areas and loss of undisturbed areas as secure roost sites for migratory shorebirds and other waterbirds.	Approve and apply SEA legislation. Strictly prohibit major developments in areas identified for essential ecosystem functions and socio-economic needs. Strengthen EIA enforcement. Strengthen awareness campaigns to public and planners.	International lobbying can be applied through international conventions/ programmes; media coverage and diplomatic lobbying by International agencies. Technical assistance has been provided by Word Bank and other donors.

Root causes/ drivers	Perverse processes	Resultant threats to intertidal zone	Ultimate problems	Domestic solutions	International solutions
Failure to mainstream biodiversity, short-sighted economic policies; lack of suitable regulations and subsidies to promote wiser land allocations.	Mega-development plans for new economic zones; perverse incentive schemes, land allocations.	Sea walls, reclamation of mudflats, blockage of original water flows.	Destruction/loss of intertidal habitats.	Development of National Biodiversity Strategies and Action Plans. Ensure biodiversity is considered by all relevant sectors. Strengthen SEA processes and EIA application. Publicize real costs of development and values of economic services delivered (e.g. TEEB).	Core articles of CBD. Many programmes willing to work with countries towards better biodiversity mainstreaming. Diplomatic comment and lobbying by international organizations and programmes. International projects should set good example following highest standards.
Failure to harmonize human water needs with environmental water needs. Failure to mainstream biodiversity into hydro projects. Weak control of water use.	Damming, water diversions and river water extraction; water wastage due to inefficient irrigation.	Reduced flow of freshwater into estuaries.	Salination kills riverine and coastal flora, coastal agriculture and many invertebrates; reduced silt flow deprives mud bars of fresh silt and nutrients, leads to a reduced rate of coastal accretion and nutrient input to wetlands.	Important to achieve good balance between different water needs; preserve water security and water quality. Tight regulations and controls on water use and abuse.	Rivers cross national boundaries. Several international programmes tackle entire water systems – Greater Mekong Programme, Amur River Programme etc. Funders and investors in hydro and irrigation projects should apply high environmental standards.
Weak landscape level planning; weak regulation enforcement.	Deforestation and agriculture in steep landscapes. Failure to attend to erosion scars.	Excessive silt loads in rivers; loss of precious topsoil.	Silting kills coral reefs undermining the structure of coastlines and resulting in shoreline erosion.	Restrict forest clearance, limit bio-fuel production; expand reforestation but with local species; use PES to reward good catchment protection.	CBD obligations and GEF funds available for combating land degradation.
Weak hunting controls. Some perverse policies like netting birds on airports. Weak law enforcement in PAs.	Use of guns and traps, electricity, poisons and explosives. Mist netting of birds in reserves, agricultural lands, airports.	Excessive hunting and mist netting (especially shore and water birds) for sport, food, sale or to protect crops or for air safety.	Loss of millions of birds annually, all down the migration flyway.	Review the need to erect mist-nets on airports. Provide alternative livelihoods to hunters in coastal areas. Tighten hunting regulations, and tighten law enforcement.	CITES and TRAFFIC can help monitor illegal trade lines. International organizations and programmes can exert diplomatic pressure to encourage countries to better tackle these issues.
Failure to curb and limit release of greenhouse gases; excessive and continuing destruction of natural vegetation.	Anthropogenic climate change.	Increased extreme weather (both hot and cold, wet and dry); more typhoons, floods, droughts, heatwaves; raised sea temperatures, sea levels and sea pH; changes ocean currents; loss of glacier water sources.	Raised stress on all ecosystems. Bleaching of corals. Changes to species migration patterns and mismatch of timings. Loss of coastal habitat through sea level rise.	Reduce national greenhouse gas emission levels; encourage development of clean energy alternatives; develop national strategy for biodiversity and climate change; revise PA system for greater climate change resilience, especially to promote network connectivity.	Climate Change Protocols encourage countries to curb greenhouse gas emissions. GEF available to fund projects aimed at tackling climate change issues. REDD programmes. Ensure biodiversity concerns are included in climate change mitigation plans.
Poverty and lack of alternative livelihoods; weak control of forest damage; lack of suitable incentives.	Unsustainable cutting of mangroves for fuel and tannins; uncontrolled harvest of other resources.	Conversion of mangroves into fish ponds.	Destruction of mangrove habitat; acidification of soils and waters; source of invasive alien species.	Law enforcement, awareness activities, assistance with alternative livelihoods.	Technical assistance, advocacy, aid in alternative livelihoods, adherence to certification systems.

Appendix 3 cont'd. Major problems, drivers and possible solutions to reduce loss of intertidal habitats and biota (based on literature review and expert input).

Root causes/ drivers	Perverse processes	Resultant threats to intertidal zone	Ultimate problems	Domestic solutions	International solutions
Uncontrolled release of invasive alien species (IAS).	Forestry, horticulture, agriculture, aquaculture and accidents all bring new species.	Spread of many invasive alien species of fauna and flora; spread of diseases and pathogens.	Damage to environment, displace local species, destroy local species; damage health of wildlife, domestic animals and humans.	Adopt cautionary IAS legislation with provisions for safe trials, releases, monitoring, and responses. Should include secure genetically modified organism (GMO) regulations. Undertake studies, reporting and monitoring.	This issue is covered under CBD and PoWPA. Assistance can be gained from some international programmes, by way of information sharing, best control practices etc. IUCN SSC support from Invasive Species Specialist Group.
Corruption; lack of transparency.	Approval of developments that enrich a few powerful people but at cost of: environment, long-term economic sustainability, wider public, biodiversity.	Lack of mainstreaming of biodiversity into plans and developments. Whitewash EIA. Diversion of key funds. Misappropriation of farmers and public lands. Failure to include environmental costs and externalities into development cost/ benefit calculations.	Destruction of habitat; promotion of many illegal actions.	Constantly fight and punish corruption; develop better transparency; greater public participation and comment; greater freedom of media to cover environmental issues.	Diplomatic lobbying; setting good examples.
Lack of awareness; lack of funding.	Failure to build long-term environmental concerns into development process.	Lack of funding, weak environmental protection, lack of concern at degrading environment.	Loss of habitat, loss of species; weak protection of PAs; excessive consumption of unsustainably harvested products.	Promote awareness campaigns; include environmental training in education; reward environmental awareness in performance evaluation.	Development of or distribution of awareness materials in local languages.
Low capacity for research and monitoring; low funding allocations.	Lack of reliable data on coastal biodiversity; low awareness.	Decisions are made without sound information base.	Damaging developments and losses of habitat.	Strengthen research and monitoring. Involve academic institutions in management advice; promote better data sharing; participate in international programmes.	Improve the collation, analysis and publication of relevant data. Improve access to data via open websites and in local languages.
Lack of agreement on marine boundaries.	Failure of countries to take sustainable use approach.	"Opportunistic exploitation of marine biodiversity".	Inability to establish protected areas or apply sustained harvesting of resources.	Refrain from irreversible developments or actions pending dispute resolution.	Encourage peaceful resolution, peace parks or get both sides to agree on necessary conservation measures.

Appendix 4. List of major international programmes with direct relevance to the EAAF.

Programmes	Mission/Functions	Activities
A. Programmes under international conventions		
UN Convention on Biological Diversity (CBD)	Articles cover the entire spectrum of actions to conserve biodiversity.	Programme of Work for Protected Areas specifically tries to promote compliance in protecting natural areas for biodiversity.
Ramsar Convention on Wetlands	Protection of globally significant wetlands especially for waterbirds.	Requests member countries to protect globally significant wetlands. Provides EIA/SEA guidance.
Convention on Migratory Species (CMS)	Worldwide UN convention.	Conserves all types of migratory species but currently only has a few contracting parties in East Asia (see Appendix 8).
East Asian-Australasian Flyway Partnership (EAAFP)	Convention of migratory waterbirds and their habitats.	Establishes and supports protection for a network of protected sites for habitat of migrating birds along the Flyway. Supports several task forces, including Spoon-billed Sandpiper Task Force.
Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)	Cooperation between South Korea and Australia.	Co-operation in taking measures for the management and protection of migratory birds and their habitat and the prevention of the extinction of certain birds.
China Australia Migrating Birds Agreement (CAMBA)	Cooperation between China and Australia.	Support protection of sites and study of migrations between the two countries.
Japan-Australia Migratory Bird Agreement (JAMBA)	Cooperation between Japan and Australia.	Support protection of sites and study of migrations between the two countries.
China-Japan Migratory Bird Agreement (CJMBA)	Cooperation between China and Japan.	Supports protection of migrating bird sites of birds shared between the two countries.
B. Programmes under specific international organizations		
International Union for Conservation of Nature (IUCN)	Has special volunteer Commissions to assist with Protected Areas and Species.	Provides standards, guidance and best practices. Significant work on guidance for EIA/SEA. World Commission on Protected Areas pushes CBD Programme of Works on Protected Areas (PoWPA) and develops regional action plans; Species Survival Commission attends to species concerns with many taxonomic specialist groups. Produces Species Action Plans.
BirdLife International	A global Partnership of national conservation organizations that strives to conserve birds, their habitats and global biodiversity, represented in 14 countries and territories in the EAAF. The IUCN Red List Authority for birds.	Maintains comprehensive database on globally threatened birds, and promotes their conservation through the Preventing Extinctions Programme. Important Bird Areas (IBA) Programme identifies, documents and protects key sites for bird conservation worldwide. Global Flyways Programme is currently initiating new activities in EAAF.
Wetlands International (WI)	Global specialized NGO for wetlands conservation. Acts as co-convenor, along with IUCN SSC, of waterbird Specialist Groups.	Promotes importance for and supports protection of wetlands globally. Coordinates the International Waterbird Census and Waterbird Population Estimates programmes. Several national offices within the EAAF region.
Global Flyway Network (GFN) Research Programme	Research programme supervised under University of Groningen/Royal Netherlands Institute of Zoology.	Supports dedicated demographic and migration ecology research on a few key migrant species along the Flyway (Red and Great Knots, Bar- and Black-tailed Godwits), focusing the actual research efforts in north-west Australia (Roebuck Bay and Eighty-Mile Beach) and Bohai Bay, China, the latter in collaboration with Beijing Normal University.
WWF	Global conservation NGO with many national programmes within EAAF region.	All forms of conservation activity but a long history of supporting wetlands conservation. Manages key site at Mai Po Ramsar Site Marshes in Hong Kong, SAR China.
Royal Society for the Protection of Birds (RSPB)/BirdLife in the UK	Specialist society supporting all types of bird conservation activities in UK and worldwide.	Supports Spoon-billed Sandpiper Task Force. Provides funds, news and technical materials.
Wildfowl and Wetlands Trust (WWT)	Promotes research, conservation and education on matters of wildfowl and their wetlands.	Has special project for conservation of Spoon-billed Sandpiper using artificial breeding and head-starting.
C. Other		
Global Environmental Facility (GEF)	Provides funds for regional and national projects under CBD.	Has undertaken regional Southern Seas Project, Yellow Sea large Marine Ecosystem project and many national wetlands protection projects.
Asian Development Bank/ World Bank and several bilateral aid programmes	Fund development projects in Asia both as loans and grants and technical assistance.	Many environmental protection projects including wetlands and corridors.

