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THE COMPREHENSIVE REPORT OF THE YELLOW SEA ECOREGION SUPPORT PROJECT 2007-2014

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Front cover photo: A young girl digs for shellfish in the tidal flats off Korea's western coast
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FOREWORD

LIU Rongjie

Deputy Director, Ocean & Fishery Department of Liaoning Province

Between 2010 and 2012, Liaoning Ocean and Fisheries Science Research Institute (LOFSRI) completed the Yalu River Coastal Area Ecosystem Based Management Demonstration Project, which was funded by WWF and Ocean & Fishery Department of Liaoning Province (OFDLP), with technical support from the United Nations Development Programme and Global Environment Facility Trust Fund Yellow Sea Large Marine Ecosystem (UNDP/GEF YSLME) Project. The purpose of the project was to determine the impact of human activities on the wetland ecosystem and the resulting ecological effects, to develop adaptive management measures for the conservation of rare or endangered species and the protection of migrating birds, to balance ecosystem conservation with sustainable resource exploitation and to provide reference for the development of a scientific and rational coastal wetland management model. Taking place on 2 February 2010 and witnessed by experts from relevant communities, representatives of WWF-China and WWF-Japan, OFDLP, UNDP/GEF YSLME project, Panasonic Corporation and LOFSRI signed a Memorandum of Understanding on Cooperation (MoU) in Shenyang, China. On 1 April 2010, representatives of the parties held an official inauguration ceremony for the project in Dandong, China, where the project was located. After three years of survey and research, the project had finally delivered fruitful results, including sound management plans and proposals on balancing economic development and ecological conservation in line with the local conditions. It is our wish that WWF would continue to work with OFDLP by honouring its phase II commitments as specified in the MoU. Through better management of the coastal habitat at the Yalu River Estuary, we would be able to summarize the lessons learned and results of the Yalu River Coastal Area Ecosystem-Based Management Demonstration Project for promotion across the Yellow Sea Ecoregion, and in similar habitats across the world.

KIM Chul-ju

Muan County Governor

In our lives, things are often too close to us for us to be able to truly appreciate them. From the time we were born, from the time our parents were born, the dark silk of the tidal flats has been a living, breathing part of our lives. They have given us much, but their value has somehow eluded us.

Situated in South Jeolla Province in the Republic of Korea, the Muan Tidal Flat is registered as the country's first Tidal Flat Wetland Protection Area. It boasts a history dating back three millennia, sharing its life with the people of the region since time immemorial. A land of abundance, it has provided a habitat for life of all kinds, helping to feed the area's people and enrich its environment. We possess a great resource in our tidal flat, a precious legacy that we must leave intact for future generations. To protect the marine ecosystem, its animals and their habitats, Muan County has established the Muan Ecological Tidal Flat Center, a facility designed for more effective administration of the protected area.

As part of a habitat preservation pilot effort from 2010 to 2012, the county has provided active support to the Yellow Sea Ecoregion Support Project (YSESP), a conservation programme aimed at managing the area's biodiversity and governance and ensuring sustainable use through resident communication and engagement. The South Jeolla tidal flats that include Muan — and those on the Yellow Sea coast in general — represent a vital ecosystem nearly without parallel in the world. Unfortunately, the Yellow Sea is also a region in urgent need of protection, as nonstop development over the past several decades has left its waters, which are shared by Korea and China, plagued with marine habitat devastation, pollution and indiscriminate overfishing.

Reports indicate that Yellow Sea fishing yields have dropped in recent years, and the diversity of the species making up the aquatic ecosystem has dropped precipitously as a result of climate change and the introduction of exotic species. Addressing these issues affecting the Yellow Sea ecosystem, and helping the waters return to life, will require more than the efforts of the government and academics — it also demands awareness and efforts from ordinary people, especially those living in coastal regions.

In addition to its work to achieve the YSESP's aim of promoting popular awareness, Muan County plans to continue working on other related projects to generate a synergy effect and encourage further collaborations. We hope to see these projects bearing fruit and leading to the sharing of experience and information, suggesting new directions for conservation and coexistence with the Muan Tidal Flat, a habitat that has served as home to so much life over these years.

TAKEYASU Satoshi

Executive Officer,
Panasonic Corporation

Panasonic Corporation has been supporting WWF-Japan's activities such as environmental education and wetland conservation in Japan since 1999. In 2007, Panasonic became the organization's first corporate supporter in Asia, which is an international corporate partnership scheme of WWF International. Since then, we have started to support the YSESP from a more global standpoint.

Over the course of the seven-year project, we have been providing ongoing financial support. Moreover, we have been involved in programmes in Japan, China and the Republic of Korea through public relations activities such as photo exhibitions and seminars to widely inform the public of the abundance of biodiversity in the Yellow Sea, exchange forums of small grants recipients and Panasonic employee trainings at the model site of this project.

Concerning the model project in Yalu River in China, we are very pleased that the Liaoning Ocean Fishery Bureau welcomed a proposal based on survey results for promoting sustainable fisheries with a great care for migratory shorebirds. Regarding the model project in Muan, Republic of Korea, we are really gratified that a strategy has been designed for conservation management of local governments in collaboration with local communities. We have no doubt that the Yellow Sea ecosystem can look forward to a more harmonious future with its human inhabitants, and that its natural resources will be used sustainably.

JIANG Yihang

Former Project Manager of the UNDP/GEF YSLME Project

The biodiversity conservation in the Yellow Sea is the major task of the UNDP/GEF Project titled Reducing Environment Stress of the YSLME, and the Yellow Sea Ecoregion Planning Project (YSEPP), two initiatives that started at nearly the same time. Both projects have had clearly defined objectives that include the protection of the marine environment in the Yellow Sea, particularly the marine biodiversity in the sea's coastal areas.

The first MoU for cooperation and coordination was signed in March 2005 during the first meeting the Project Steering Committee in Seoul, Republic of Korea, when YSLME just started its implementation of the project activities. The meeting provided a good opportunity to design joint efforts and activities in implementing the relevant actions in the conservation of biodiversity in the Yellow Sea. With the common interests and objectives created in the spirit of cooperation, the YSLME and YSEPP (the YSESP in the latter case) have worked to provide the coastal countries of the Yellow Sea with more benefits as a result of their effective cooperation.

Both projects jointly prepared the common criteria for the regional assessment of the marine biodiversity in the Yellow Sea, jointly applied the regional criteria in selecting the demonstration projects for both the YSLME project and the YSESP in China and the Republic of Korea and jointly approached the central and local governments to obtain political and financial support for implementing the demonstration projects. The comprehensive planning for the demonstration project and the joint efforts for the conservation of the Yalu River Estuary generated RMB 1,000,000 in financial support from the Liaoning provincial government, and also ensured the implementation of the demonstration activities.

Cooperation between the YSLME project and the YSESP greatly assisted the design of an ecosystem-oriented approach to be applied in the YSLME Strategic Action Programme (SAP) for its first time in the GEF International Water Project. Moreover, the joint activities ensured not only the successful implementation of the biodiversity activities in the Yellow Sea, but also assisted in generating the donor assistances from both Panasonic Corporation and GEF for the both projects, in particular the second phase of the YSLME project to implement the management agreements as listed in the YSLME SAP. These effects provide maximum benefits to the coastal countries in protecting marine environments and sustainable uses of coastal and marine resources.

I would like to send my sincere congratulations to the YSESP for the successful preparation of this publication that includes major outcomes and outputs of the YSEPP and YSESP. I am looking forward to learning more from this publication.

HIGUCHI Takamasa

Chief Executive Officer, WWF-Japan

Japan has benefited greatly from the well-functioning ecosystem services of the Yellow Sea Ecoregion (YSE), and has shared the responsibility for its conservation and sustainable use. Working together with partners in China and the Republic of Korea, WWF-Japan has been focusing on the conservation activities of the YSE since 2001.

Thanks to the financial support of the Panasonic Corporation, we were able to launch the Yellow Sea Ecoregion Support Project in 2007. At first, the project began with a small grant-awarding scheme for supporting local conservation NGOs and academic groups in China and the Republic of Korea. During the three years that followed, our conservation efforts in demonstration sites in China and the Republic of Korea were heightened considerably. We have seen substantial results while collaborating with the Liaoning Provincial Government and Muan County Government, as well as many enthusiastic experts and local stakeholders.

Expansion and effective conservation management of Marine Protected Area (MPA) is one of the most important international challenges. There are two effective management approaches applied at the two demonstration model sites for this project: ecosystem-based management (EBM), a scientifically integrated management based on ecological linkage, and community-based management (CBM), or community involved resource management. Both have been shown to be some of the best MPA management practices.

This comprehensive report describes the valuable results of our seven-year project, mainly focusing on the positive efforts made in the demonstration sites at the Yalu River Estuary and Muan Tidal Flat. We have introduced the project's conservation approach to the international research community through presentations at the Convention on Biological Diversity, the Ramsar Convention and the International Union for Conservation of Nature (IUCN) Asia Parks Congress, among others, but the success of this project depends on how the results can be shared with stakeholders and applied to other regions bordering the Yellow Sea.

WWF-Japan strongly hopes that all stakeholders in the YSE will proactively participate in conservation initiatives and promote the sustainable use of natural resources, thus enabling future generations to fully enjoy the benefits of a healthier and richer YSE.

LO Sze Ping

Chief Executive Officer,
WWF-China

The Yellow Sea Ecoregion, including the Bohai Sea, the Yellow Sea and the estuary of the Yangtze River, is a high priority for environmental conservation because of its unique biodiversity and rich fishing resources. This ecoregion is considered to be one of WWF's highest priority conservation areas in the world because these wetlands, the tidal flats especially, are the stopover site on the East Asian-Australasian Flyway (EAAF) migration route for millions of shorebirds. The areas are also major production sites for domestic aquatic product, with up to 2 million tons of shellfish harvested annually.

Over the past 50 years, more than half of the wetlands around the Yellow Sea Ecoregion have disappeared due to land reclamation for construction projects, real estate development, industrial park building and the development of aquaculture industries in shore areas. We may lose these coastal wetlands in the near future without a proactive conservation effort.

To protect what remains of these coastal wetlands, WWF-China and its partners have been conducting coastal wetland conservation projects since 2002.

Between 2002 and 2006, WWF-China carried out a project called Yellow Sea Ecoregion conservation planning with WWF-Japan, KIOST and KEI. A potential priority areas (PPA) map, indicating where the conservation efforts are most needed, had been endorsed by UNDP as a reference in 2006. In 2007, the seven-year Yellow Sea Ecoregion Supporting Programme was launched with the financial support of Panasonic Corporation.

This comprehensive report is a summary of Yellow Sea Ecoregion Support Project, and also serves as an expression of gratitude for LOFSRI's contributions made during the research project, as well as for the technical support and advice provided by the Ocean & Fishery Department of Liaoning Province, UNDP/GEF and the wildlife experts. We hope that this report can provide valuable information for other coastal wetland researchers who are studying conservation management.

WWF hopes that, with the efforts of all stakeholders, we can effectively protect and manage the key habitats that are important for sustaining the biodiversity in the Yellow Sea. In doing this, we seek to help with the recovery of struggling habitats and facilitate the development of those species that are considered to have the most ecological, economic and cultural significance. Our final goal is to improve the conditions of the local marine ecosystem and help it succeed in its function to create sustinence for the communities living in the Yellow Sea Ecoregion.

JIANG Lianxin

Liaoning Ocean and
Fisheries Science Research
Institute

The Yellow Sea, an integral part of the world's ocean ecosystem, is imperative to the survival of the people and countries along its shores. As a result of this reliance, however, an array of problems have emerged, such as the depletion of biological resources, the decline of biodiversity and the overall degradation of surrounding coastal ecosystems. These issues are heavily linked to inadequate knowledge regarding the ecological system in the water and a lack of both effective administration and coordination between environment and resource issues, which all contribute to a serious threat to the sustainability of the Yellow Sea Ecosystem. At present, addressing all kinds of problems facing the Yellow Sea ecosystem and improving the coordinated management of marine resources have become top priorities of the surrounding countries.

Located near the beautiful Heishijiao Reef along the coast of the Yellow Sea, Liaoning Ocean and Fisheries Science Research Institute (LOFSRI) was founded in 1950 as a subsidiary to the Ocean and Fishery Department of Liaoning province. Being a key scientific research institute at the provincial level, its main functions include developing the province-wide ocean development strategy, maritime resources protection, management and sustainable use in Liaoning province, demonstrating the harness of the sea area, marine environment monitoring and protection,and the investigation and appraisal of oceanic pollution accidents, among other mandates. Over the past 60 years, LOFSRI has been committed to the exploration and protection of oceanic environment and fishing industry. It has undertaken hundreds of scientific research projects at the provincial and national levels, earning the institute some 15 national-level awards including National Award for Science and Technology Progress, the National Award for Natural Sciences, the Science and Technology Progress Award established by the Ministry of Agriculture and the Technology Innovation Award established by the State Oceanic Administration.

In order to effectively protect the ecosystem of the coastal wetland within the Yellow Sea Ecoregion, LOFSRI has implemented the project of "Ecological based Coastal Estuarine Wetland Protection and Management–Demonstration of Coastal Habitat at the Yalu River Estuary" in the city of Dandong, Liaoning province of China, co-funded by WWF and Liaoning Provincial Department of Ocean and Fisheries. With the implementation of the project, it is our hope that the general public will better understand the importance of oceanic ecosystems, make efforts to save rare and endangered species, and ensure that the important wildlife habitats in the Yellow Sea Eco-region can be well protected.

The integrity and health of the Yellow Sea ecosystem is a responsibility shared by all of the bordering countries in the region. We will work together with the people of these countries to protect our common home of the blue ocean.

KIM Woong-Seo

Korea Institute of Ocean Science and Technology

Shared among the Republic of Korea, China and North Korea, the YSE is a treasure trove of biological, mineral and energy resources. The broad tidal flats that have taken shape along its coast form an ecosystem that is nearly remarkable for its biodiversity. But decades of coastal development, overfishing and improper disposal of contaminants and waste materials have destroyed marine habitats, left the sea in danger of resource depletion and caused disturbing levels of pollution, respectively. Fish catches have been steadily dropping since the 1990s, and there have been drastic changes in species that make up the region's ecosystem, a problem has been exacerbated by climate change and the introduction of exotic species.

Addressing the various problems that confront the YSE and bringing its waters to life once again requires efforts not only from the central and local governments and academics, but from all Koreans—particularly those living in coastal regions. It is in recognition of this fact that YSESP was introduced. Launched in 2007 for the preservation and administration of important habitats in the YSE, YSESP is a joint effort by the Korea Institute of Ocean Science and Technology (KIOST) and the Chinese and Japanese branches of WWF, with additional support from Panasonic Corporation. The organization's first small-scale project was carried out in both 2007 and 2009 to promote awareness about biodiversity and ecosystem conservation in the local community. Since 2009, pilot projects have been under way to develop models for community- and ecosystem-based management for the Muan Tidal Flat in the Republic of Korea and the Yalu River Estuary in China. Our hope is that these projects have helped the public gain a better understanding of the importance of preserving the marine environment and helped ensure the future conservation of the YSE.

Historically, the Republic of Korea and China have coexisted for millennia on either side of the YSE. With the issue of ocean conservation growing in importance and intraregional cooperation on environmental management becoming a major focus of attention since the beginning of the 21st century, the Republic of Korea and China have been working together in various ways to manage and protect the shared asset that this sea represents. These efforts, however, have typically been government-led efforts such as cooperation on ocean science and technology and joint research studies. An effective way of producing more substantive results and ensuring the future protection of the marine environment in the YSE would be for a range of actors — not just the South Korean and Chinese governments, but civic groups and other stakeholders as well — to give updates on their activities and experiences on an ongoing basis.

The findings in this report are the result of hard work by residents throughout the region under difficult conditions. Our thanks go out to the government offices, universities and civic groups that contributed their efforts to preserve the Yellow Sea's habitats and biodiversity.

ACKNOWLEDGEMENT

This project started in 2007 as an international project with the aim of promoting sustainable resource use and the conservation of biodiversity in the Yellow Sea. The Yellow Sea Ecoregion Support Project (YSESP) has been working to provide both financial and technical support for conservation groups in the area, as well as demonstrating the importance of conservation management-based on scientific knowledge and the effectiveness of community-based conservation action. We sincerely hope that this comprehensive report, which includes a summary, a list of achievements and description of lessons learned from the project, will be utilized widely by the people concerned and, thus, the Yellow Sea's irreplaceable biodiversity will be preserved for the future.

As implementing bodies of this project, WWF-Japan, WWF-China and KIOST offer their utmost thanks to Panasonic Corporation for providing the project funds; the Ocean & Fishery Department of Liaoning Province of China (OFDLP), Liaoning Ocean and Fisheries Science Research Institute (LOFSRI), the Muan County Government of South Jeolla Province of Republic of Korea and the Eco-Horizon Institute (EHI) for supporting and implementing the demonstration site activity; the UNDP/Global Environment Facility Yellow Sea Large Marine Ecosystem Project (UNDP/GEF YSLME Project) for providing technical advice and support to the project; and all the people and institutes concerned for giving helpful advice and kind cooperation from the planning stage until the final editing of this report.

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EXECUTIVE SUMMARY

The Yellow Sea Ecoregion (YSE) supports large populations of marine life and migratory species. Not only do local communities rely on its well-functioning ecosystem, but entire neighboring countries as well. In 2006, WWF, in close collaboration with KIOST and the Korea Environmental Institute (KEI), has identified 23 Potential Priority Areas (PPAs) of the YSE as deliverables of the biological multi-taxa assessment conducted by the Yellow Sea Ecoregion Planning Programme (YSEPP) (Appendix 1). In 2007, with financial support from Panasonic Corporation, WWF launched a transboundary project, namely, the Yellow Sea Ecoregion Support Project (YSESP), whose mandate was to improve the effectiveness of habitat management to help conserve the of biodiversity of the 23 PPAs.

The seven-year project is composed of three stages

During the first stage from 2008 to 2009, a small grant-awarding scheme was created that supported the activities of 16 conservation research groups within the PPAs with such activities as environmental education and civil monitoring. The exchange programme of grants recipients organized on this stage has helped by not only enhancing the capacity building of each group but by also providing the opportunity to reconfirm the importance of networking in terms of ecology and social awareness. Project participants were also able to gather a variety of information about the status of high-conservation value areas, key stakeholders, conservation methodology and its overall effectiveness once applied.

During the second stage, two demonstrations were carried out both in China and the Republic of Korea (ROK) to improve the management effectiveness of two existing MPAs within the PPAs. Ecosystem-Based Management (EBM) and Community Based-Management (CBM) approaches were applied in the Yalu River Estuary Coastal Wetland, Liaoning province, China (PPA No. 14) and the Muan Tidal Flat Wetland Protected Area, South Jeolla Province, ROK (PPA No. 20), respectively, as management options upon which the YSE biodiversity conservation efforts and the sustainable use of resources could be modeled.

Demonstration site in China

In the Yalu River Estuary, Liaoning province, the demonstration site activity plan was developed with consideration for the ecological links among migratory shorebirds, local fisheries and the intertidal biological community. The three-year-long research project contributed to the provision of first-hand scientific information about the serious loss of habitat and structural damage that have caused changes to tidal communities since the 1960s, which has also led to the reduction the food sources available to shorebirds. Based on these research findings, the YSESP proposed seven policy recommendations for the Ocean & Fishery Department of Liaoning Province of China (OFDLP), such as the promotion of sustainable fishing practices, the introduction of zoning management and the development of more comprehensive regulations overall.

The Yalu River Estuary Coastal Area Ecosystem-Based Management Demonstration Project (hereafter referred to as the YSESP Yalu Project) has a lifespan of three years,

from 2010 to 2013. It was implemented in 2010-2012 with ¥ 15 million (equivalent to US$ 150,000) funded by Panasonic through WWF. OFDLP also contributed the same amount of the funding to the project, and technical support and guidance were mainly provided by YSLME.

Demonstration site in the Republic of Korea

In Muan, South Jeolla Province, the Regional Development Orientated Coastal Area Management Demonstratoin Project (hereafter referred to as the YSESP Muan Project) were made to develop, implement and review a CBM approach that would ensure tidal flat conservation and sustainable resource use while including the participation of the local community. When locals began preparation of a wetlands festival, they began to recognise how local customs were connected to tidal wetlands. Both the Muan government and its residents realized the importance of community participation for effective tidal flat resource management, and then proactively started to promote community-driven actions.

The YSESP Muan Project has a lifespan of three years, i.e., from 2010 to 2013. It was implemented in 2010-2012 with ¥ 15 million (about US$ 150,000) funded by Panasonic through WWF.

The final two years of third stage were spent disseminating and sharing lessons regarding the two conservation models in China and the ROK, working with national stakeholders as well as the international conservation community. All the affected countries surrounding the YSE have agreed with the Convention on Biological Diversity's (CBD) Aichi Target 11, which states that at least 10 per cent of coastal and marine areas need to be effectively and equitably managed by 2020. The YSESP expects the local and national stakeholders in and around the YSE, along with the international conservation community, to utilize the methodology, achievements and lessons learned from the YSESP's two demonstration sites as models for effective ecosystem management.

1 INTRODUCTION AND OVERVIEW

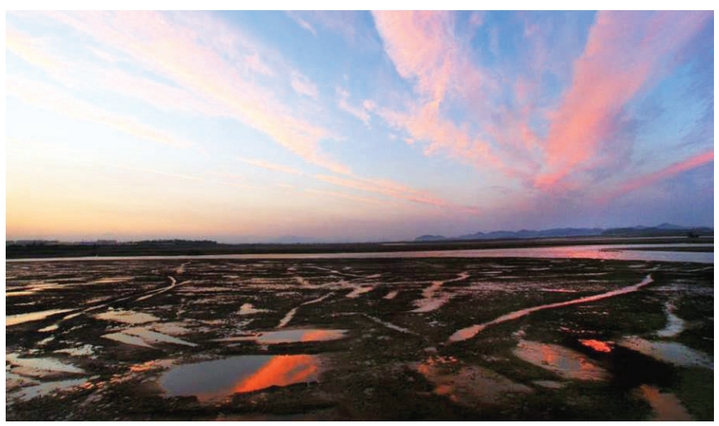
1.1. BACKGROUND

In the coastal area surrounding the YSE, there are a number of large cities with populations of over 1 million — Shanghai, Seoul, Tianjin and Dalian, among others. The total population in the watershed areas that drain into the YSE, such as the Yellow River, Yalu River, Yangtze River, Han River and Nakdong River, is 600 million people, or approximately 10 per cent of the world's population. In addition, the YSE is a key area for international shipping routes (UNDP/GEF, 2007b). The consequence of this intersection is that while many people in the neighboring countries enjoy significant benefits because of their access to the YSE, at the same time, they also have an adverse impact on the YSE either directly or indirectly.

1.1.1. GEOGRAPHY AND CLIMATE

The YSE has one of the largest continental shelves around the world; a surprising detail, however, considering the region used to be dry land. The last glacial cycle brought dramatic environmental changes to the area, such as the Holocene marine transgression, which flooded the region, creating the Yellow Sea (Kim et al., 2000). At present, the YSE is a large inland sea with a total area of 458,000 km². It is located between longitudes 117°and 126°, and latitudes 31°and 41°, and surrounded by China and the Korean peninsula. Reaching less than 200m at its deepest point, the average depth of the Yellow Sea is 46m; the Bohai Sea to the northwest, by contrast, averages just 26m (Barter, 2002).

This vast sea is mainly composed of water from the Yellow River, Yalu River and Yangtze River, three of China's major waterways. It also receives output from such major Korean rivers as the Keum (Geum) River and Nakdong River (Moores et al., 2001), as well as sand, mud and other types of sediment, which come as a result of water influx. The Yellow River in particular, which is the second longest river in China, has the largest amount of sediment loading in the world and accounts for the majority of the sediments accumulated in the Sea. These sediments also form a large number of intertidal flats on



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the Yellow Sea, covering an area of approximately 20,000km² (Barter, 2002). In total, the annual amount of influx from rivers is 1,500 billion tonnes of water with more than 460 billion tonnes of rainfalls and 1.6 billion tonnes of sediments (UNDP/GEF, 2013).

The Yellow sea extends broadly and is meteorologically located between the subtropical Pacific Low and the Siberian High. Accordingly, while the mean temperature in July is 24°C in the north and 28°C in the south, the average temperatures in January are -8°C and -4°C, respectively. The average sea surface temperatures also drop in winter, falling between -2°C and 0°C in January and February. Because of this cooling, the surfaces of Liaodong Bay, Bohai Bay, northern Korea Bay and the areas around the Yalu River Estuary will freeze for a couple of months every year. As spring comes closer and the temperature rises, the ice breaks up and begins to drift. There is a large amount of drift ice—up to 35 cm in thickness — found in the Bo Hai Sea, the northern part of Korea Bay and around the Changshan Peninsula (Barter, 2002).