Appendix 5. Matrix of issues affecting different countries/territories. Matrix of issues scored by authors in discussion with experts attending the EAAFP meeting 2012 and reviewed by national authorities and experts

A. Destructive drivers impacting (or historical impacts) on intertidal habitats

Territory ISO3 code /importance of destructive driver	CHN	HKG	TWN	KOR	PRK	JPN	PHL	VNM	KHM	THA	MYS	BRN	SGP	IDN	MMR	BGD	Total
Reclamation for urban development and ports	***	***	**	***	**	**	**	*	*			*	***	*	**	*	27
Reclamation for forestry or agricultural land (including historical)	*		*	*	**	**		**		*				***	*	***	17
Conversions to fish ponds or salt-pans (including historical)	*	*		*			*	**	*	***	**			**	*		15
Coastal protection engineering	*		*	*	*	*	*	*		**			*	*	*	*	13
Coastal tourism impacts/ development	**	*	*	*		*	*	**	*	**	*	*	*	*			16
Demographic pressure	**	**	*	*			**	*		*		*	**	***		*	17
Total driver score	10	7	6	8	5	6	7	9	3	9	3	3	7	11	5	6	36% of possible

B. Effective conservation-oriented tools in place

Territory (ISO3 code) /strength of protective tools	CHN	HKG	TWN	KOR	PRK	JPN	PHL	VNM	KHM	THA	MYS	BRN	SGP	IDN	MMR	BGD	Total
Mandates of responsibility clearly defined	*	**	*	*	**	**	***	**	***	**	***	***	*	*	**	**	31
Adequate PA system (coastal coverage)	**	***	**	*	*	*	**	*	*	*	*	*	*	**	*	*	22
Strong Ramsar programme in relation to identified potential	**	***		**		**	*	**	*	**	*	*		**	*	*	21
Strong PA legislation and enforcement	*	***	**	**	*	*	**	**	**	**	**	**	**	**	**	***	31
Effective PA coverage and effective management	*/**	***	**	**	*	***	*	*	*	**	**	**	***	*	*	**	28.5
Monitoring migrant birds	**	***	**	***	*	***	*	**	*	**	**	*	*	*	*	*	27
Effective EIA process (law and application)	**	**	**	**	*	**	*	**	*	*	**	**	**	*		*	24
Integrated planning/ SEA	**	**	**	**	*	*	*	**	*	*	**	*	**	**	*	**	25
Local community involvement	*	**	**	*		**	**	**	*	**	*	*	**	**	**	**	25
Public awareness of issue	**	**	**	**		*	*	*		*	*	*	*	*	*	*	18
Total tools in place	16.5	25	18	18	8	18	15	17	12	16	17	15	15	15	12	16	53% of all possible tools

Appendix 6. Comparative review of protected area legislation and management.

Country/ Territory	Main laws for establishment/management of Protected Areas	% intertidal habitats lost since 1970s (measured by N. Murray in 2011 for Yellow Sea and Bohai Sea area, otherwise based on Google Map)	% territory protected (Chape *et al.* 2008)	% coastline protected (Assessed from PA maps of each territory)	No of coastal Ramsar Sites out of identified potential Ramsar Sites (BirdLife International 2005)
Bangladesh	Bangladesh Wildlife Preservation Act, 1974	<10%	1.7%	<5%	1/3
Brunei Darussalam	1934 Forest Act (revised in 1984); 1978 Wildlife Protection Act	<10%	59%	5-10%	0/2*
Cambodia	Royal Decree 1993; King designations ad hoc	<5%	24%	10–20%	1/6
China (mainland, including Macao, SAR China)	National regulations on establishment of nature reserves (1985); Forest Law (1984, revised 1998); Fishery Law (1986); Law on Protection of Wild Animals (1988); Environment Protection Law (1979, revised 1989)	c. 51%	15%	c. 20%	5 out of 53; Macao has one potential Ramsar Site
Hong Kong, SAR China	Country Parks Ordinance, 1976 revised 2005; Marine Parks Ordinance, 1995, Wild Animals Protection Ordinance, 1976	10–20%	48%	c. 26%	1/ 1
Taiwan, Province of China	National Parks Law, 1972; Cultural Heritage Preservation Law, 1982; Wildlife Conservation Law, 1989	10–20%	12%	38%	0/23
DPR Korea	Law on Forests, 1992; Law on Prevention of Sea Pollution, 1997	c. 10%	6%, NBSAP plans for 20%	<5%	0/23*
Indonesia	Forestry Act No. 41/1999	5–10%	24%	5–10%	1/31
Japan	Nature Conservation Law, 1972; Natural Parks Law, 1957 (revised 2002); Promotion of Nature Restoration Act, 2003	40%	17%	<5%	10/103
Malaysia	National Parks Act 1980; National Forest Act 1984 (Act 313); Wildlife Conservation Act 2010; Marine Parks under Fisheries Act 1985 (Act 317, revised 1993), all supported by State level legislation	<10%	27%	<5%	1/17
Myanmar	1994 Protection of Wildlife and Protected Areas Law (being revised)	<5%	5.2%	<5%	1/5
Philippines	National Integrated Protected Areas System Act of 1992 (being revised)	<10%	19%	10–20%	1/11
Republic of Korea	Natural Parks Act, 1997 (revised 2001); Natural Environment Conservation Act, 1991; Wetlands Conservation Act, 1999; Law on Conservation and Management of Marine Ecosystems; plus specific acts for protection of some small islands, main mountain range, cultural and genetic resources	55%	7%	<5%	0/29
Singapore	Parks and Trees Act 2005; National Parks Board Act sets up the organization	>70%	6.5%	4%	0/1*
Thailand	Wild Animal Protection and Preservation Act 1960 (revised 1992); National Park Act 1961; Conservation of National Environmental Quality Act 1992	>15%	22%	5–10%	3/13
Vietnam	Forest Law (1962 defines special forests); Decree No 117/2010/ND-CP organization and management of Special forest in Forestry System; Biodiversity Law 2008	10–20%	6.3%	<5%	1/14

* Not a party to Ramsar

Appendix 7. Comparative table of legislative procedures for EIA /SEA by country/territory (based on Phillips *et al*. 2009, World Bank 2006 and national expert comments).

Main EIA/SEA legislation	Coverage	Who responsible for EIA	Public involvement	Comments	Penalties
Bangladesh					
EIA Regulations, 1992; Environment Conservation Act (ECA), 1995 Environmental Conservation Rules (ECR), 1997	All construction projects falling under orange and red categories of impacts.	Developer prepares report after TOR approved by Department of Environment who then must approve report.	Citizens may lodge petitions against any development.	EIA legislation for industrial projects does place emphasis on biodiversity/ ecosystems.	Appellate body hearing petitions may impose fines, other penalties or order closure of development.
Brunei Darussalam					
Draft law not yet approved	In principle the Government requires EIA for large and heavy industries.		Not applicable.		Not applicable.
Cambodia					
Sub-decree on EIA, 1999	Projects impacting on environment.	Ministry of Environment.	General statement in regulations.	No monitoring stipulated.	Penalties determined by court of law.
China (mainland)					
Environmental Impact Assessment Law, 2003	Should be undertaken before any development project starts.	Ministry of Environment and its provincial bureaus of Environmental Protection.	Public consultation is mandated with 2 weeks for public hearings.	Enforcement weak. Biodiversity content of reports is also poorly defined.	Maximum fine is only US$30,000, way below the cost of any development.
Hong Kong, SAR China					
EIA Ordinance, 1998	Policies, plans and projects.	Department of Environmental Protection. Review panel established for each case.	Strict and concrete requirements in regulations. NGOs and public can be involved during the public consultation.	A statutory advisory body (Advisory Council for the Environment) has been established with members coming from public, academic and NGOs. Requires alternates studies and full disclosure. Effectiveness depends on strength of Review panel.	Range of fines up to HK$5,000,000 and/or up to 5 years in prison.
Taiwan, Province of China					
Environmental Impact Assessment Act (revised 2003)	All development activities and constructions for which there is concern of adverse impact on the environment.	Environmental Protection Administration, Executive Yuan, at the central level, local governments at lower levels.	Phase II of EIA process involves public notification, public explanation meeting, public inspections and development of residents plan.	Developer prepares phase I EI statement for review by competent authority. Depending on review, may be required to move to phase II with fuller EIA, alternate plans, etc.	A range of penalties are defined with prison for maximum of 3 years and fines up to 1.5 million NT.
DPR Korea					
Law of Environmental protection, 1986 (with Enforcement Decree dated 1995). Specific EIA regulations are lacking	A joint report by UNEP and Government of DPRK admits that environmental laws and regulations need to be formulated or upgraded urgently.	State Environmental Protection Bureau.	Not required.	DPRK has seen red tides and withered crops, as well as the destruction of ecosystems, and water pollution, all side-effects of severe environmental pollution.	Courts can impose fines and closures.