1.1.2. BIODIVERSITY

(1) YSE has a great deal of variability in its local organisms such as fish, birds, mammals and invertebrates. It is also an important region in that people who live around its coasts obtain various marine resources from the sea. The diversity of its fish population is particularly high, with 339 species having been recorded: 45 per cent are warm water species, 46 per cent are warm temperate forms and 9 per cent are cold temperate forms. Furthermore, there have been around 100 species of polychaete, 171 species of molluscs, 107 species of crustaceans and 22 species of echinoderms that have been recorded in the region (UNDP/GEF, 2013).

(2) As for the ROK, there are 276 species of fish, 188 species of shorebirds, 18 species of marine mammals, 500 species of marine invertebrates, 70 species of phytoplankton, 300 species of marine macroalgae, 50 species of halophytes and six species of sea grasses; in total, there are 1,964 species found in the Yellow Sea Ecoregion. Likewise, China has 1,140 species recorded (Moores et al., 2001). In an ecoregion with such rich biodiversity, marine mammals are integral. In particular, finless porpoise (*Neophocaena phocaenoides*) play an important role as a keystone species. In addition, other mammals such as the minke whale (*Balaenoptera acutorostrata*); grey whale (*Eschrichtius robustus*), whose population has been decreasing; largha seal/spotted seal

(Phoca largha); and Eurasian otter (*Lutra lutra*) greatly influence the YSE (Yellow Sea Ecoregion Planning Programme, 2008).

Furthermore, the YSE is essential for migratory birds passing through this area for wintering and general travel. The region is a bottleneck of sorts, and there are 12 and 8 stopovers in China and the ROK, respectively, then 5 and 6 places out of those exist on land, respectively (Moores et al, 2001). Thus, 173 species of shorebirds and 9 species of seabirds in China, and 162 species of birds such as long bills, sandpipers, ducks and geese, sea gulls, swans and Japanese cranes in Korea utilize the respective stopovers (Eco-Horizon Institute et al., 2012). In total, when they move north, it is estimated that about 200 million birds, which is 40 per cent of all the birds using East Asian-Australasian Flyway (EAAF), pass through the region; when they move southward, about 100 million other birds follow (Moores et al., 2001).

1.1.3. FOOTPRINTS

The YSE serves a variety of ecological functions. This utility, however, is connected to the area's pristine habitats, which have been greatly deteriorated because of environmental destruction. In China, the number of tidal flats has decreased by 37 per cent in comparison to that of 1950s. In the ROK, 43 per cent of the coast's tidal flats have been lost since 1917. The major reasons cited are reclamation due to human development in coastal areas and the expansion of aquaculture industry.

In coastal areas of the YSE, natural coastlines have been converted to farmlands, saltpans and farm operations for fish, shrimp and shellfish because of land reclamation by drainage. Sixty-three million hectares of the YSE's coastal areas are covered by farms, which is equivalent to around 60 per cent of the overall farms in China. More tidal flats of the YSE in China have been transformed into saltpans; consequently, 30 per cent of the area's tidal flats have been turned into saltpans. The degradation of the natural environment caused by a wide variety of development is now a serious problem not just for plants, shellfish, shrimp and invertebrates but for their predators such as birds and mammals.

In addition, the exhaustion of fish resources and the pollution caused by overfishing is now a critical matter. Though the YSE's fishing resources are abundant, the reckless nature with which the industry has been handled means its stocks have a high probability of exhaustion. The nations surrounding the YSE not only consume its marine products but also generate profit by selling them overseas. In particular, Japan imports and consumes a large quantity of the products such as manila clams, hard clams and octopuses and is deeply implicated in this matter. If the populations of such species have decreased, there is a high possibility that Japan's consumption has had an influence on the changes in the environment. Such excessive use of resources is also a serious factor in the degradation of the YSE's ecosystem. Furthermore, overfishing creates demand for large-scale fishing practices such as drift net fishing, which has been used in both coastal waters and in the estuary of Yangtze River. This practice also leads to the exhaustion of resources due to the bycatching of untargeted fish and mammals.

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In addition to the matters above, red tide is another issue that cannot be ignored because of its role in causing the widespread deaths of fish and shellfish. In the coastal areas of the YSE, the number of instances of red tide has been increasing since the mid-1980s, and the scale has also expanded in recent years due to the industrialization of communities and the centralization of populations. Such huge outbreaks of phytoplankton are most likely caused by the human development in the coastal areas and the corresponding decrease in tidal flats. One of the causes is domestic and industrial wastewater released into the ecosystem at high temperatures, problematic because it includes nitrogen and phosphorus, which are both essential for plankton growth. Likewise, the decrease in manila clam, which feeds on plankton because of the loss of many tidal flats, is also an important element. Some plankton causing red tide are known to contain toxins. As a result, there is a substantial risk for humans and shorebirds eating shellfish and fish contaminated by these toxic plankton.

1.1.4. CHRONOLOGY OF THE YELLOW SEA PROJECTS

Aimed at conserving the YSE's biodiversity and maintaining its life-supporting ecosystem services, WWF kicked off its conservation initiative with a comprehensive, ecoregion-wide biodiversity assessment in 2002. With support from Panasonic Corporation, WWF launched a transboundary project named the Yellow Sea Ecoregion Support Project (YSESP).

In 2005, supported by the Global Environment Facility (GEF), United Nations Development Programme (UNDP) launched a project titled Reducing Environmental Stress in the Yellow Sea Large Marine Ecosystem (YSLME), which aims at assisting people of China and the ROK to realize ecosystem-based, environmentally sustainable management of the Yellow Sea and its watershed. Sharing similar goals, UNDP and WWF formally established a partnership in 2005. Since then, the two parties have been pulling resources together and working in a highly coordinated way. With contributions from WWF for its biodiversity component, the YSLME Project first completed a

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Transboundary Diagnostic Analysis (TDA) that, using the most advanced research and facilities available, identified the Yellow Sea's threats and outlined the root causes and impacts of these problems (UNDP/GEF, 2007c).

Based on the TDA, the YSLME Project then developed a regional Strategic Action Programme (SAP), which identifies feasible management actions that can address transboundary environmental issues in the Yellow Sea in the most effective way possible. It was agreed by WWF and the YSLME Project that it would be more beneficial to the coastal countries of the YSE if the efforts would be coordinated to develop and implement a joint management plan.

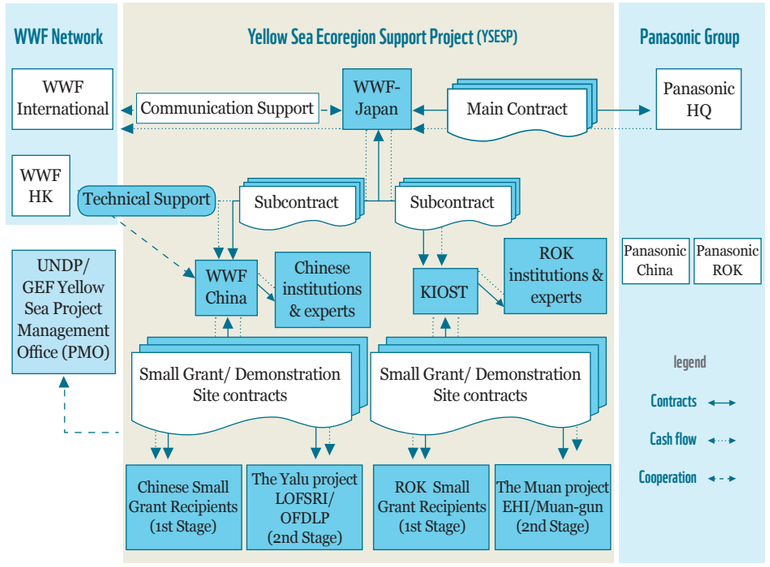
[Table 1-1] Chronology of the Yellow Sea Project

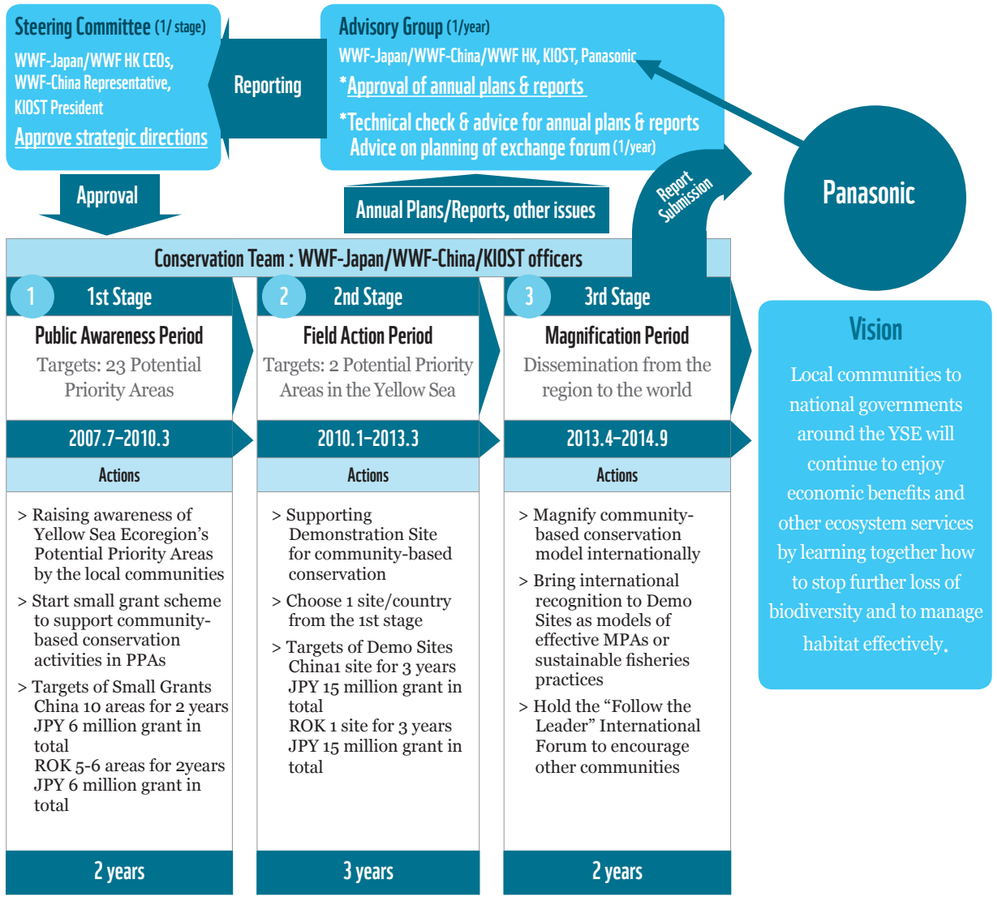
Month/Year	Activity
1997	WWF selects Global 200 Ecoregions. The Yellow Sea is listed.
Mar. 2001	WWF, Wetlands & Birds Korea and WI publishes "Reconnaissance Report on Identification of Important Wetland and Marine Areas for Biodiversity Conservation."
2002-2006	YSEPP (WWF, KIOST; formerly KORDI, KEI) selects PPAs in the YSE.
May 2005	YSEPP (WWF, KIOST, KEI) and UNDP/GEF YSLME project sign a MoU.
Dec. 2006	YSEPP issues the PPAs map in the YSE in the "East Asia Marine Conference 2006."
2007	Panasonic Corporation concludes a contract and becomes a corporate supporter of WWF International.
Sept. 2007	WWF makes a joint declaration with Panasonic Corporation in Beijing (launch of the YSESP).
2007	UNDP/GEF YSLME publishes the book *Transboundary Diagnostic Analysis for the YSLME*.
2007-2009	YSESP–Small grant programmes (5 groups in the ROK and 10 in China).
Oct. 2008	YSESP participates in "Ramsar COP 10" in Changwon, ROK.
Dec. 2008-Mar. 2009	YSESP holds a photo exhibition in Tokyo and Beijing.
2008	YSESP and UNDP/GEF YSLME project implements "Assessment of Management Effectiveness for Korean Ecologically Important Areas of the Yellow Sea."
2009	UNDP/GEF YSLME project publishes the book *Strategic Action Programme for the YSLME*.
Jan. 2009	YSESP holds an exchange forum at the Beijing Panasonic Center in Beijing.
Jul.-Aug. 2009	YSESP holds a photo exhibition in Osaka, Japan.
2010-2012	YSESP – demonstration site activities (one group in the ROK and one group in China)
2010-2013	YSESP implements a hearing survey about Korean demonstration site activities.
Feb. 2010	WWF, YSLME PMO and OFDLP sign a MoU in Shenyang, Liaoning, China, and the second stage and third action period begin.
Mar. 2010	YSESP (WWF, KIOST, EHI) and Muan-gun sign a MoU.
Mar. 2010-	YSESP works on environmental educational activities.
May 2010	YSESP holds an exchange forum in Muan and gives a certificate to small grant recipients.
May-Jun., Jun.-Jul. 2010	YSESP holds two photo exhibitions in Seoul.
Jul., Dec. 2010; Feb. 2011	An article about YSESP is published in *Eco & Nature*.
Oct. 2010	YSESP participates in "CBD COP 10" in Aichi, Japan, and holds a side event and installs a booth.
Jan. 2011	An article about YSESP is published in *Man and the Biosphere*.
May 2011	YSESP publishes the Muan Tidal Flat cookbook Cooking with the Riches of the Tidal Flat (in Korean)
Sep. 2011	YSESP participates in "IUCN Asia Regional Conservation Forum" in the Republic of Korea.
Sep. 2011	An article about Japan-Korea workshop is published in *Donga Science*.
Oct. 2011	The scientific research "A study on bio-ecology of the stopover site of waders within China's Yalu River estuary" is published in *Acta Ecologica Sinica*.
Nov. 2011, Mar. 2012	YSESP holds the event "Learn with *Sakana-kun* about Seas in Japan and the Yellow Sea" twice.
Jan. 2012	Japan-Korea tidal flat workshop is introduced in a symposium about the promotion of regional cooperation between Japan and Korea.
Jan. 2012	Japan-Korea tidal flat workshop is introduced in a symposium about the promotion of regional cooperation between Japan and Korea.
Apr.-Dec. 2012	YSESP implements various ecotour programs (seven times).
May 2012	YSESP cooperates the opening of Muan Tidal Flat festival.
May 2012	Yongsan village wins an award of excellence from the Korean Tourism Organizaiton.
May 2012	Muan County receives a presidential citation regarding their tidal flat conservation based on community participation.
May 2012	An article about activities in Muan is published in *Mainichi-Shinbun*.
Jul. 2012	YSESP participates in "COP11" in Bucharest, Romania.
Jul. 2012	YSESP makes a pamphlet titled "Promise for the Biodiversity in the Yellow Sea" (in English and Korean).
Jul. 2012-Nov. 2013	YSESP plans and implements socioeconomic surveys about bivalve resources in the Yellow Sea.
Jul. 2012	YSESP holds a roundtable discussion/exchange forum about ecological surveys in the Yalu estuary.
Nov. 2012	The scientific research, "The Yellow Sea Ecoregion Conservation Project" is published in *Journal of the Korean Society for Marine Environmental Engineering*.
Nov. 2012	YSESP holds an exchange forum in Shanghai.
Nov. 2012	YSESP holds a workshop about wetland management training in Hong Kong.
Feb. 2013	An article about the third Exchange Forum in Shanghai is published in *Donga Science*.
Mar. 2013	YSESP holds a workshop about wetland management training in Hong Kong.
Jun. 2013	YSESP submits 7-point policy recommendation to OFDLP based on the research findings and result of the Yalu demonstration site activities.
Aug.-Sep. 2013	Liaoning Marine Fisheries Research Institute holds a special exhibition for the general public.
Sep. 2013	YSESP participates in "Green Asia Forum 2013" in Busan, Republic of Korea
Nov. 2013	YSESP participates in "1st Asia Parks Congress" in Sendai, Japan.
Dec. 2013	YSESP participates in "East Asian–Australasian Flyway