Main EIA/SEA legislation	Coverage	Who responsible for EIA	Public involvement	Comments	Penalties
Indonesia					
Environmental Management Act No.23, 1997; EIA Law, 2001	Projects with impacts on environment.	Environmental Impact Management Agency under MoE.	Strict and concrete requirements in regulations. Difficult for public to access details. NGOs may represent public.	Alternatives study and follow-up monitoring stipulated in regulations. Lack of cross sectoral coordination.	Fines imposed by local courts following standards and conditions (colour coded).
Japan					
EIA Law promulgated 2008 (revised 2011)	Projects with impacts on environment.	Proponent submits EI statement and summary to prefectural governor.	All steps are open to mandatory public review.	A series of steps are taken depending on the nature of the project, the relevant ministry and the review comments received from public and related agencies. All relevant authorities must approve the EIA.	Penalties for non-compliance are not specified in the Law.
Malaysia					
Environmental Quality Act, 1974	Section 34A, requires EIA for developments that have significant impact to the environment.	Ministry of Environment.	Limited. DG of department can approve reports after internal review with no need for public review. EIA is now becoming devolved to State Governments.	Specific guidelines are available for EIA on Coastal and Land Reclamation and also for coastal tourism developments and ports.	Contravention of regulations can carry fine up to RM 100,000 with up to 2 years imprisonment.
Myanmar					
The need for EIA laws is recognized by the Myanmar Agenda 21. New law is in draft.	Projects undertaken by international agencies with mandatory EIA policies.	National Commission for Environmental Affairs (NCEA) has authority to require the commissioning of EIAs.	Depends on external agency conducting EIA. Public consultation mandatory.	EIAs are conducted on an ad hoc basis for projects funded by international organizations and some foreign corporations. New legislation is being developed.	Legal penalties to be included in new law.
Philippines					
EIA Regulations DOA 30/2003	Projects with impacts on environment.	Department of Environment and Natural Resources.	Strict and concrete requirements in regulations with particular respect for indigenous cultural communities.	Alternatives study and follow-up monitoring stipulated in regulations. Developers still try to get round these regulations.	Up to 6 months in prison or up to 200,000 peso fine or both.
Republic of Korea					
Environment Preservation Act, 1997; EIA Act, 1993	Urban development projects, industrial site constructions, energy developments.	Korea Environment Institute (KEI) under Ministry of Environment.	All the projects subject to EIA must be approved through a public hearing.	Responsible administrative agency should implement consultation results, monitor implementation, and assign responsibilities for keeping records of the implementation procedures.	Improper implementation may result in the suspension of construction, sentence up to five years in prison, or fines up to 5,000,000 won.
Singapore					
Environmental Protection and Management Act, 2000; covers only impacts of chemical air and water pollution, and noise controls.	Projects impacting on environment. There is a separate Traffic Impact Assessment process.	Ministry of Environment and Water Resources. NGOs may submit independent EIA. Biodiversity Impact Assessment is administrative process managed by the Urban Redevelopment Authority.	Not required.	Follow-up monitoring stipulated in regulations.	Different fines for different offences up to S$50,000 and up to 2 years imprisonment.

Appendix 7 cont'd. Comparative table of legislative procedures for EIA /SEA by country/territory.

Main EIA/SEA legislation	Coverage	Who responsible for EIA	Public involvement	Comments	Penalties
Thailand					
National Environmental Quality Act, 1992	Projects that will impact environment.	Ministry of Natural Resources and Environment took over from Ministry of Science and Technology.	Only a general statement in technical guidelines.	Biodiversity not specified. No information disclosure or follow-up monitoring stipulated.	Fees and penalties to be paid into Environmental Fund'. Up to 5 years in prison, up to 50,000 Baht, 4 times published fees and damages including any clean-up costs.
Vietnam					
Decree 175/CP 18 October 1994 under Law on Environmental Protection, revised 2007	All large-sized or high potential impacts projects, of which several types are defined under the decree.	Ministry of Science Technology and Environment (MOSTE).	Local community representatives can input opinions.	Public disclosure required. No follow-up monitoring stipulated.	Law refers to fees and fines but does not specify maximum, decided by courts.

Appendix 8. Participation in Multilateral Environmental Agreements and associated actions.

ISO3 code /MEA party	BGD	BRN	CHN	IDN	JPN	KHM	KOR	MMR	MYS	PHL	PRK	SGP	THA	VNM
UN Convention on Biological Diversity	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	yes	yes
UN Convention to Combat Desertification	yes	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
UN Framework Convention on Climate change	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Convention on Migratory Species	party	no	sign	yes	no	sign	no	sign	sign	party	no	no	sign	sign
Ramsar Convention	yes	no	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes	yes
East Asian-Australasian Flyway Partnership	yes	no	yes	yes	yes	yes	yes	ngo	yes	yes	no	yes	yes	yes
UN Convention on the Law of the Sea	yes	yes	yes	yes	yes	ratify only	yes	yes	yes	yes	ratify only	yes	yes	yes
Updated National Biodiversity Strategy and Action Plan (NBSAP) or equivalent	yes	no	yes	yes	yes	yes	yes	yes	state level	yes	yes	yes	yes	yes

Appendix 9. A selection of case studies in key areas.

Conditions and drivers vary greatly from one country to another. The following case studies reveal contrasting problems at different key sites along the EAAF.

A. Tianjin Land reclamations affect Bohai Sea shorebird populations

Land rentals in the special economic zone of Tianjin Municipality, China, are so high that although there is plenty of land available, it is cheaper and less trouble to reclaim new land from the sea. A huge new economic development complex being created on such reclaimed lands is causing extensive loss of important shorebird habitats. CCCC Tianjin Dredging Co., Ltd. won the US$125 million contract from local government to construct 46 km of sea walls and fill the area with dredged silt and sand. A rather complicated and expensive process is used to consolidate this new land before building on it. However, with no rock for some 300 m below the construction zone, and the potential for such a sand / mud mix to liquefy in the event of an earthquake, the entire project looks expensive, ecologically damaging and unsafe; 250,000 people died when the Tangshan earthquake hit this region of China in 1976. It seems developers are willing to take the risks and 44 km^2 of new industrial land is being created.

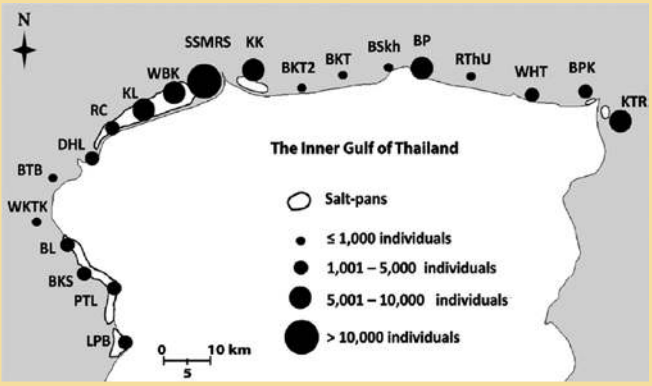
The extent of civil engineering has changed the sea floor of the Yellow Sea, decreasing the size of a deep cold trough where fish survived the summer heat. Turbidity and pollution accumulate because the semi-enclosed Bohai Sea has a very slow seven-year replenishment rate. Loss of birds from Tianjin flats have resulted in big increases in birds at adjacent Tangshan whose flats may not be able to sustain increased populations and is itself threatened by provincial reclamation plans of Caofeidian (Yang *et al.* 2011a).

Key decision makers: Planners at national, provincial and municipal levels
Key drivers: National, provincial and municipal development plans; high prices for land rent

B. Gulf of Thailand threatened but salt-pans are better than fish ponds (Sripanomyom *et al*. 2011)

Almost all original mangroves and mudflats of the Gulf of Thailand have been converted into fish ponds, agriculture or salt-pans. Teams studying numbers of 35 species of non-breeding shorebirds at 20 localities around the Gulf of Thailand analysed the influence of landscape characteristics on species richness, abundance, and diversity of shorebirds from October 2006 through to April 2007. Sites with salt-pans present held significantly higher species richness, abundance and diversity of shorebirds. Areas with larger proportions given over to aquaculture tended to have lower species richness, abundance and diversity, partly due to lack of feeding space and also lack of secure high tide roosts. The inset figure shows overall abundance for surveyed sites.

The gulf exhibits examples of both good and poor coastal planning. The Department of Fisheries has tried to develop coastal zone planning for aquaculture. Provincial committees have been encouraged to take responsibility for this duty through the support of the Ministry of the Interior and the Ministry of Agriculture and Cooperatives, but progress has been slow. This may be because of the many conflicts which occur over coastal land use, as well as inadequate laws and regulations (Tookwinas 1998). Recent plans to reclaim and develop a 10-km strip along the northern end of the Gulf are currently being promulgated as part of electioneering promises.



Key decision makers: Planners at national, provincial and county levels, local landowners, farmers
Key driver: National and Provincial plans for development of coastal region, investors in reclamations, businessmen, market forces

Appendix 9 cont'd. A selection of case studies in key areas.

C. Issues at Jiangsu and Shanghai coast

Yancheng Marshes has been a nature reserve since 1983, protecting a total coastline of >250 km, and serving as an important site for shorebirds, Endangered Red-crowned Cranes *Grus japonensis* and breeding site of Vulnerable Saunders's Gull *Larus saundersi* and Chinese Water Deer *Hydropotes inermis* (Scott 1989). Immediately adjacent to the southern buffer zone of the nature reserve, the unprotected intertidal flats in Rudong County have recently been identified as probably one of the most important sites on the entire Chinese coastline for Spoon-billed Sandpipers, hosting the biggest flock seen anywhere for 12 years (Li 2011; also see www.birdlife.org/community/2011/10/triple-figures-of-spoon-billed-sandpiper-in-china/).

Reclamation, despite the status of Yancheng NR, has led to rapid loss of intertidal habitats to agricultural, salt-pans and mariculture (Ke *et al.* 2011) resulting in the almost complete loss of a major breeding site for Saunders's Gull (Cao *et al.* 2008), the spread of introduced *Spartina* grass (Chung 2006), and a wind farm and extensive reclamations behind a 5-m wall at Rudong. A total of 200 wind turbines are planned for the wind farm, with more than half already erected, at a total investment of US$300 million from local government to generate tax revenues of US$6 million/annum. The coastline is overharvested for various shellfish which involves raking flats and digging in salt-marshes. The Three Gorges Dam, which closed in 2003, has resulted in greatly reduced silt flow from the Yangtze Estuary, which has led to a substantial slowing of coastal accretion (formerly up to up to 200 m per year). As sea levels rise erosion of these new lands is likely to result.

Key decision makers: Planners at national, provincial and county levels
Key driver: State plans for development of coastal region, investors in reclamations, state companies of chemical factory and wind farms

D. Banyuasin delta and Indonesia's transmigration programme

In a programme started in Dutch colonial days and continuing to the present, a total of more than 16 million people have been permanently moved from the overcrowded islands of Java and Bali and resettled in less densely populated and less developed Sumatra, mostly near the coasts. At its peak in the 1980s, the programme was funded by the World Bank, Asian Development Bank and other international agencies. The programme has been criticized on ethnic, economic and environmental grounds; certainly, the programme has accelerated the rate of deforestation, increased the spread of bush fires (especially in peatlands), and led to the clearance of much of the coastal wetlands of the Sumatra. Spontaneous migration of sea-faring people, such as the Sulawesi Bugis, has also destroyed wide swathes of coasts along eastern Sumatra, even inside major nature reserves such as Kutai and Berbak. Another historical problem has been the removal of more than 1 billion cubic meters of beach sands each year, sold to Singapore to serve as landfill. Indonesia banned such sand exports in 2003. The huge system of beaches, mangroves, freshwater swamps and peat swamps has been 95% destroyed since 1970, leaving the only remaining large protected swamp complex at Sembilang National Park at Banyuasin in South Sumatra province. Consequently, this site is of heightened importance for waterbirds, but whether current refugial populations can be sustained in this reduced area remains to be seen.

Key decision makers: Planners at national, provincial and Kabupaten county levels, settlers, local landowners, farmers, fishermen
Key driver: National and Provincial plans for transmigration programmes, overseas investment banks, market forces

E. Bangladesh reclamation plans

Bangladesh reclaimed 1,000 km^2 of new land in the Meghna Estuary by building two dams in 1957 and 1964.The Bangladesh government has now approved an ambitious project under which a series of dams would be built in the Meghna Estuary to connect islands and help deposit hundreds of millions of tonnes of sediment, reclaiming 600 km^2 of land from the sea over the next five years. At a cost of only US$18 million, the dams will expedite all sedimentations and manage the tidal system. The mighty Ganges and the Brahmaputra rivers join in Bangladesh before flowing into the Bay of the Bengal carrying more than one billion tonnes of sediment a year. Small islands will become linked with the mainland as shallow areas in the estuary fill up with sediment. A new seaport is planned at Sonadia.

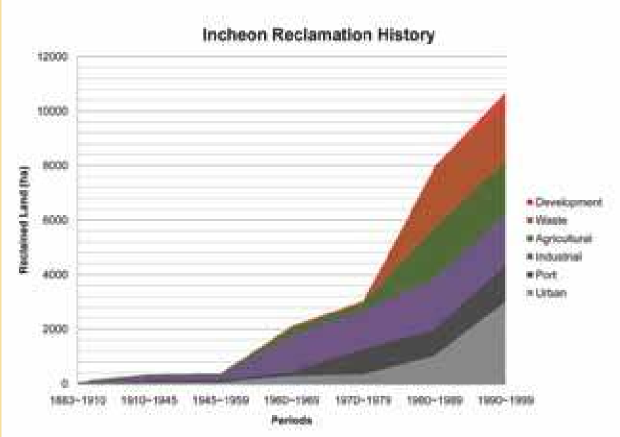
Together with the controversial policy of planting mangroves as soon as new mudbanks form, and the establishment of fishponds, salt-pans and hunting of birds by local fishermen (Chowdhury *et al.* 2011), these major developments will certainly impact the non-breeding grounds of many important shorebirds, including the Critically Endangered Spoon-billed Sandpiper which is almost entirely dependent on the Ganges Delta in the non-breeding season (Zöckler *et al.* 2005). A study by the Dutch-funded Institute of Water Modelling (IWM) claims that the damming process would not affect other parts of the coastline or aggravate erosion of the country's largest island, Bhola (CCC 2009). The country is one of the worst victims of climate change, with the UN's Intergovernmental Panel on Climate Change (IPCC) predicting that 17% of its land could go under rising sea levels by 2050.

Key decision makers: Planners at national, and provincial levels, settlers, farmers, fishermen
Key driver: National and Provincial plans for coastal protection, flood control and port developments, international aid programmes and donors including Royal Netherlands Government. UNDP, international banks

F. Reducing impacts of threats to Republic of Korea Yellow Sea coast

Following the great loss of Saemangeum intertidal habitats, other sites along the Korean coast have assumed greater importance for migrating shorebirds. At Ramsar CoP10 in 2008, Prime Minister Lee Myung-bak pledged that no new reclamation projects will be undertaken.

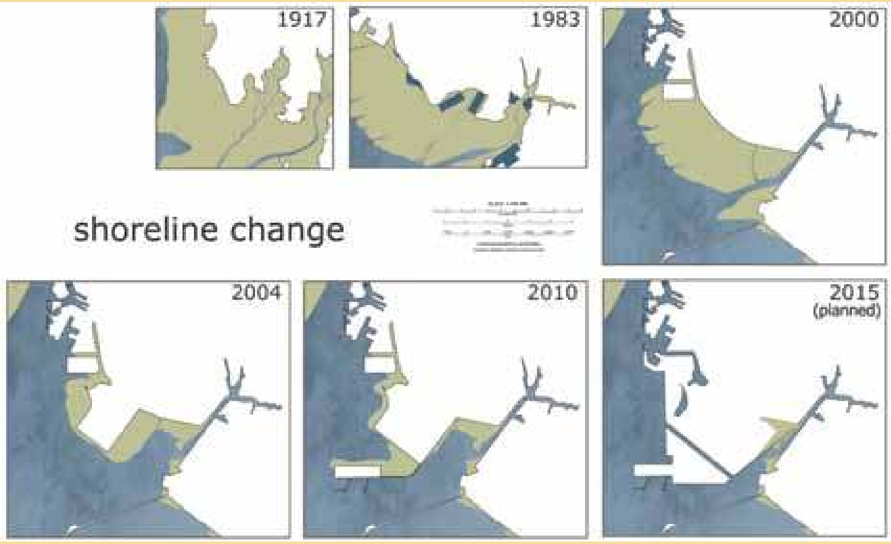
Following on from an original masterplan developed by the military government in the mid-1980s to reclaim 67% of all ROK estuaries, the current government had a long pipeline of plans in the name of 'Green Development' (Kim 2011). These would have included several more reclamations and also the development of large-scale tidal energy plants which overlap with important bird areas near Incheon. The existing plans are under review. The proposal for Ganghwa Tidal Power Plant was revised last year. The new proposal would occupy half the area and have half the power production capacity (420 MW instead of 840 MW), and it would not directly conflict with Natural Heritage Site No. 419 (K. Schubert, pers. comm.; see map).

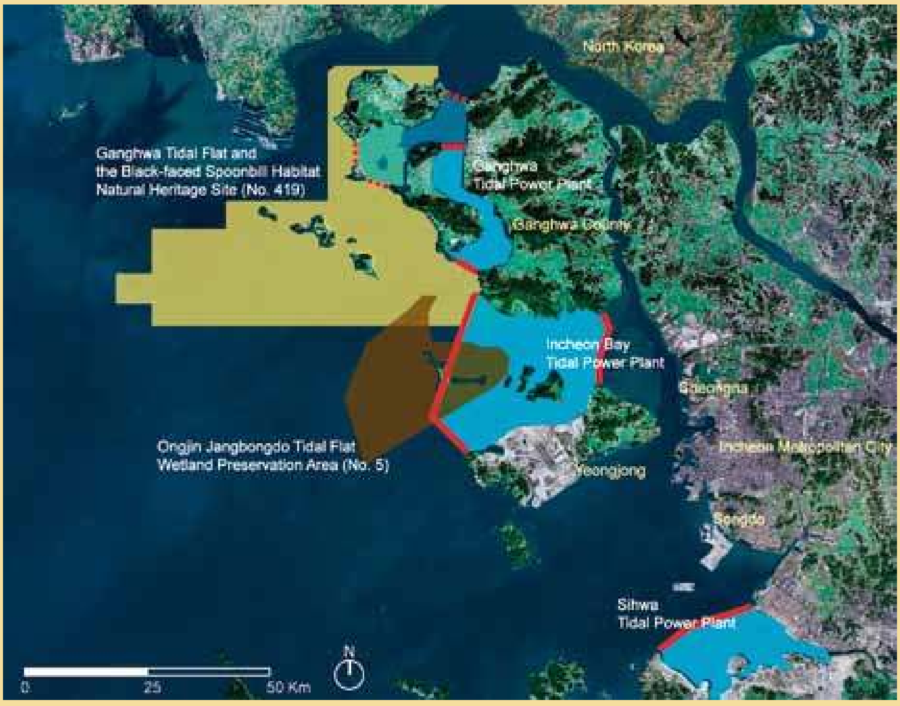


Key decision makers: Planners at national, provincial and city levels

Key driver: National and Provincial plans for reclamation and energy, government budgets, construction industry

Songdo Shoreline Change: Songdo Intertidal habitat was called "Meon-eoh-geum" = "endlessly far"! Tidal power plant plans overlap two Important Bird Areas (maps of shoreline change over the years courtesy of Fiona Cundy, Shannon Fiala, Claudia Jimenez, and Gar-Yin Lee, based on a document by Incheon Korean Federation for Environmental Movement; map of the conflicts among the proposed tidal power plants with Wetland Preservation Area no. 5 courtesy of Yekang Ko, Derek K. Schubert, Randolph T. Hester, based on a document by Korean Federation for Environmental Movement (KFEM) using a NAVER aerial image); reclamation history courtesy of Yekang Ko, Derek K. Schubert, Randolph T. Hester, based on data from *Seeing the 120 Years of Incheon through Maps*, Incheon Development Institute, 2004.





Appendix 10. List of attendees of the 6th Meeting of Partners of the East Asian–Australasian Flyway Partnership (EAAFP MOP6), 19–22 March 2012, and the 9th Spoon-billed Sandpiper Task Force Meeting, 23–24 March, Palembang, Indonesia.