1.2. FRAMEWORK OF THE YSESP

WWF and Panasonic Corporation have signed a seven-year agreement for the latter's sponsorship of the YSESP, which is managed by WWF-Japan. The project's implementing partners are WWF-Japan, WWF-China and KIOST. These implementing partners were members of the preceding project, the YSEPP. The reasons for selecting these partners is that, aside from having shared experience in the previous project, they also jointly agreed to the recommendations by the Steering Committee of the previous project that these organisations would further develop and implement strategic field projects together, which are complementary to conservation of PPAs, and the results from these projects should be also influence Biodiversity Component and Fisheries Component of SAP in YSLME later. WWF-Hong Kong joined as an important supporting partner, especially to WWF-China. Another key partnership for this project was the one with UNDP/GEF Yellow Sea Project Management Office (PMO). In February 2010, WWF signed a MoU with UNDP/GEF YSLME Project and the Ocean & Fishery Department of Liaoning Province of China (OFDLP) to make joint efforts in implementing the YSESP Yalu Project from 2010 until 2012, and in March 2010, signed another MoU with the Muan County of South Jeolla Province, Eco-Horizon Institute (EHI) and KIOST for the implementation of the Muan Tidal Flat Demonstration Project.

[Figure 1-1]
The YSESP implementation structure





1.3. VISION AND OBJECTIVES

The YSESP is expected to work to achieve the following vision and goals, both on its own and with other stakeholders. Through its lifetime, it is expected to contribute to achieve objectives, serving as a platform that connects governments, research institutions, local communities and NGOs and cooperates with them in order to conserve internationally important species and habitats in the YSE. For more detailed results chain and assumption of the YSESP, see Appendices 2 and 3. The YSESP result chain is a graphical depiction of a project's core assumption, the logical sequence linking project strategies to one or more direct threats and their associated conservation targets.

Vision

Local communities and national governments around the YSE will continue to enjoy economic benefits and other ecosystem services by learning how to prevent any further loss of biodiversity and to manage the habitat effectively.

Goals

(Collective Impacts of all Activities)
- Increased capacity to manage habitat effectively through zoning, MPAs and other identified options;
- Established policies on promoting and financing habitat management;
- Reduced threats to habitats and species of PPAs.

(People-Centred Impacts)
- Increasing number of local city leaders with good understanding of the importance of biodiversity in PPAs and commitment to habitat management;
- A sustained ecoregional learning centre of habitat management;
- An operational network of practitioners of habitat management and public awareness.

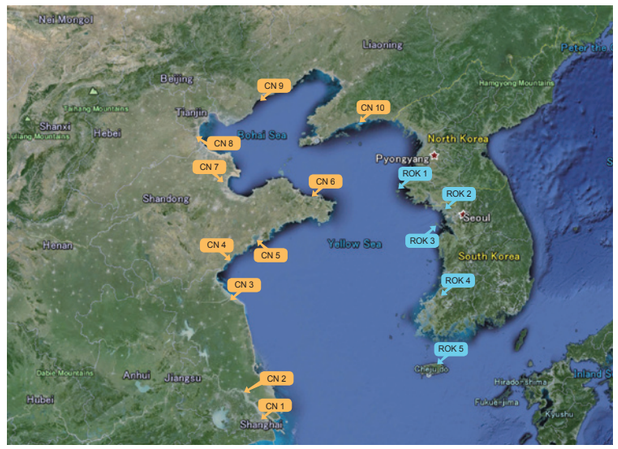
Objectives

- Small grant recipients continue to use improved skills of public awareness;
- Awareness of users and managers of habitats and species of PPAs enhanced;
- Improved zoning scheme implemented or a plan to implement improved zoning scheme adopted;
- Two visionary local leaders of the demo sites committed to implementation of improved zoning;
- Improved management effectiveness of demonstration site MPAs;
- Commitment to policies/mechanism to sustain this learning centre.

1.4. SMALL GRANT-AWARDING SCHEME

The YSESP small grant scheme (2007 -2008) supported the activities of 16 conservation groups within the PPAs in China and the ROK such as environmental education and civil monitoring (Appendix 4 List of the YSESP Small Grants Recipients). Also, the exchange programme of grants recipients organized on this stage has helped by not only enhancing the capacity building (e.g., skills of public awareness activities utilizing digital camera) of each group but by also providing the opportunity to reconfirm the importance of networking in terms of ecology and social awareness. Project participants were also able to gather a variety of information about the status of high-conservation value areas, key stakeholders, conservation methodology and its overall effectiveness once applied. This small grant scheme was designed for small grant recipients to continue to use improved skills and to enhance awareness of key stakeholders such as local managers and resource users of habitats and species of PPAs.

[Figure 1-2]
Small grant recipients



ROK

- ROK 1 2008, Green Korea, Baekryeong-do, Incheon
- ROK 2 2009, PGA Wetland cology Institute, Goyang-si, Gyeonggi Province
- ROK 3 2009, Korean Network for Coastal Conservation, Ansan-si, Gyeonggi Province
- ROK 4 2008-2009, Eco-Horizon Institute, Muan-gun, South Jeolla Province
- ROK 5 2008, Jeju Wildlife Research Center, Seogwipo, Jeju Island

CN

- CN 1 2009, Shanghai Wild Bird Society, Shanghai
- CN 2 2008, China Ocean Newspaper; Oceanic and Fishery Department of Nantong City; Nantong Municipal League; Fisheries Society of Nantong City; The Marine Environment Monitoring Center of Nantong City; Dongzaogang Primary School, Haimen City, Nantong Jiangsu
- CN 3 2009, Huaihai Institute of Technology and Undergraduate Environment Protection Association of Huaihai Institute of Technology, Lianyungang Jiangsu
- CN 4 2009, Institute of Oceanology, Chinese Academy of Sciences, Rizhao Shandong
- CN 5 2008, Shandong Law Society, Environmental Resource Law Research Society, Qingdao Shandong
- CN 6 2008, Shandong University Weihai Campus, Ocean Academy, Weihai, Shandong
- CN 7 2008, State Oceanic Administration, First Oceanic Research Center, Dongying Shandong
- CN 8 2009, Environmental Protection Agency of Cangzhou, Hebei province, Cangzhou Hebei
- CN 9 2008, Qinhuangdao Entrepreneurs Association-Urban Environment Development Research department, Qinhuangdao Hebei
- CN 10 2009, Ecological Research Center in Technology University of Shenyang and Dandong Municipal Forestry Bureau, Zhuanghe, Liaoning province

1.5. SITE SELECTION OF THE DEMONSTRATION SITE ACTIVITY

In order to select the most suitable site for the demonstration project, the following activities were carried out by the YSESP and YSLME project jointly: 1) preparation of a joint workshop plan for selection of potential demonstration projects under both the YSLME project and the YSESP; the joint work plan includes the assessment considerations, assessment methodologies, responsibilities of all relevant parties and the timetable for the implementation; 2) design of an assessment procedure and contents, including the nature environment conditions assessment and the management effective assessment; 3) design of a selection of demonstration procedures and criteria to be used for the selection of YSLME demonstration sites and YSESP project demonstration sites.

1.5.1. DEMONSTRATION SITE SELECTION IN CHINA

A preliminary assessment of important and representative coastal or marine habitats along the coast of the Yellow Sea was organized. An information collection table was designed by referring to the Ramsar Information Sheet. A habitat's importance would be judged against Ramsar Criteria 2 (endangered species), 5 (20,000 shorebirds), 6 (1 per cent shorebirds) and 8 (fish habitat). Nine habitats were then listed in the information collection table based on WWF's PPA map and in consultation with experts. The nine habitats were first grouped by their dominant wetland types, followed by a comparison within each of these groups. In consultation with an expert, the nine habitats were then divided into four groups. Finally, the experts consulted and recommended four specific sites from each habitat group considering their representativeness or their abundant biodiversity. In summary, the YSESP suggests four representative habitats as potential demonstration sites. Based on the scoring results of the 19 elements classified four criteria regarding management effectiveness, the Yalu River Estuary was selected as the demonstration site in China.

[Table 1-2] Assessment criteria for demonstration site selection in China

Selection Criteria	Elements of scoring
Criterion 1 Practicality of demonstrating improvement in management effectiveness	a) Level of difficulty at site
	b) Why little or no management has been achieved until now
	c) Level of opportunity for improvement—how our management plan can address the problems
	d) Level of support at site (financial, personnel and institutional)
	e) Opportunity for inclusion of cross component management actions (e.g., pollution)
	f) Opportunities for sharing and learning lessons acquired parallel with YSLME demo sites
	g) Ease of producing tangible outputs and outcomes within a project period (three years for YSESP)
Criterion 2 Local government commitments	a) Past examples of environmental management activities and achievements within the province (two to three examples)
	b) Current provincial efforts in biodiversity conservation and likely outcomes
	c) Future environmental management plans at the proposed site
	d) Financial support (source and size of matching funds)
	e) Personnel support (experience and qualifications of a planned project leader and a coordinator)
	f) Willingness of other relevant government divisions to develop a coordinating institutional mechanism for management of the demo site
Criterion 3 Stakeholder participation	a) Willingness of current resource users (e.g., fishers) to participate in the management
	b) Previous records of management by users
	c) Previous records of cooperation with local government
	d) Financial/personnel support by stakeholders
Criterion 4 Replicability of model	a) Identified concrete replication sites
	b) Perception of impact of replication by relevant government agencies

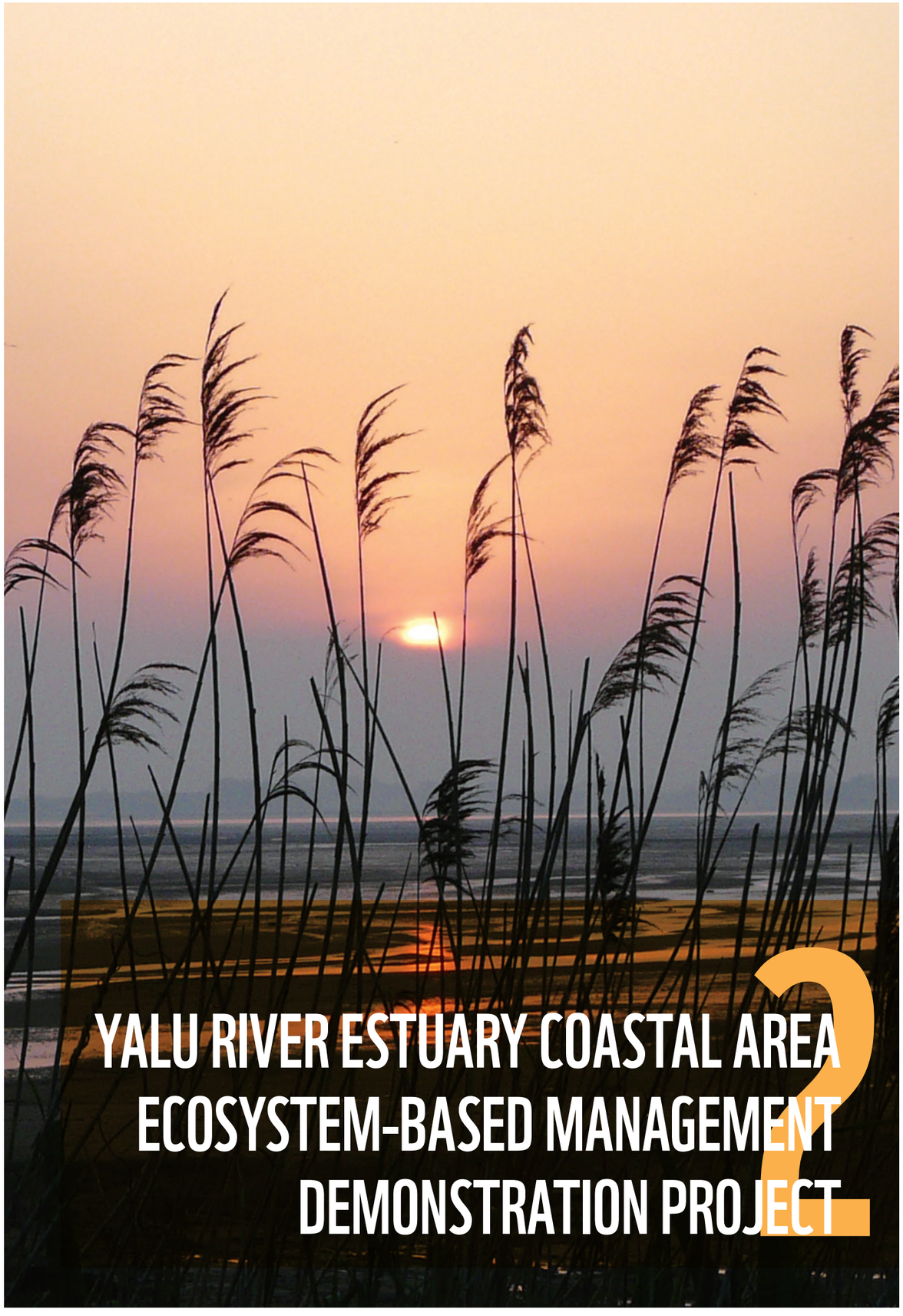
1.5.2. DEMONSTRATION SITE SELECTION IN ROK

The YSESP and the UNDP/GEF YSE Project conducted a joint assessment for the selection of a demonstration site. Following the marine biodiversity assessment carried out by the UNDP/GEF YSE Project and the assessment of management effectiveness carried out by KIOST for the YSESP, there were five candidate sites considered for the potential demonstration site. With the 14 evaluation elements of six criteria, seven panels reviewed all five proposals with respect to quantitative evaluation and qualitative evaluation. The Muan Tidal Flat was selected as the demonstration site in the ROK.

[Table 1-3] Assessment criteria for demonstration site selection in the Republic of Korea

Selection Criteria	Elements of scoring
Criterion 1 How well the proposal addresses the concept of EBM	a) The situation analysis is well presented with good understanding of the concept of EBM.
	b) Core management targets (biodiversity and governance targets) are well developed and addressed in the proposal. management by users
	c) Optional management targets (sustainable use targets, e.g., fisheries, ecotourism) are well developed and addressed in the proposal.
Criterion 2 How well the management actions are designed	a) Management actions are logically developed.
	b) Management actions include core components of EBM.

Selection Criteria	Elements of scoring
Criterion 3 Feasibility of demonstrating improvement in management effectiveness	a) Threats and challenges are well handled.
	b) Management actions are feasible.
	c) Collaboration with YSLME project
Criterion 4 Management capacities of the site and the recipient organization	a) The site possesses existing management resources.
	b) The management capacity of the recipient organization is high.
Criterion 5 Stakeholder participation	a) Local governments are willing to collaborate.
	b) Other stakeholders are willing to collaborate.
	c) Collaboration among stakeholders is secured.
Criterion 6	a) The EBM model could be usefully replicated in the future.



2 YALU RIVER ESTUARY COASTAL AREA ECOSYSTEM-BASED MANAGEMENT DEMONSTRATION PROJECT

2.1. PROJECT OVERVIEW

2.1.1. PROJECT DESCRIPTION

(1) Background/baseline

Characteristics of coastal estuarine wetland

A coastal estuarine wetland is one located at the mouth of a river into ocean and is one of the three types of wetland in China. As a habitat for many types of migrant wildlife, estuaries represent the ecological landscape with the most biodiversity in nature and one of the most important living environment for human beings. Most bottom materials at an estuarine wetland are formed by silt deposition taken by seawater and river water to the estuary, thus containing rich organic matters which provide important food source for fish and shellfish. The estuary is also a place that migratory fish must pass through, and this is why there are usually more species of fish at an estuary than the neighboring oceanic or river ecosystem. The estuarine wetland is also a good breeding and wintering place for birds, as well as an indispensable stop for birds to migrate.

Coastal estuarine wetland is capable of providing a dozen of kinds of ecosystem services including food production, water reservation, flood regulation, climate regulation, water purification, gene resources, leisure and recreation and wildlife habitats, as well as high biological productivity. The coastal estuarine wetland system can provide people with food sources such as fish, shellfish, shrimp and crab; it has rich plant communities that absorb large amounts of carbon dioxide while releasing oxygen to regulate atmospheric components more effectively; when runoff takes fertilizer, pesticide, heavy metals and other pollutants to a wetland, the vegetation and silt there can slow down water flow, beneficial for suspended particles carrying poisons and causing nutrients to settle down and be absorbed. Once the poisons and nutrients settle down, they are absorbed by plants, stored and transformed by chemical and biological processes and pollutants are retained. Besides, micro-organisms in a wetland can purify water through decomposition and transformation of pollutants. However, coastal estuarine wetlands are susceptible to human development activities. In particular, the human activities in northern China with regards to wetland functions such as shipping, fishing and land reclamation have caused significant impacts on the estuarine ecosystem.

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Ecosystem-Based Management concept

Ecosystem-Based Management (EBM) takes humans and ecosystems into consideration and comes out to address the increasing dilemmas faced by humans in relation to environmental protection and economic development. More and more people have become aware of the harms of the management pattern in which economic benefits are put first and relations between humans and nature are undermined, and they have begun to reflect on how humans can coexist with nature in a harmonious way.

Compared to traditional management patterns, EBM has the following features:

- Regarding humans as part of the ecosystem and planning ecosystem building and socioeconomic development as a whole;
- The objects under management are not limited to the ecosystem itself, but more importantly includes human activities;
- Management units are divided by the border of each individual ecosystem instead of administrative demarcation;
- For uncertainties in ecosystem and social system, adaptive management may be adopted in order to collect and analyse information supporting decision making in a planned and purposeful way and keep improving management;
- Guide major stakeholders to engage and cooperate in the course of management.

In fact, EBM has penetrated into the fields related to ecosystems, including biodiversity protection, natural resources, environment, river basins and land use planning, and its importance has been widely recognized in the world. Coastal estuaries are susceptible to human development activities while they are a habitat for many migrant wildlife, represent the ecological landscape with the most biodiversities in nature and are one of the most important living environment for human beings. Therefore, to develop EBM approaches for coastal estuarine wetlands and to coordinate the relations between human activities and nature protection are good for biodiversity protection and the sustainability of ecosystem in coastal estuarine wetlands.

At present, ecosystem management in coastal estuarine wetlands are based on cycle of matters, energy flow, wetland hydrology and spatial field causality and other models. EBM is an important channel for wetland ecosystem management although there are not so many researches on it. The coastal estuarine wetland at the Yalu River Estuary still has the relatively well-preserved original ecosystem that is rare among coastal wetlands in China. Our previous surveys showed that benthic community, birds featuring wading birds and shell communities are important factors affecting the development of the coastal estuarine wetland at the YRE. Considering this fact, we start from discussion on the key ecological relations and coordination among the three biological components, carry out ecological relation-based coastal wetland biotope protection and management at the YRE, and seek for solutions to complicated social and ecological issues, with a view to find a way to achieve the coordinated development among human, society and nature.

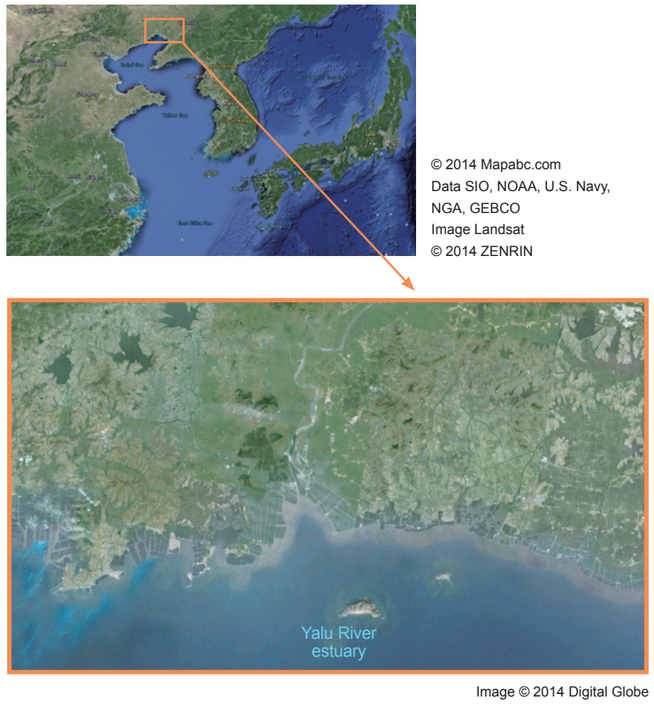
Situation of coastal wetland at the Yalu River Estuary

The sea area near the City of Dandong is located at the northernmost of coastline of the Yellow Sea, with Yalu River to its east and the Yellow Sea to its south. The city has a 125 km-long coastline, 3500 km^2 of sea area, 242 km^2 of intertidal zone mud flat, 3500 km^2 of sea area within 20m isobath. The intertidal zone extends along east-west land direction in a zonal arrangement with an average width of 5 km and an average gradient of 1.3‰.