Name of officials/experts	Partner organization		At 9th SBS Task Force meeting
Mr Zulkifli Hasan	Indonesia (Host)	Minister of Forestry	
Mr Darori	Indonesia	Director General of Forest Protection and Natural Resources Conservation	
Mr H Alex Noerdin	Indonesia	Governor of South Sumatra	
Mr H Amiruddin Inoed	Indonesia	Head of Banyuasin District	
Mr H Eddy Santana Putra	Indonesia	Mayor of Palembang City	
Dr Novianto Bambang Wawandono	Indonesia	Director, Directorate of Biodiversity Conservation	
Mr Agus Sriyadi Budi Sutito	Indonesia	Deputy Director for Species Conservation, Directorate of Biodiversity Conservation	
Mr Dadang Suganda	Indonesia	Head of Wasur NP	
Mr Tatang	Indonesia	Head of Sembilang NP	
Dr Yin Kimsean	Cambodia (Chair)	Secretary of State of the Ministry of Environment	
Dr Srey Sunleang	Cambodia	Director, Ministry of Environment	
Prof. Hem Bonarin	Cambodia	Pannasastra University of Cambodia	
Prof. Lei Guangchun	China (Vice Chair)	Beijing Forestry University/EAAFP China Secretariat	
Dr Yan Zhou	China	Beijing Forestry University	
Mr Paul O'Neill	Australia	Assistant Director	
Ms Makiko Yanagiya	Japan	Ministry of the Environment	
Mr Anson Tagtag	The Philippines	Protected Areas and Wildlife Bureau- Department of Environment and Natural Resources	
Mr Jeong Ik Jang	Republic of Korea		
Ms Soo-Mi Oh			
Dr Jin-Han Kim		National Institution of Biological Resources (NIBR), Senior Researcher	
Dr Evgeny Syroechkovskiy	Russian Federation		y
Ms Sharon Chan (Chan Khar Luang)	Singapore	Asst Director (SBWR)	
Mr How Choon Beng		Senior Conservation Officer (Sungei Buloh Wetland Reserve, SBWR) National Parks Board	
Ms Grace Yap		National Environment Agency	
Mr Douglas Alcorn	United States	United States Fish and Wildlife Service	y
Mr Mohammad Shamsul Azam	Bangladesh	Deputy/BANGLADESH FOREST DEPARTMENT	
Md. Mahmudul Hassan	Bangladesh	Bangladesh Forest Department	
Mrs Aree Wattana Tummkird	Thailand	Director	
Mr Sunate Karapan		National Park, Wildlife and Plant Conservation	
Dr Batbold Dorjgurkhem	Mongolia	Director	
Dr Colin Francis John O'donnell	New Zealand	Department of Conservation	
Mr Douglas Hykle	CMS		
Dr Boripat Siriaroonrat	FAO Regional Office for Asia and the Pacific	Emergency Center for Transboundary Animal Diseases – Wildlife Health and Ecology Coordinator	n
Mr Ken Gosbell	Australasian Wader Studies Group (AWSG)		y
Phil Straw			
Mr James Thomas Harris	International Crane Foundation (ICF)		
Mr Doug Watkins	Wetlands International – Oceania	Manager	
Mr Roger Jaensch	Wetlands International – Oceania	Professional Associate	
Dr Taej Mundkur	Wetlands International HQ	Programme Manager – Flyways	y
Mr Bena Smith	WWF Hong Kong	Mai Po Reserve Manager	
Dr Yvonne Ingje Verkuil	IUCN-Canada/Netherlands	Independent scientific consultant	y
Dr John Ramsay Mackinnon	IUCN-UK	Individual Expert	y
Mr Jonathan Routely Stacey (Programme Manager)	BirdLife International		
Ms Cristi Nozawa	BirdLife International		y
Mr Simba Chan	BirdLife International		y

Mr Noritaka Ichida	BirdLife International		
Mr Nobuhiko Kishimoto	BirdLife International		
Dr Mayumi Sato (Global Seabird Programme Asia Coordinator)	BirdLife International		
Mr Le Trong Trai (Senior Programme Officer)	BirdLife International – Vietnam		y
Ms Vivian Fu (Fu Wing Kan)	BirdLife national partner	Hong Kong Bird Watching Society (HKBWS)	y
Mr YU Yat-Tung	BirdLife national partner	Hong Kong Bird Watching Society (HKBWS)	y
Mr Htin Hla (Myanmar)	BirdLife national partner	Biodiversity And Nature Conservation Assoiciation (BANCA, Myanmar)	y
Mr Don Geoff Eya Tabaranza	BirdLife national partner	Haribon Foundation, Philippines	
Mr Yeap Chin Aik	BirdLife national partner	Malaysian Nature Society	
Mr Wicha NARUNGSRI	BirdLife national partner	Bird Conservation Society of Thailand (BCST)	y
Mr Wichyanan Limparungpatthanakij	BirdLife national partner	Bird Conservation Society of Thailand	y
Mr Menxiu Tong		Rudong Spoon-billed Sandpiper Survey Group	y
Mr Gao Chuan		Fujian Birdwatching Society	y
Dr Shuihua Chen		Zhejiang Museum of Natural History	
Dr Sivananinthaperumal Balachandran	BirdLife national partner	Deputy Director, Bombay Natural History Society (BNHS)	y
Mr Minoru Kashiwagi	BirdLife national partner	Wild Bird Society of Japan (WBSJ)	y
Dr Baz Hughes	Wildfowl & Wetlands Trust (WWT)	Head of Species Conservation Department	y
Mr Keith Woodley	Miranda Naturalists' Trust	New Zealand	
Mr Rick Humphries	Rio Tinto		
Mrs Denise Goldsworthy	Rio Tinto – Dampier Salt		
Mrs Nguyen Thi Luong Duyen	Vietnam	Biodiversity Conservation Agency, Vietnam Environment Administration, Ministry of Natural Resources and Environment	n
Ms San San New (Myanmar)	Myanmar, Forest Department, Ministry of Environmental Conservation and Forestry (MOECAF)	Staff Officer, Nature and Wildlife Conservation Division	
Ms Lily Anak Sir	Malaysia	SARAWAK FORESTRY CORPORATION (National Government) Conservation Executive	
Dr Christoph Zöckler	Spoon-billed Sandpiper Recovery Task Force	UNEP WCMC, EAAFP SBS Task Force Coordinator	y
Mr Masayuki Kurechi		Japanese Association for Wild Goose Protection (JAWGP)	
Mr Sayam Uddin Chowdhury		Bangladesh Bird Club	TF
Ms Jing LI	Rudong Spoon-billed Sandpiper Survey Group	China Coastal Waterbird Census, Rudong Team, Shanghai	y
Ms Nicola J Crockford	Royal Society for the Protection of Birds (RSPB)- BirdLife in the UK	International Species Policy Officer	y
Dr Robert David Sheldon	Royal Society for the Protection of Birds (RSPB) – BirdLife in the UK	Head of International Species Recovery	y
Dr Morozov Vladimir	Birds Russia		y
Mr Pavel Ktitorov	Russian Society for Conservation and Study of Birds (BirdsRussia)		?
Dr Nigel Anthony Clark	UK Spoon-billed Sandpiper Support team and BTO (British Trust for Ornithology)		y
Dr Nils David Warnock	BirdLife national partner	Audubon Alaska	y
Mr Nial Moores	Birds Korea	ROK representative of the SBS task Force Team	y
Karin Eberhard	BirdLife national partner	Biodiversity And Nature Conservation Assoiciation (BANCA, Myanmar)	y
Nguyen Thang	Univeristy Ho Chi Minh City		y
Mr Nick Murray	Queensland University	Scientific advisor	
Dr Richard Fuller	Queensland University	Scientific advisor	
Mr Zaini Rakhman	RAIN (Raptor Indonesia)	Head	
Mr Yus Roosila Noor	Wetlands International -IP	Wetlands International Indonesia Program	
Dr Dewi Malia Prawiradilaga	Indonesian Institute of Science	Researcher for Indonesian Science Institute	
Ms Dwi Mulyawati	BirdLife national partner	Burung Indonesia	
Mr Yoppy Hidayanto	BirdLife national partner	Burung Indonesia	
Mr Spike Millington		Individual Expert	y
Ms Carina Stover			n
Mr Seung-Joo Hyun		Finance Officer	y
Ms Minseon Kim		Public Information Officer	y
Ms Yuna Choi		Communication Officer	y
Mr Kyoung-Seog Min		Deputy Director	n

Appendix 11. The 388 sites considered in the IUCN situation analysis to identify key areas. Only sites for which biodiversity data was available could be included. Sites in bold had high biodiversity value, and fall within a key area (black) or outside (grey). Details of the identified key areas are provided in Appendix 2 (for each identified key area, additional sites might be named because they were later identified to be part of the key area, although no initial data was available for these sites).

Country/Territory	IBA name	Lat	Long	IBA number	Ramsar Site name
Bangladesh	Char Bhata*	22.83	91.25		
Bangladesh	Char Tania (Charan Dweep)*				
Bangladesh	Char Piya*	22.67	91.00		
Bangladesh	Maulavir Char (Moulavir Char)*	22.38	91.02		
Bangladesh	Nijum Dweep & Char Osman	22.12	91.05		
Bangladesh	**Ganges-Brahmaputra-Meghna delta***	22.30	91.17	11	
Bangladesh	Ghatibhanga	21.52	91.90		
Bangladesh	Hatiya Island	22.58	91.17		
Bangladesh	Mendol Haor				
Bangladesh	Muhuri Dam	22.85	91.47	12	
Bangladesh	Noakhali	22.33	91.17		
Bangladesh	Patenga Beach	22.23	91.80	16	
Bangladesh	Sonar Char*	22.30	90.92		
Bangladesh	**Sonadia Island & Cox's Bazar)**	21.31	91.54		
Bangladesh	**Sunderbans (East, South, West Wildlife Sanctuaries)**	21.83	89.67	10	The Sundarbans Reserved Forest
*The delta is highly dynamic and therefore charts for which data was collected in the last century might currently not exist					
Brunei Darussalam	Brunei Bay	4.50	114.50	5	
Brunei Darussalam	Seria Coast or Sungei Bera	4.62	114.32	1	
Cambodia	Bassac Marshes	11.00	105.17	38	
Cambodia	Koh Kapik (Koh Kong or Kaoh Kapik)	11.50	103.03	28	Koh Kapik and Associated Islets
Cambodia	Koh Rong Archipelago	10.72	103.25	34	
Cambodia	Prek Taek Sap	10.57	103.68	33	
Cambodia	Prek/Stung Kampong Smach	10.63	103.87	32	
Cambodia	Sre Ambel	11.10	103.68	29	
China (mainland)	Baoshan Steel Plant Reservoirs	31.43	121.43		
China (mainland)	**Beidaihe**	39.82	119.50	311	
China (mainland)	Beili Wan Sigeng (Dongfang county)	19.18	108.67	507	
China (mainland)	**Chongming Dongtan Nature Reserve**	31.50	121.75	375	Chongming Dongtan Nature Reserve, Shanghai
China (mainland)	Coast between Ao Jiang and Feiyun Jiang	27.62	120.68	397	
China (mainland)	Coast southwest of Fangcheng	21.58	108.13	484	
China (mainland)	Coastal wetlands of northern Chongming Dao island	31.47	121.27	374	
China (mainland)	Daqing He	39.17	118.92		
China (mainland)	**Dongsha Islands**	33.12	121.35		
China (mainland)	Dongshan Wan	23.70	117.38	417	
China (mainland)	Dongzhaigang Nature Reserve	19.97	110.58	500	Dongzhaigang
China (mainland)	Funing Wan	26.90	120.05	410	
China (mainland)	**Futian (Futian-Neilingding) Nature Reserves**	22.53	114.03	496	
China (mainland)	Guangdong Haifeng Wetlands	22.70	115.20		Haifeng Wetlands
China (mainland)	Hangzhou Wan	30.30	120.75	382	
China (mainland)	Houshui Wan	19.88	109.47	502	