The tide here is regular semi-diurnal tide, having twice rising and falling tides each day at a mean range of 4 m. There are a wide variety of marine biological resources, including fishes, shrimps, crabs, shellfishes and algae here, over 200 of which have been explored for use. The land reclamation and coastal engineering emerging during 1960s-1990s took up most of high and middle tidal zones (only a small amount of high and middle tidal zones are left at the Yalu River Estuary and the Dayang River Estuary), with mud flat area diminishing by half from that in 1950s (342 km^2). The middle tidal zone in some areas is even less than 300 m wide.

The coastal wetland at the Yalu River Estuary, which is within Dandong City, starts from the sea boundary between China and Korea, conjoining Zhuanghe of Dalian City to its west and extending in zonal arrangement along the coastline in Donggang City. The wetland is a complex ecosystem consisting of inland wetland, waters, oceanic and coastal ecotype. The coastal wetland covers an area of 1010 km^2, including 20% of intertidal zone. The bottom materials in the intertidal zone are mud, silt, fine sand and sand from bank to sea. Generally speaking, such bottom materials are more suitable for the growth of annelid and mollusc. The wetland is located at the Yalu River Estuary and Dayang River Estuary, both of which have abundant water with annual net flow of over 30 billion cubic meter. The two rivers carry large amount of organic matters, allowing the sea area to contain more nutritive salt and phytoplankton than other waters in Liaoning's coast along the Yellow Sea and constituting the material base for productivity in offshore waters.

[Figure2-1] Location of Yalu River Estuary Wetland in Yellow Sea Ecoregion



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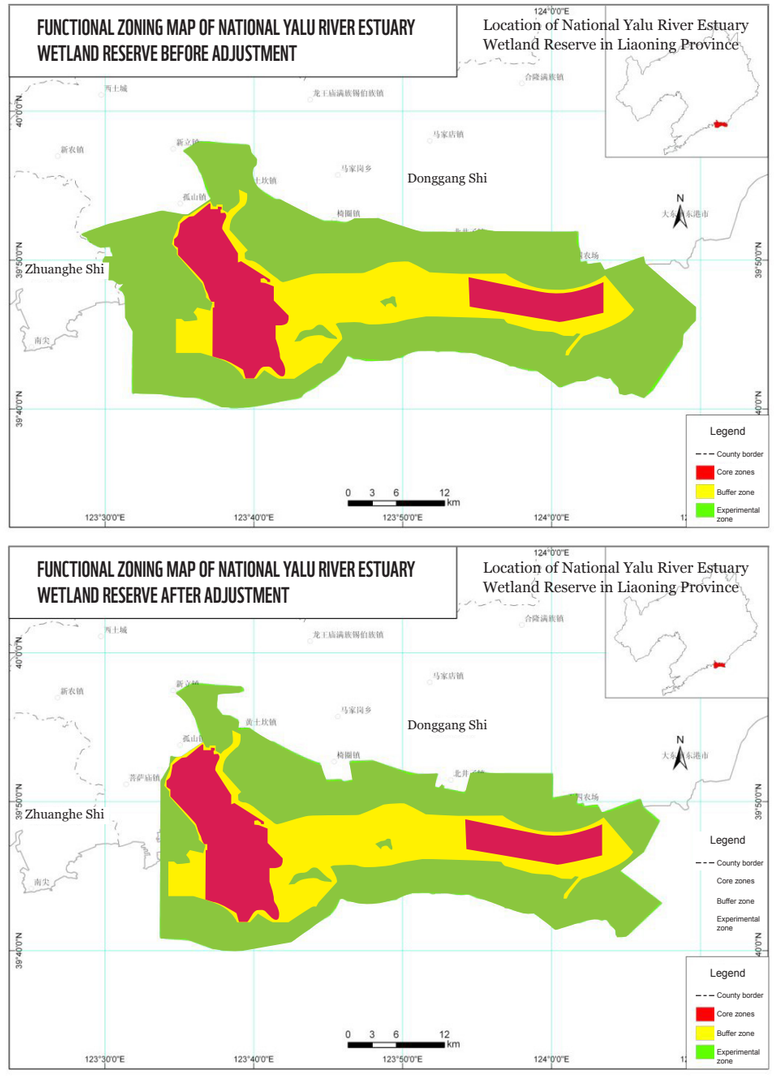
A nature reserve was established in the coastal wetland at the Yalu River Estuary in 1987, and in 1997 it became a national-level nature reserve approved by the State Council, mainly protecting coastal wetland ecosystem and rare wild fauna and flora. In 2007 the adjusted area of the nature reserve was 101,000 hectares (81,400 hectares after the adjustment in 2013). Almost all of the coastal wetlands are located in the nature reserve. In July 1999, the Nature Reserve was named one of the seven component wetlands of the East Asia-Australasian Flyway (EAAF) network. Recognized by many Chinese and international experts and researchers as the largest migrant bird stopover in the world, as well as the most important supply stop of the East Asia-Australasian Flyaway (EAAF), it has significant influence worldwide.

[Figure 2-2] Functional zoning map of National Yalu River Estuary Wetland Reserve before (2007) and after (2013) adjustment



Fully aware of the irreplaceable position of the Coastal Wetland at Yalu River Estuary (CWYRE) in terms of maintaining the diversity and integrity of the world ecosystem, and ensuring sustainable development of local economy. The Demonstration Project was intended as a means for the development and implementation of a scientific ecosystem-based coordination and management plan for the region. Through the design and implementation of the ecosystem-based coordination and management plan, it would be possible to effectively maintain and protect eco-resources with the highest ecological, economic and cultural values in CWYRE, to improve the harmony between people and nature, and to build the CWYRE into a role model of wetland conservation and management in temperate river Estuary regions for extensive promotion across the Yellow Sea Region and other coastal regions with similar conditions across the world.

(2) Project team (skill and role)

Yalu River Estuary Coastal Area Ecosystem-Based Management Demonstration Project was developed jointly by Ocean & Fishery Department of Liaoning Province (OFDLP), WWF and UNDP/GEF Yellow Sea Large Marine Ecosystem (YSLME). Liaoning Ocean and Fisheries Science Research Institute (LOFSRI) conducted the specific implementation of the fieldwork with the cooperation and support by OFBDC and National Yalu River Estuary Wetland Reserve Administration (NYREWRA).

OFDLP is a provincial-level government agency in charge of marine affairs and fishing industry of the province. Its responsibilities include the development of province-wide strategies and policies for developing ocean- and fishing industry-related matters, to protect marine environments, to monitor fishing zones, to supervise the administration of marine reserves and special conservation zones and to and organize the forces that protect the province's ecosystems. OFBDC is a municipal-level government agency whose responsibilities are to protect the marine environment, to monitor fishing zones, to supervise the discharge of land-sourced pollutants into the sea, to organize the forces to protect the municipality's ecosystems, to give directions on the protection of fishing waters, to ensure mud flats suitable for fishing, to act as a wetlands and biological species resource and to protect and explore fishing resources in a rational manner. NYREWRA is a government agency in charge of the protection of wildlife resources in a national-level nature reserve at the Yalu River Estuary (including publicity and implementation of relevant national laws, rules and regulations concerning environmental and nature protection), the protection and development of rare and precious animal and plant resources in the nature reserve, the investigation and punishment of illegal behaviors regarding damage to the natural environment and resources, the facilitation of scientific research and science education concerning nature reserve, the advancement of science and technology exchanges and exploration of useful applications, the development of biological resources and the construction and maintenance of the nature reserve in accordance with the overall plan and design. LOFSRI, a subsidiary to OFDLP, is a provincial-level key scientific research institution whose main functions are the development of Liaoning's ocean development strategy, as well as overseeing the region's ocean resource conservation, administration and sustainable use of marine resources, investigation and appraisal of marine pollution accidents, sea area use demonstration and marine environment monitoring and protection, among other things.

In accordance with the objective, requirements and scope of the YSESP Yalu Project, an organizational structure was developed to ensure the project's successful implementation. In order to handle tasks under the different project mandates, three workgroups were established, with responsibilities and staffing described as follows:

① YSESP Yalu Project Steering Committee

Established by OFDLP, the YSESP Yalu Project Steering Committee (hereafter referred to as the Steering Committee) was responsible for leading, organizing and supervising the implementation of the project, guiding and coordinating activities taken for the purpose by government agencies and institutions, and submitting project reports to WWF.

The Steering Committee operates under the guidance of OFDLP, and convenes whenever necessary. The meetings are convened by the chair or a member appointed by the chair. Any decision shall be made on a consensus basis.

② YSESP Yalu Project Expert Committee

The YSESP Yalu Project Expert Committee (hereafter referred to as the Expert Committee) reports to the Steering Committee. It is responsible for providing the Steering Committee with expert opinions, solving technical issues encountered during the project implementation process and providing the project owner with expert opinions and guidance if necessary.

The Expert Committee is composed of experts and officers from relevant institutes: LOFSRI, National Marine Environmental Monitoring Center, Ocean & Fishery Department of Dandong City, Environmental Protection Bureau of Dandong City (EPBDC), NYREWRA, Dalian Fisheries Industry, WWF-Japan and Aquaculture Technology Promotion Station of Dandong City.

③ YSESP Yalu Project Office

The YSESP Yalu Project Office (hereafter referred to as the Project Office) is responsible for organizing and holding inter-organization or inter-government agency seminars as required by the cooperation agreements signed, developing and implementing the YSESP Yalu Project, reporting to and exercising duties assigned by the Steering Committee.

The Project Office is composed of officers from relevant institutes: OFDLP, OFDLP, LOFSRI and NYREWRA.

(3) Scope (geography and theme)

The coastal wetland region of the Yalu River Estuary is located in Donggang, a city in southeast Liaoning; it adjoins the village of Erdaogou to the east, and the border between Donggang and the city of Zhuanghe to the west, as well as Heda Highway at the north and the Yellow Sea to the south. As a belt along the coastline in Donggang, it has a hybrid ecosystem that combines an inland wetland and aquaculture ecosystem with a marine ecosystem. Affected by natural conditions such as terrain, climate, soil and tide, the wetland has cultivated rich varieties of biological resources and species, as well as animal communities, most of which are birds. Altogether, there are 250 types of birds, including the endangered black-billed gull (*Chroicocephalus bulleri*) and Japanese swamp warbler (*Locustella pryeri*); eight Class-I protected bird species, including the red-crowned crane (*Grus japonensis*), white-naped crane (*G. vipio*), Siberian crane (*G. leucogeranus*) and white stork (*Ciconia ciconia*); and 29 Class-II protected bird species, including the whooper swan (*Cygnus cygnus*) and white-fronted goose (*Anser albifrons*). In addition, the CWYRE is home to 114, or 50.2 per cent, of the 227 species

identified in the agreement between the Japanese and Chinese governments for the protection of migratory birds and their habitat, and 43, or 53 per cent, of the 81 species identified in the China-Australia Migratory Bird Agreement.

With excellent hydrological conditions and water quality, the CWYRE is also a desirable fish habitat. There are currently 88 fish species, including 35-40 for commercial fishing, making it one of the most important aquaculture farms in China. In addition, it has 74 shellfish species, including Manila clam (*Ruditapes philippinarum*), Duck clam (*Mactra veneriformis*), Chinese mactra (*Mactra chinensis*), hard clam (*Meretrix meretrix*), Korean mud snail (*Bullacta exarata*), Chinese Dosinia (*Cyclina sinensis*) and Jack knife clam (*Sinonovacula constricta*). About 30 of these shellfish species are of notable economic value, for which reason the CWYRE is also one of the most important shellfish farming areas in the Yellow Sea Ecoregion, exporting products to Japan and Korea. Most of the shellfish are cultivated on the 242 km² tidal flat, which is one of the best-conserved tidal flats in the Yellow Sea Ecoregion (YSE).

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(4) Conservation target

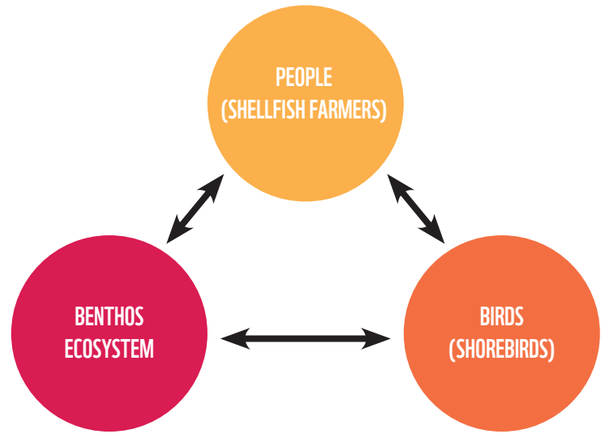
The conservation target is the ecosystem service of CWYRE, which is an integrated, well-managed hybrid system of the inland wetland and aquaculture ecosystem with a marine ecosystem featuring stable functions and a complicated structure. In general, the CWYREhas a typical estuary-coastal wetland (i.e. YRE temperate wetland) ecosystem, which consists of a number of sub-ecosystems, including an inland ecosystem, a reed-marsh ecosystem, a tidal flat ecosystem, a shallow sea ecosystem and an island ecosystem. In the context of world environment, the CWYRE has a significant impact on the research of the structure, functions and productivities of humid wetland ecosystems.

Tidal flats are an important component of the wetland ecosystem, a reality that motivates the desire to protect the balance of the ecosystem. Mass destruction of the wetland in CWYRE will deprive the local ecosystem of its basis for survival, as well as its ecological capacities for flood control, weather adjustment and water purification. There would also be either a significant decrease or even a total loss of land, freshwater, marine and tidal flat species. In fact, the existence of this important habitat and stopover for migratory birds in northeast Asia allows for the survival and prosperity of local animal, plant and aquatic species, as well as the circulation of physical matters and energy within this ecosystem. In addition, the existence of the wetland in the CWYRE has proven to be significant not only to northern China, but also to the neighboring countries, e.g., North Korea. Therefore, it is safe to say that CWYRE is one of the key enablers of the ecological balance in east Liaoning.

Due to the combination of its natural conditions, including terrain, weather, soil and tide, the CWYRE is known for its abundant biological resources and numerous species; put simply, it is a large, natural gene bank capable of providing valuable flora and fauna today and in the future. At the same time, as one of the few well-protected, integral natural gene banks left in the world, the CWYRE exists to not only serve the purpose of preserving a vital ecosystem, but also meet the demands for sustainable development of the human society.

The ecosystem at the YSESP Yalu Project site consists of three major elements (where people are considered to be a component of the ecosystem): benthos, birds (primarily wading birds) and people (primarily those engaged in shellfish farming). These three elements are interconnected from an ecological point of view:

[Figure 2-3] Key elements of CWYRE ecosystem



① Tidal flat species

There are more than 100 benthos species across CWYRE, or the YSESP Yalu Project site, including almost all shellfish species that carry any economic value. As a key link along the coastal wetland food chain, benthos converts energy into organic debris, microbes and algae into food sources for higher life beings, including birds and human. As a result, it plays a critical role in the physical matter and energy circulation of the ecosystem.

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② Birds

Sitting at higher position on the coastal wetland food chain, birds, primarily shorebirds, are among the prime targets of protection at CWYRE. In spring and autumn each year, hundreds of thousands of shorebirds come to CWYRE to seek food to supplement the energy loss during their migration routes. A healthy,

integral benthos system is the basis for the survival of the shorebirds, which, on the other hand, play a unique role in maintaining a stable population of the benthos species through their feeding activities. For CWYRE (from the standpoint of mankind), the existence of birds has important significance in three aspects: 1) birds can be an intuitive indicator of health and integrity of the ecosystem, as well as one for the harmony between mankind and the nature; 2) with notable aesthetic value, birds enable a range of tourist activities; and 3) as a world citizen, migratory birds have improved the popularity of both CWYRE and the YSESP Project in China and globally.

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③ Human activities

At the top of the coastal wetland food chain are people engaged in shellfish farming at CWYRE. According to initial estimates, each year, approximately 300,000 tons of shellfish are collected from CWYRE. Through artificial farming, human activities has significantly improved the production of shellfish, which have both positive and negative impacts on the benthos species. In the meantime, the shellfish collection activities have considerable impact – again, both positive and negative – on benthos and bird species.

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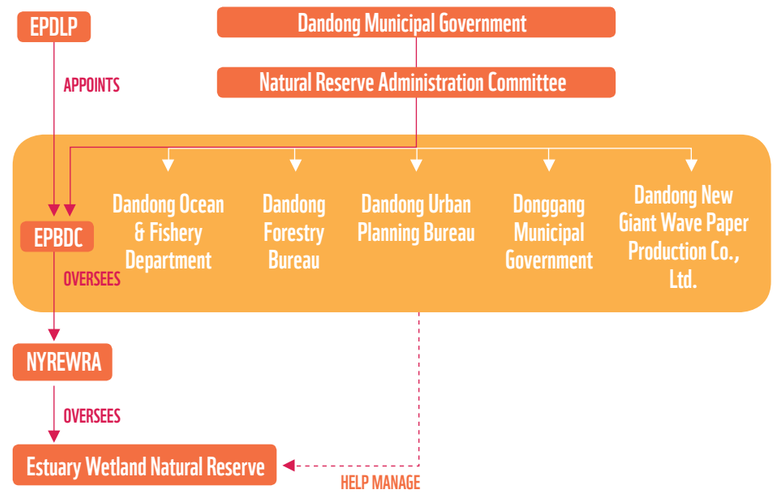
(5) Stakeholders

Land types at CWYRE include reed field, paddy field, dry land, tidal flat and shallow sea area. The reed field is operated by Dandong New Giant Wave Paper Production Co., Ltd. as a raw material supply base. The paddy field and farmland are owned by the local government and leased to farmers for a cultivation term of 30 years. The tidal flat is owned by the local government and leased for aquaculture farming purposes. The shallow sea area is owned by the state.

The YSESP Yalu Project is mainly located at the Dandong Yalu River Estuary Wetland (almost all the CWYRE is within the Nature Reserve), which is managed through the following administration model: appointed by Environmental Protection Department of Liaoning Province (EPDLP), the EPBDC is responsible for the management of the Nature Reserve through one of its subordinate offices, the Dandong Yalu River Estuary Wetland Reserve Administration. In 2001, an administration committee was established for the Nature Reserve under the leadership of the Dandong municipal government, with members from the Environmental Protection Bureau, Ocean & Fishery Department, Forestry Bureau and Urban Planning Bureau of the city, the Donggang municipal government and Dandong New Giant Wave Paper Production Co., Ltd. (China Rili Group) to be responsible for the coordination of administrative activities. The member organizations are tasked with developing regulations and carrying out protection and management activities for the Nature Reserve in accordance with applicable laws, regulations, guidelines and policies. In addition, their responsibilities also include creating surveys and documentation concerning the natural resources available, organizing environmental monitoring activities and facilitating research, public awareness, education and moderating eco-tourism activities in the Nature Reserve.

[Figure 2-4] Organization structure of National Yalu River Estuary Wetland Reserve Administration (NYREWRA)



The project site is mainly located in the tidal flat, which is under the direct administration of the NYREWRA and the OFBDC, with the latter mainly responsible for activities involving the aquaculture farming businesses and the former for wading bird-related surveys.

2.1.3. ACTION PLAN

(1) Goals (long-term results)

To conserve environmental quality at YRE, maintain and restore the local marine ecosystem, oversee the conservation of natural resources, especially the habitat of migratory birds, to ensure the stability and diversity of the habitat;

To establish a mechanism for and enhance the overall ability of biodiversity conservation and management in line with the status of the region; and

To establish and improve the biodiversity conservation and monitoring system to ensure effective management of key habitat at YRE, achieve sustainable management of the resources that support biodiversity and contribute to the sustained economic development of the region.

(2) Objectives (project cycle results) and activities

Objectives

To study the ecological functions of the coastal wetland, explore its ecological linkage with socioeconomic activities, propose an EBM plan for reference by similar regional conservation projects through the analysis of the features of the CWYRE; and to cultivate the EBM mindset of relevant government agencies to improve the management of the greater ocean ecosystem protection.

Activities

① Conduct a CWYRE field survey

- Biological resource survey and assessment in the YRE intertidal zone;
  Investigate and assess the structure of the biological community, the dominant species and their niche breadths and species diversity in the intertidal zone.
- Shorebird resource survey and assessment;
  Investigate the community composition, behavior and dynamics of shorebirds in YRE during the migration process, their feeding strategies and behavior, their spatial distribution in the intertidal zones, energy estimates and substitution rates of prey species, and feeding pressure of shorebirds.
- Socioeconomic survey and capacity assessment on shellfish farming;
  Gain insight on tidal flat resources and shellfish farming; and to assess the capacity of *Ruditapes philippinarum* farming.

② Develop CWYRE Management Plan

Develop an adaptive management plan for CWYRE based on the above surveys; analyze existing ecological challenges, propose specific ecological protection objectives; develop a monitoring plan that can be used as reference for similar coastal wetlands; develop a biodiversity protection plan and sustainable shellfish farming standards in line with the identities of such farming activities and shore birds' migration habits.

③ Conduct exchange forum and training

Organize and participate in a series of exchange forums and training programmes, including targeted training on benthos species surveys and coastal wetland protection management training; organize field visit to Kumamoto, the famous shellfish farming base in Japan to learn leading shellfish farming and management techniques and share the results of the YSESP Yalu Project; share the latest progress and results of the Project with the UNDP/GEF YSLME Project and the MPA Network on a regular basis; organize and participate in exchange forums among Chinese, Japanese and Korean stakeholders engaging coastal wetland conservation and marine reserves management.

④ Submit policy proposals for the conservation of Yellow Sea Ecoregion

Submit a "Proposal for the Conservation of the Yellow Sea Ecoregion" to the marine administration authorities for the effective conservation of the CWYRE and the entire YSE.

⑤ Implement publicity and education programmes

Implement a series of publicity and education programmes to enhance public awareness of the ecological services of the wetland, of the necessity for wetland conservation and of the pressing challenge of resource shortage. Specific publicity and education activities include the production of documentaries about the biodiversity of YSE, traditional shellfish collection activities and shellfish farming and supply chains; and organizing lectures and exhibitions on the ecological functions of coastal wetlands from time to time.

(3) Indicators

Prior to the YSESP Yalu Project launch, indicators for the different areas were developed by WWF and LOFSRI to measure results from the three-year effort. The indicators, which fall into six categories in total, are listed below.

① Completion of a technical report based on the results of the three-year YSESP Yalu Project research programme

- The results of the research include those of surveys and assessments on benthic resources, bird resources available in the YRE intertidal zones, the socioeconomic impact of shellfish farming and the ecological connections between these elements.
- Develop an ecosystem-based CWYRE management plan.
- Invite 7-10 experts to a workshop on the evaluation of the report. Share the report with relevant institutions, universities, assessors and government agencies, and share the report online.

② Provide policy proposals to decision makers based on the results of the research.

③ Publish one to two academic essays on the project.

④ Organize two to three exchange forums, training programmes and project experience sharing seminars in China or elsewhere in the world.

⑤ Organize one to two publicity and education activities.

(4) Budget

The portion of the budget funded by Panasonic Corporation through WWF and used for the YSESP Yalu Project represents the third, fourth and fifth action period budgets, or ¥ 31,830,000. The project was also funded jointly by OFDLP with the same amount as the matching fund.

[Table 2-1] Budget for the YSESP Yalu Project

Action Period		Research Budget (¥)
YSESP 3rd Action Period	1 Jan. 2010—28 Feb. 2011	10,610,000
YSESP 4th Action Period	1 Jan. 2011—28 Feb. 2012	10,610,000
YSESP 5th Action Period	1 Jan. 2012—28 Feb. 2013	10,610,000
Total		**31,830,000**

2.2. RESULTS AND DISCUSSION

2.2.1. MAJOR ACHIEVEMENT

The YSESP Yalu Project involved surveys and assessments on the benthos, migratory shorebird and cultivated shellfish species in CWYRE. During the three years of field survey and research work, the project developed a clear picture regarding the structure and features of the biological community in the CWYRE intertidal zone (a stopover for migratory shorebirds) and food sources of shorebirds, gained insight about the composition of the migratory shorebird communities in the CWYRE, conducted surveys on local tidal flat aquaculture activities and existing challenges and analyzed the ecological linkage among CWYRE ecosystem, migratory shorebirds and shellfish farmers.

2.2.2. ACTIVITY 1 (INTERTIDAL ZONE BENTHOS RESOURCE SURVEY AND EVALUATION)[1]

The intertidal zones are the most biologically diversified areas, as well as the primary feeding site and stopover for migratory shorebirds in CWYRE. During the 2010-2011 time frame, the project team conducted a number of surveys and assessments on the biological community structure, dominant species and their niche breadths, and species diversity in the in CWYRE intertidal zones.