Country /Territory	IBA name	Lat	Long	IBA number	Ramsar Site name
China (mainland)	Jiazhouwan	36.18	120.17		
China (mainland)	**Jiuduansha Nature Reserve (Jiu Duan Sha NNR)**	31.17	121.85	376	
China (mainland)	**Laizhou Wan**	37.17	119.25	328	
China (mainland)	Lianyungang saltworks (Haizhouwan (Taibei) Saltworks)	34.71	119.23	365	
China (mainland)	**Linghekou**	40.87	121.58		
China (mainland)	Luan He Estuary	39.42	119.25	312	
China (mainland)	Miao Gang	30.91	121.88		
China (mainland)	**Min Jiang Estuary**	26.17	119.50	411	
China (mainland)	Nandagang Wetland Nature Reserve (South-west Bo Hai Wan)	38.50	117.50	316	
China (mainland)	Nanhui - Eastern tidal flat of Nanhui	31.03	121.75	377	
China (mainland)	Nanliu Jiang Estuary	21.60	109.05	486	
China (mainland)	**North Bo Hai Wan**	39.08	118.43		
China (mainland)	Northern Jiangsu Coastline	35.60	119.70		
China (mainland)	**North-west Bo Hai Wan**	38.92	117.83		
China (mainland)	Qidong Northern Yangtze Estuary Nature Reserve	31.49	121.27	373	
China (mainland)	Qingdao – Rizhao coastal wetland and islands	36.00	120.33	332	
China (mainland)	Qinglangang Nature Reserve	19.62	110.87	501	
China (mainland)	Quanzhou Wan and Jin Jiang Estuary	24.87	118.68	416	
China (mainland)	Rong Jiang Estuary	23.28	116.72	498	
China (mainland)	Rudong	*31.70*	*121.00*		
China (mainland)	Sanmen Wan	29.17	121.58		
China (mainland)	Shankou Mangroves Nature Reserve	21.53	109.75	487	Shankou Mangrove Nature Reserve
China (mainland)	**Shi Jiu Tuo/Daqing He**	39.13	118.82		
China (mainland)	**Shuangtaizihekou NNR (Shuangtai(zi) Estuary) and Inner Golf of Liaodong**	40.84	121.75	52	Shuangtai Estuary
China (mainland)	**South Bo Hai Wan**	38.13	118.20		
China (mainland)	**South-west Bo Hai Wan (incl. Tianjin & Nandagang)**	38.47	117.67	320/316, part of	
China (mainland)	Taizhou Wan	28.62	121.58	391	
China (mainland)	**Tangshan / Caofeidian**	39.50	118.14		
China (mainland)	**Tianjin - coastal mudflat of Tianjin**	38.40	117.40	320	
China (mainland)	Wafangdian Fuzhou Wan	39.67	121.58	55	
China (mainland)	Wenzhou Wan	27.88	120.85	396	
China (mainland)	Wuyumen	29.15	121.70	388	
China (mainland)	Xiamen coast (Xinghuawan)	24.30	118.09		
China (mainland)	Xuanmen Wan	28.15	121.28	395	
China (mainland)	Xuwei Saltworks	34.50	119.72		
China (mainland)	**Yalu Jiang Estuary (Dandong)**	39.82	124.11	62	
China (mainland)	**Yancheng Nature Reserve**	33.67	120.50	367	Yancheng National Nature Reserve / Dafeng Milu National Nature Reserve
China (mainland)	**Yellow River (Huang He) Delta Nature Reserve**	37.83	119.00	327	
China (mainland)	Yinggehai Salt Pans	18.52	108.68	511	
China (mainland)	Yong Jiang Estuary	30.00	121.65	385	
China (mainland)	Yueqing Wan	28.23	121.17	394	
China (mainland)	Zhuanghe Coast	39.58	122.75	59	
Hong Kong, SAR China	**Inner Deep Bay (Mai Po) and Shenzhen River catchment area**	22.48	114.03	1	Mai Po Marshes & Inner Deep Bay
Macao, SAR China	Taipa-Coloane Wetland	22.10	113.53	1	

Appendix 11 cont'd. The 388 sites considered in the IUCN situation analysis to identify key areas.

Country/Territory	IBA name	Lat	Long	IBA number	Ramsar site name
Taiwan, Province of China	Aogu Wetlands	23.48	120.17	21	
Taiwan, Province of China	Beimen	23.27	120.12	25	
Taiwan, Province of China	Budai Wetlands	23.35	120.13	23	
Taiwan, Province of China	Changhua Coastal Industrial Park	24.07	120.38		
Taiwan, Province of China	Chihben Wetlands	22.68	121.05	40	
Taiwan, Province of China	Chiku	23.13	120.08	27	
Taiwan, Province of China	Chingkunshen	23.20	120.10	26	
Taiwan, Province of China	Cho-Shui-Hsi S.	23.83	120.22		
Taiwan, Province of China	Chu'an	24.82	121.78	47	
Taiwan, Province of China	Chuan-Hsing	24.20	120.45		
Taiwan, Province of China	Dapingding and Hsutsuo Harbor	25.07	121.18	6	
Taiwan, Province of China	Hanbao Wetlands	24.02	120.35	14	
Taiwan, Province of China	Han-Pao	24.05	120.37		
Taiwan, Province of China	Hsinchu City Coastal Area	24.78	120.97	9	
Taiwan, Province of China	Hualien River Estuary	23.95	121.60	43	
Taiwan, Province of China	Kaomei Wetlands	24.32	120.55	11	
Taiwan, Province of China	Kaoping River	22.50	120.40	37	
Taiwan, Province of China	Kinmen National Park	24.45	118.40	48	
Taiwan, Province of China	Kuantu	25.12	121.45	3	
Taiwan, Province of China	Ku-Liao	24.80	120.92		
Taiwan, Province of China	Lanyang River Estuary (Lan-Yang-Hsi River)	24.72	121.82	46	
Taiwan, Province of China	Lin-Pien-Hsi	22.40	120.50		
Taiwan, Province of China	Pohtzi River Estuary	23.47	120.17	22	
Taiwan, Province of China	Sitsao Wildlife Refuge	23.05	120.13	29	
Taiwan, Province of China	Szu-Tsao Wildlife Reserve	23.02	120.13		
Taiwan, Province of China	Tacheng Wetlands	23.85	120.25	16	
Taiwan, Province of China	Taipei City Waterbird Refuge	25.05	121.47	4	
Taiwan, Province of China	Ta-Too-Hsi	24.13	120.41		
Taiwan, Province of China	Tatu Rivermouth Wildlife Refuge	24.20	120.48	13	
Taiwan, Province of China	Tseng-Wen-Hsi	23.08	120.08		
Taiwan, Province of China	Watzuwei Nature Reserve	25.17	121.40	2	
Taiwan, Province of China	Yungan (Yung-An)	22.83	120.23	30	
DPR Korea	Amrok River Estuary	39.80	124.23	13	
DPR Korea	Chongchon River Estuary (including Mundok Nature Reserve)	39.60	125.42	19	
DPR Korea	Chongdan field	37.97	125.93	32	
DPR Korea	Daedong Bay	38.58	125.12	28	
DPR Korea	Kangryong field	37.90	125.60	31	
DPR Korea	Kumya Bay	39.40	127.42	8	
DPR Korea	Onchon field	38.83	125.25	21	
DPR Korea	Ongjin Bay	37.85	125.25	30	
DPR Korea	Orangchon River Estuary	41.40	129.75	3	
DPR Korea	Ryonghung River Estuary	39.82	127.50	6	
DPR Korea	Sogam-do, Daegam-do, Zung-do, Ae-do and Hyengzedo islands	39.24	125.15	17	
DPR Korea	Taedong River Estuary	38.72	125.25	22	
DPR Korea	Unryul Kumsanpo	38.58	125.07	27	

Country/Territory	IBA name	Lat	Long	IBA number	Ramsar site name
Indonesia	**Bagan Percut - Sungai Ular**	3.72	98.78		
Indonesia	Bali	-8.25	115.00		
Indonesia	Bali - Benoa Bay	-8.75	115.20		
Indonesia	**Banyuasin Delta (Tanjung Koyan)**	-3.00	105.00	33	
Indonesia	Berbak	-1.45	104.33	28	Berbak
Indonesia	Delta Mahakam	-0.67	117.42	56	
Indonesia	Krueng Aceh	5.58	95.32		
Indonesia	Kuala Tungal to Tanjung Djabung coast	-1.00	103.75		
Indonesia	Kupang Bay	-10.06	123.75		
Indonesia	Muara Cimanuk	-6.28	108.25	86	
Indonesia	Muara Gembong-Tanjung Sedari	-5.97	107.03	71	
Indonesia	Muara Kendawangan	-2.70	110.62	46	
Indonesia	Pantai Timur Surabaya	-7.52	112.75	103	
Indonesia	Pesisir Pantai Jambi	-1.00	103.95	30	
Indonesia	Pesisir Riau Tenggara	0.00	103.75	19	
Indonesia	Pesisir Timur Pantai Sumatera Utara	3.47	99.27	7	
Indonesia	Pulau Dua	-6.02	106.20	68	
Indonesia	Pulau Rambut	-5.97	106.68	69	
Indonesia	Rawa di Pesisir Kapuas	-0.67	109.50	48	
Indonesia	Segara Anakan-Nusa Kambangan	-7.73	108.90	92	
Indonesia	**Sembilang NP**	-2.05	104.83	31	
Indonesia	Solo Delta (Ujung Pangkah)	-6.95	112.55	102	
Indonesia	Sumenep	-7.20	113.53	113	
Indonesia	Taliwang	-8.72	116.82	118	
Indonesia	**Tanjung Selokan**	-2.58	105.58	32	
Indonesia	Ujung Pangkah (Solo Delta)	-6.88	112.60	102	
Indonesia	Wasur National Park	-8.75	140.58		
Indonesia	Way Kambas	-4.93	105.75	38	
Japan	Achisu Kantakuchi	34.01	131.36		
Japan	Akashi-Iwayakouro	34.62	135.02		
Japan	Ano(u)-gawa and Shitomo-gawa estuaries, Toyotsuura	34.73	136.53	113	
Japan	Arao Kaigan (part of Inner Ariake bay)	33.03	130.47	140, part of	
Japan	Asa-gawa Kakou	34.00	131.15		
Japan	Asahata Yuusuichi	35.02	138.40		
Japan	Atago-gawa, Kushida-gawa (part of Kumozugawa, Atagogawa and Kongogawa estuaries)	34.60	136.57	114, part of	
Japan	Awase Higata	26.30	127.82	160	
Japan	Banzu and Futtsu tidal flat (in Tokyo bay)	35.42	139.92	73	
Japan	Chidorihama Kiya-gawa Kakou	34.53	133.73		
Japan	Chiri-hama (part of Takamatsu coast)	36.88	136.72	100, part of	
Japan	Daijugarami (part of Inner Ariake bay)	33.17	130.27	140, part of	
Japan	Daimyoujin-gawa Kakou	33.95	133.08		
Japan	Fujimae Higata	35.08	136.83	111	Fujimae-higata
Japan	Fukiagehama Kaigan (part of Manosegawa Estuary)	31.41	130.26	153, part of	
Japan	Futtsu (in Tokyo bay)	35.25	139.86	73, part of	
Japan	Hachirougata-shiokuchi	40.00	140.00	58	
Japan	Hakata bay (with Imazu Higata)	33.62	130.35	139	

Appendix 11 cont'd. The 388 sites considered in the IUCN situation analysis to identify key areas.

Country/Territory	IBA name	Lat	Long	IBA number	Ramsar site name
Japan	Hamamatsu-Si Shouwa-cho	34.73	137.58		
Japan	Hayatsue-gawa Kakou (Inner Ariake bay)	33.15	130.33	140, part of	
Japan	Hikata Hachimangoku	36.75	140.68		
Japan	Hikawa Estuary, Shiranui	32.62	130.62	145	
Japan	Hori-kawa, Magame-gawa (with Nabaki-gawa)	35.49	140.43		
Japan	Ichinomiya-gawa Kakou	35.39	140.39		
Japan	Iioka Kaigan (Hazaki coast)	35.70	140.72	70, part of	
Japan	Ikawazu	34.62	137.13	107	
Japan	Inba-numa	35.78	140.32		
Japan	Inbanuma-Cyuuouhaisuiro	35.75	140.25		
Japan	Inner Ariake bay	33.13	130.25	140	
Japan	Inner Tokyo bay	35.60	139.88	74	Yatsu-higata
Japan	Isahaya Higata (Ariake bay)	32.83	130.08	141	
Japan	Izumi Kantaku	32.08	130.37	151	
Japan	Kagawa Kitanoe Kaisaku	34.07	131.03		
Japan	Kahokugata (Takamatsu coast)	36.67	136.68	100	
Japan	Kaitsu-cho Nokouchi	35.16	136.66		
Japan	Kakinoki-cho	35.83	140.78		
Japan	Kamisu-Chou Takahama (with Ikisu-Omigawa)	35.87	140.63		
Japan	Kamo-gawa Kakou	33.92	133.17	131	
Japan	Kasai Kaihinkouen (Inner Tokyo bay)	35.62	139.87	74, part of	
Japan	Kashima Shingomori (Inner Ariake bay)	33.12	130.10	140, part of	
Japan	Kashimanada	36.00	140.66		
Japan	Kikuchi-gawa Kakou (Ariake bay)	32.88	130.53		
Japan	Kiritappu Shitsugen (Kiritappu marsh, Biwase bay)	43.16	145.18	15	Kiritappu-shitsugen
Japan	Komaiko Kaigan, with Neagari Kaigan (Takamatsu coast)	36.47	136.47	102	
Japan	Komuke-ko (Komukeko and Shibunotsunaiko lake)	44.27	143.48	7	
Japan	Kujukuri Hama	35.79	140.57	72	
Japan	Kuma-gawa Kakou / Kumakawa Estuary	32.47	130.57	146	
Japan	Kumedaike	34.45	135.42		
Japan	Kumozugawa, Atagogawa and Kongogawa estuaries	34.62	136.55	114	
Japan	Lake Furenko (Fuuren-ko) and nearby wetlands (Onnetou ohashi)	43.30	145.35	12	
Japan	Lake Notoroko and Lake Abashiriko	44.05	144.17	8	
Japan	Lake Tofutsuko	43.93	144.40	9	
Japan	Makuharinohama (Inner Tokyo bay)	35.65	140.05	74, part of	
Japan	Manko tidal flat	26.18	127.68	161	Manko
Japan	Manosegawa Estuary	31.43	130.30	153	
Japan	Matsugishi-higata (Hazaki coast)	35.73	140.80	70, part of	
Japan	Messe Chuushajou (Inner Tokyo bay)	35.65	140.03	74, part of	
Japan	Mikumo-cho Kaigan Kouhaichi	34.63	136.55		
Japan	Miyagawakakou, Sotoshirotagawakakou	34.50	136.72		
Japan	Mogamigawa Estuary	38.90	139.83	61	
Japan	Morie-wan	33.40	131.67		
Japan	Morigasakinohana (Inner Tokyo bay)	35.56	139.77	74, part of	
Japan	Moriyamashi-kogan	35.13	135.92		
Japan	Mukawa Kakou	42.57	141.93	27	
Japan	Nagasaki Kaigan (Hazaki coast)	35.70	140.80	70, part of	

Country/Territory	IBA name	Lat	Long	IBA number	Ramsar site name
Japan	Nakatsu and Usa tidal flats	33.58	131.25	147	
Japan	Narashino-akanehama (Inner Tokyo bay)	35.65	140.02	74, part of	
Japan	Naruto-machi Suiden	35.34	140.28		
Japan	Nisikaminomiya-machi	36.32	139.15		
Japan	Notsuke bay, Odaito	43.58	145.30	11	
Japan	Obitsu-gawa Kakou (Tokyo bay)	35.33	139.92	73, part of	
Japan	Okita-gawa Kakou	32.53	131.68		
Japan	Okukubi-gawa Kakou	26.43	127.95		
Japan	Omaezaki-kaigan	34.60	138.23		
Japan	Onaga Higata	26.15	127.67		
Japan	Ookubo Noukouchi	35.99	139.03		
Japan	Oono-gawa, Suna-gawa Kakou (Hikawa Estuary)	32.62	130.65	145, part of	
Japan	Ootagawa-kakao	34.67	137.90		
Japan	Osaka Nanko / Nankou Yachouen	34.63	135.47	119	
Japan	Rokkaku-gawa Kakou (Inner Ariake bay)	33.20	130.22	140, part of	
Japan	Saigawa-karyuu (Takamatsu coast)	36.60	136.58	100, part of	
Japan	Sanbanze (Inner Tokyo bay)	35.67	139.98	74, part of	
Japan	Saroma-ko	44.13	143.83		
Japan	Shigenobu-gawa Kakou	33.72	132.70		
Japan	Shimofusa-machi Taka	35.90	140.38		
Japan	Shiokawa tidal flat (with Jinno Shinden)	34.68	137.30	108	
Japan	Shiraho, Miyara-wan	24.35	124.21		
Japan	Shirakata-chou (Takamatsu coast)	36.19	136.13	100, part of	
Japan	Shirakawa Estuary	32.78	130.60	144	
Japan	Shoudai	??	??		
Japan	Sone tidal flat	33.82	130.97	135	
Japan	Suzuka-gawa Kakou, Suzuka-hasen Kakou	34.92	136.65		
Japan	Takamatsu, Kahoku Kaigan (Takamatsu coast)	36.75	136.70	100, part of	
Japan	Takase-gawa Kakou	40.73	141.42		
Japan	Teganuma	35.85	140.08		
Japan	Tennou Kaigan	39.90	139.96		
Japan	Teruma Higata	26.34	127.91		
Japan	Tochigi-ken Nanbu, Suiden-chitai	36.28	139.80		
Japan	Todomekigawa-kakou	35.05	136.88		
Japan	Tokyo Port Wild Bird Park (Inner Tokyo bay)	35.59	139.78	74, part of	
Japan	Tonegawa Estuary (Hazaki coast)	35.75	140.83	70	
Japan	Torinoumi-higata	38.03	140.92		
Japan	Toukyou-kou Chobokujou (Inner Tokyo bay)	35.62	139.84	74, part of	
Japan	Toukyou-kou, Yatyouen Shuuhen (Inner Tokyo bay)	35.57	139.77	74, part of	
Japan	Toyama Shinkou (Toyama coast)	36.79	137.06		
Japan	Tyuuou-bouhatei Uchi-Sotogawa Umetatechi (Inner Tokyo bay)	35.58	139.82	74, part of	
Japan	Uchiura Wan	35.07	138.84		
Japan	Umeda-gawa Kakou	34.72	137.35		
Japan	Usa Kaigan	33.57	131.43		
Japan	Wada-chikura Kaigan	34.95	139.97		
Japan	Wajiro Higata	33.68	130.42	139, part of	
Japan	Yaeyama islands	24.33	123.83	166	
Japan	Yahagigawa Estuary	34.82	136.98	109	

Appendix 11 cont'd. The 388 sites considered in the IUCN situation analysis to identify key areas.

Country/Territory	IBA name	Lat	Long	IBA number	Ramsar site name
Japan	Yahagihuru-kawa Kakou	34.80	137.20		
Japan	Yatsu Higata (Inner Tokyo bay)	35.68	140.03	74, part of	
Japan	Yodaura Suiden	35.92	140.53		
Japan	Yonaha-wan	24.75	125.27		
Japan	Yone and Gushi tidal flats (Gushi Higata)	26.17	127.65	162	
Japan	Yoshino-gawa Kakou-higata	34.07	134.58		
Malaysia	**Bako-Buntal Bay (or Buntal Bay)**	1.73	110.42	37	
Malaysia	Batu Maung	5.37	100.30		
Malaysia	Brunei Bay	4.90	115.15	55	
Malaysia	**Kapar Power Station (North-central Selangor coast)**	3.13	101.33	11, part of	
Malaysia	Klias peninsula	5.21	115.35	28	
Malaysia	Kuala Gula (Matang coast)	4.93	100.47	5, part of	
Malaysia	Kuala Kedah to Kuala Sungai coast	6.25	100.22		
Malaysia	Kuala Kelumpang (Matang coast)	4.87	100.50	5, part of	
Malaysia	Kuala Mersing	2.42	103.88		
Malaysia	**Kuala Samarahan to Kuala Sadong, coastline**	1.60	110.62		
Malaysia	Matang coast	4.92	100.50	5	
Malaysia	North-central Selangor coast	3.33	101.25	11	
Malaysia	**Pantai Rasa Sayang (North-central Selangor coast)**	3.47	101.13	11, part of	
Malaysia	**Pantai Tanjong Karang ((North-central Selangor coast)**	3.42	101.18	11, part of	
Malaysia	Papar, Sabah	5.70	115.93		
Malaysia	Parit 30/ Parit Jawa				
Malaysia	**Pulau Bruit National Park**	2.57	111.35	42	
Malaysia	**Pulau Tengah (Klang Islands)**	2.97	101.31		
Malaysia	**Sadong-Saribas coast**	1.72	110.92	41	
Malaysia	South-west Johor coast	1.65	103.17	15	Tanjung Piai / Pulau Kukup / Sungai Pulai
Malaysia	Sungai Air Hitam				
Malaysia	Sungai Batu Pahat - Sungai Suloh Kechil (South-west Johor coast)	1.75	102.92	15, part of	
Malaysia	Sungai Betul Bagan Tiang				
Malaysia	Sungai Larut to Port Weld (Matang coast)	4.83	100.58	5, part of	
Malaysia	Tanjong Bidadari, Sabah	5.92	118.08		
Malaysia	**Tanjung Datu-Samunsam Protected Area**	1.92	109.60	34	
Malaysia	Tanjung Piai			34, part of?	
Malaysia	Teluk Air Tawar-Kuala Muda coast	5.52	100.43	3	
Malaysia	Tempasuk plains	6.43	116.45	33	
Myanmar	Arrakan (Bay of Arrakan)	19.36	93.38		
Myanmar	**Ayeyarwaddy / Irrawaddy Delta**	16.12	94.74	47	
Myanmar	Central Tanintharyi	12.26	98.37		
Myanmar	**Dawei River in the Tanintharyi coastal zone**	14.05	98.12		
Myanmar	**Gulf of Martaban / River mouth area of Sittaung River**	16.32	97.36		
Myanmar	Kaladan Estuary	20.15	92.95		
Myanmar	Kyetmauktaung Dam	20.80	95.25		
Myanmar	**Labutta (in Ayeyarwaddy / Irrawaddy Delta)**	16.12	94.74		
Myanmar	**Letkok Kon (Ayeyarwaddy / Irrawaddy Delta)**	16.33	96.17		
Myanmar	Minhla-Nyaung Lake	20.83	96.03		

Country/Territory	IBA name	Lat	Long	IBA number	Ramsar site name
Myanmar	**Nanthar Island in the Rakhine Coastal Zone**	18.45	93.36		
Philippines	Arevalo-Muanduriao	10.70	122.52		
Philippines	Buguey wetlands	18.28	121.83	12	
Philippines	Davao River Mouth	7.03	125.60		
Philippines	Mactan, Kalawisan and Cansaga Bays (is Cebu-Mactan)	10.33	123.97	70	
Philippines	Manila Bay	14.50	120.75	10	
Philippines	Olango Island	10.23	124.03	69	Olango Island Wildlife Sanctuary
Philippines	Ormoc Intertidal Flat	11.00	124.57		
Philippines	Pagbilao and Tayabas Bay	13.92	121.72	26	
Philippines	Panabo	7.30	125.72		
Philippines	Ragay Gulf	13.75	122.60	28	
Philippines	Talibon Protected Landscape and Seascape, with Banacon, Calituban, Tahong-tahong Islands	10.15	124.15	79	
Philippines	Talon-Talon Wetland	6.92	122.12		
Philippines	Tubbataha Reef (National Marine Park)	8.83	119.92	57	
Republic of Korea	Aphae Island	34.83	126.33		
Republic of Korea	**Asan Bay (including Asan-ho lake and Sapgyo-ho lake)**	36.95	126.82	17	
Republic of Korea	Baeksu Tidal Flat (Paeksu Tidal Flat)	35.27	126.32	24	
Republic of Korea	**Cheonsu Bay (or Seosan)**	36.49	126.44	18	
Republic of Korea	Jido-eup, Shinan-gun (part of contiguous Meian Gun Tidal Flat)	35.05	126.20		
Republic of Korea	Daebu-do / Daebu island	37.25	126.48	8	
Republic of Korea	**Dongjin Estuary (Saemangeum)**	35.78	126.75	22	
Republic of Korea	Gangjin Bay	34.53	126.80	30	
Republic of Korea	**Geum-gang river and Estuary (Kum Estuary)**	36.08	126.75	19	
Republic of Korea	Gomso Bay	35.35	126.36		
Republic of Korea	Hado-ri, Jeju	33.50	126.88	39	
Republic of Korea	Hwangsan-myeon, Haenam-gun	34.42	126.50		
Republic of Korea	Hampyeong / Hampyong Bay	35.12	126.42	25	
Republic of Korea	**Han-gang Estuary / Han River**	37.69	126.68	4	
Republic of Korea	Gochang-gun	35.42	126.58		
Republic of Korea	**Mangyeong / Mankyung Estuary (Saemangeum)**	35.90	126.75	21	
Republic of Korea	Meian Gun Tidal Flat	35.08	126.33		
Republic of Korea	Muan Tidal Flat	35.92	126.33	26	
Republic of Korea	**Nakdong-gang Estuary**	35.13	128.92	37	
Republic of Korea	Namhae	34.83	127.83		
Republic of Korea	**Namyang Bay**	37.14	126.77	10	
Republic of Korea	Seongsanpo, Seogwipo	33.45	126.92	40	
Republic of Korea	Sihwa-ho lake	37.28	126.75	9	
Republic of Korea	**Songdo Tidal Flat**	37.42	126.65		
Republic of Korea	Suncheon Bay	34.83	127.50	31	
Republic of Korea	**Tidal flat area of southern Ganghwa-do island (Kanghwa Island)**	37.58	126.40	5	
Republic of Korea	**Tidal flat area of Yeongjong-do (Yong Jong) Island**	37.45	126.53	6	
Republic of Korea	Tongjin River Lagoon and mudflat	35.74	126.63		
Republic of Korea	Yeongheung-do and Sonje-do islands	37.25	126.50	7	
Republic of Korea	Yubu-do island (Geum-gang river and estuary)	35.98	126.62	20	
Singapore	Kranji	1.42	103.72	1	
Singapore	North-East Conservation Area (with Serangoon Ponds)	1.42	103.97	2	

Appendix 11 cont'd. The 388 sites considered in the IUCN situation analysis to identify key areas.

Country/Territory	IBA name	Lat	Long	IBA number	Ramsar site name
Singapore	Sungei Buloh Wetland Reserve	1.45	103.72		
Thailand	Ao Bandon	9.28	99.45	41	
Thailand	Ao Pattani (Pattani Bay)	6.92	101.27	58	
Thailand	**Inner Gulf of Thailand**	13.51	100.53	32	Don Hoi Lot
Thailand	Khao (Kato) Sam Roi Yot National Park and surrounding wetlands	12.20	99.97	36	
Thailand	Ko Libong Non Hunting Area	7.27	99.40	50	Had Chao Mai Marine National Park - Ta Libong Island Non-Hunting Area - Trang River Estuaries
Thailand	Ko Pra Thong	9.08	98.28	46	
Thailand	Laem Pakarang	8.72	98.22	45	
Thailand	Na Muang Krabi (Krabi Bay)	7.95	98.85	48	Krabi Estuary
Thailand	Palian Lang-ngu	7.17	99.68	52	
Thailand	Thale Noi Non-Hunting Area	7.83	100.13	56	Kuan Ki Sian of the Thale Noi Non-Hunting Area
Thailand	Thale Sap Songkhla Non Hunting Area and surrounding wetlands	7.88	100.17	57	
Timor	Timor	-10.00	120.50		
Vietnam	**An Hai**	20.82	106.75	16	
Vietnam	**Bai Boi ((very close to Dat Mui)**	8.70	104.83	1	
Vietnam	**Binh Dai (Hoa Trinh, Ba Tri)**	10.13	106.75	62, 63	
Vietnam	**Can Gio**	10.52	106.90	51	
Vietnam	Cat-Tien NP	11.35	107.00		
Vietnam	**Dat Mui (very close to Bai Boi)**	8.62	104.73	2	
Vietnam	**Ha Nam**	20.87	106.82	60	
Vietnam	**Nghia Hung (Day and Ninh Co Estuary)**	19.97	106.17	12	
Vietnam	**Tan Thanh intertidal area & Ngang Island**				
Vietnam	**Thai Thuy**	20.55	106.63	14	
Vietnam	**Tien Hai**	20.30	106.60	13	
Vietnam	**Tien Lang**	20.67	106.67	15	
Vietnam	**Tra Co**	21.47	108.02	61	
Vietnam	**Xuan Thuy**	20.35	106.52	17	Xuan Thuy Natural Wetland Reserve

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