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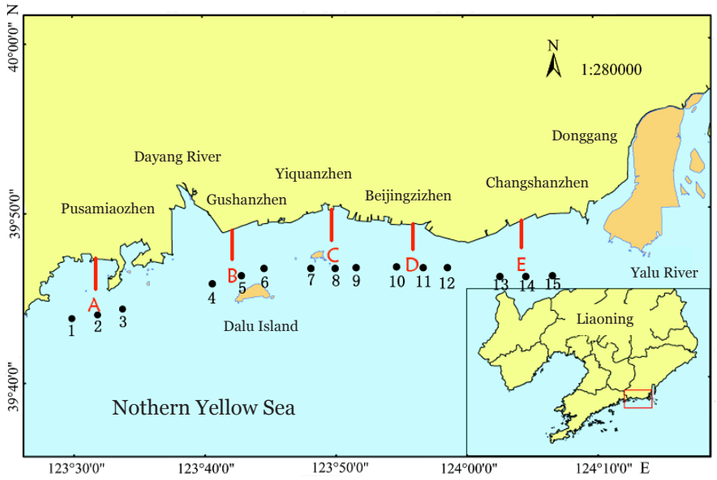
1.Song, L., Yang, G.J., Li, A. and N.B. Wang. 2011. A study on bio-ecology of the stopover site of waders within China's Yalu River Estuary wetlands (in Chinese). *Acta Ecologica Sinica* 31(24), pp 7500-7510.
Song, L., Wang, N.B., Yang, G.J. and S. Yonggang. 2013. The stress response of biological communities in China's Yalu River Estuary and neighboring waters (in Chinese). *Acta Ecologica Sinica* 33(9) pp 2790-2802.

(1) Scope

In line with the scope of CWYRE, five survey sections were established in waters off Changshan Town, Donggang (E); Beijingzi Town (D); Yiquan Town (C); Gushan Town (B); and Pusamiao Town (A). One to two sites were selected at each intertidal and subtidal zone for a benthos survey (Figure 2-5).

[Figure 2-5] Survey sections (A–E) and sites (1–15)



(2) Methodology

The surveys and analysis were conducted in accordance with methods specified in *The Specification for Oceanographic Survey* (GB/T 12763-2007) and *The Specification for Marine Monitoring* (GB 17378-2007).

© LOFSRI

(3) Findings

Our survey resulted in the following findings about the biological community in the YRE intertidal zones:

① The biological community consists mainly of Mollusca, including cultivated shellfish

Our survey found that there are 29 species of 27 genera, 24 families, 16 orders, eight classes and eight phyla in the intertidal zones. These include five cultivated species, 18 not-for-commercial-fishing natural species and six for-commercial-fishing natural species. The biological community consists mainly of Mollusca (52.0 per cent) or benthos (IN) (75.9 per cent) in terms of living environment. Based on our study of relevant literature and our site survey and analysis, it is estimated that there are 24 benthos species that can serve as the food of shorebirds in the YRE intertidal zones.

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[Table 2-2] Macrobenthos found in the surveys[2]

Phylum	Class	Order	Family	Genus	Species	Serves as Food of Shorebirds[3]
Cnidarian	Anthozoa	Actiniaria	Anthoplidae	*Anthopleura*	*Anthopleura xanthogrammica*	N
Nemertina	Anopla	Palaeonemertea	Tubulanidae	*Tubulanus*	*Tubulanus punctatus*	Y
		Phyllodocida	Glyceridae	*Glycera*	*Glycera chirori*	Y
			Phyllodocidae	*Eumida*	*Eumida sanguinea*	Y

2.1Scientific names quoted from Checklist of Marine Biota of China Seas
3.Y: Yes; N: No

Phylum	Class	Order	Family	Genus	Species	Serves as Food of Shorebirds[3]
		Nereidida	Nereididae	*Platynereis*	*Platynereis bicanaliculata*	Y
Annelida	Polychaeta	Eunicida	Lumbrineridae	*Lumbrineris*	*Lumbrineris intlata*	Y
		Scolecida	Capitellidae	*Heteromoastus*	*Heteromoastus filiforms*	Y
		Unclassified	Sternaspidae	*Sternaspis*	*Sternaspis sculata*	Y
Echiura	Unclassified	Echiuroinea	Echiuridae	*Listriolobus*	*Listriolobus brevirostris*	N
Mollusca	Gastropoda	Archaeogastropoda	Trochidae	*Umbonium*	*Umbonium thomasi*	N
		Mesogastropoda	Naticidae	*Lunatica*	*Lunatica gilva*	Y (Shell height<15 mm)
				Neverita	*Neverita didyma*	Y (Shell height<15 mm)
		Neogastropoda	Nassariidae	*Nassarius*	*Nassarius succinctus*	Y
					Nassarius variciferus	Y
		Cephalaspidea	Atyidae	*Bullacta*	*Bullacta exarata*	N
	Bivalvia	Veneroida	Tellinidae	*Moerella*	*Moerella iridescens*	Y
					Moerella jedoensis	Y
			*S*olecurtidae	*Sinonovacula*	*Sinonovacula constrica*	Y (Shell height<15 mm)
			Veneridae	*Ruditapes*		Y
				Meretrix	*Meretrix meretrix*	Y
				Cyclina	*Cyclina sinensis*	Y
			Mactridae	*Mactra*	*Mactra veneriformis*	Y (Shell height<15 mm)
	Malacostraca	Amphipoda	Urothoidae	*Urothoe*	*Urothoe huanghaiensis*	Y
		Decapoda	Callianassidae	*Nihonotrupaea*	*Nihonotrupaea harmandi*	Y
Arthropoda			Leucosiidae	*Philyra*	*Philyra pisum*	Y (Shell height<15 mm)
			Macrophthalmidae	*Macrophthalmus*	*Macrophthalmus dilatatus*	Y (Shell height<15 mm)
			Varunidae	*Hemigrapsus*	*Hemigrapsus penicillatus*	Y (Shell height<15 mm)
Brachiopoda	Lingulata	Lingulida	Lingulidae	Lingula	*Lingula anatina*	N
Echinodermata	Holothurioidea	Apodida	Synaptidae	*Protankyra*	*Protankyra bidentata*	N

② The biomass is concentrated in the lower part of the low tide zone, and tends to decrease in summer

Table 2-3 shows that the biomass in the intertidal zones tends to be high in spring and autumn and low in summer. The biomass is concentrated in the lower part of the low tide zone and in section D. In terms of seasonal changes, both total density and total biomass follow a “down-up” trend in the spring→summer→autumn timeframe.

[Table 2-3] Time-spatial distribution of intertidal species density (ind./m^2) and biomass (g/m^2) in the survey sections

Survey section	Spring			Summer			Autumn		
	M	Lu	Ll	M	Lu	Ll	M	Lu	Ll
A	33.89/ 21.46	69.09/ 28.83	95.85/ 9.14	37.71/ 14.60	39.61/ 7.60	29.62/ 9.90	5.47/ 3.21	5.09/ 6.65	18.67/ 73.54
B	37.35/ 71.56	15.28/ 29.66	16.98/ 28.71	76.52/ 101.11	84.89/ 84.54	57.72/ 39.12	17.38/ 7.67	26.97/ 22.03	16.99/ 20.77
C	86.58/ 164.81	57.55/ 219.42	98.50/ 185.29	134.12/ 62.0	57.82/ 40.30	49.30/ 87.00	46.34/ 16.23	30.15/ 14.59	37.24/ 19.96
D	37.59/ 34.76	205.49/ 188.33	381.62/ 253.91	40.74/ 11.97	258.66/ 206.51	313.32/ 225.74	166.84/ 48.69	460.10/ 371.83	393.16/ 378.87
E	51.20/ 31.77	32.00/ 46.45	42.67/ 51.73	13.92/ 7.19	15.96/ 10.36	27.16/ 17.45	14.21/ 12.97	21.58/ 9.24	36.84/ 16.16
Mean	49.32/ 64.87	75.88/ 102.54	127.12/ 105.76	60.60/ 39.38	91.39/ 69.86	95.43/ 75.84	50.05/ 17.76	108.78/ 84.87	100.58/ 101.86

M: Middle tide zone; Lu: The upper part of low tide zone; Ll: The lower part of low tide zone

③ *Bullacta exarata, Moerella jedoensis* and *Cyclina sinens is* are dominant species.

Our research finds that, throughout the spring, summer and autumn time frame, *Bullacta exarata* (AD), *M. jedoensis* (IN) and *C. s inensis* (IN) are absolute dominant species. In terms of seasonal changes, dominant species include *B. exarata*, *M. jedoensis*, *C. sinensis, Glycera chirori* and *Platynereis bicanaliculata in spring; B. exarata, M. jedoensis* and *C. sinensis in summer;* and *M. jedoensis, B. exarata, C. sinensis, Meretrix meretrix, G. chirori* and *Macrophthalmus dilatatus in autumn. Among them, C. sinensis* and *M. meretrix* are cultivated species.

B. exarata and G. chirori are distributed across the survey sections and the tidal zones; *P. bicanaliculata* is distributed mainly in Section A; *Macrophthalmus dilatatus* is distributed mainly in Section C and D and the middle tide zone; C. sinensis is distributed mainly in Section B and D and the middle tide zone; and *M. jedoensis* and *M. meretrix* are distributed mainly in Section D and the lower part of the low tide zone.

[Table 2-4] Seasonal changes of dominant species and their niche breadths

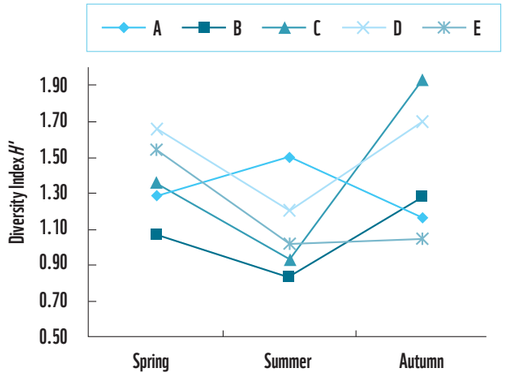
Dominant Species	Index of importance[4]			Dominance			Niche Breadth
	Sp	Su	Au	Sp	Su	Au	
Bullacta exarata	6337.6	10175.3	2444.24125	0.30	0.50	0.13	1.50
Glycera chirori	1419.2	740.6	1226.5	0.11	0.04	0.08	1.16
Platynereis bicanaliculata	1133.3	803.4	616.1	0.11	0.08	0.06	0.70
Macrophthalmus dilatatus	410.3	405.4	1179.6	0.02	0.02	0.02	0.64
Cyclina sinensis	1837.8	1195.2	1461.2	0.05	0.03	0.06	0.62
Moerella jedoensis	3471.7	5069.9	8842.4	0.27	0.29	0.44	0.48
Meretrix meretrix	664.5	904.2	1374.3	0.03	0.02	0.05	0.17

Sp: Spring; Su: Summer; Au: Autumn

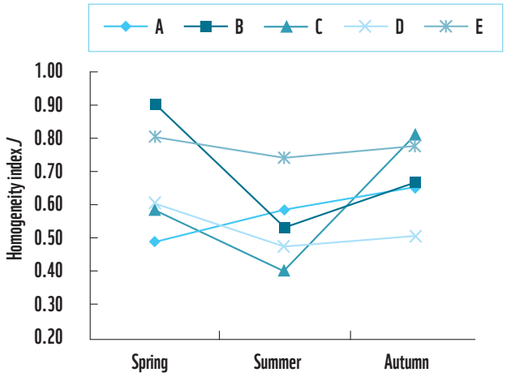
④ In general, the species diversity follows a “down-up” trend in the season cycle.

Analysis based on diversity, homogeneity and simplicity indices (Figure 2-6, 2-7 and Table 2-5) indicates that Section D has the highest diversity index, or the largest number of species, and less mean distribution, and Section B has the lowest diversity index but a relatively mean distribution. With the exception of Section A, the diversity index of all the other four sections follow a “down-up” trend in the spring→summer→autumn timeframe, indicating significant external interruption to some of the species in the intertidal zones in summer.

[Figure 2-6] Seasonal changes of diversity indices of the survey sections



[Figure 2-7] Seasonal changes of homogeneity indices of the survey sections



4.Index of importance indicates dominant species. Dominance indicates the position and role of a species in the biological community. Niche breadth indicates the total amount of resources available for a specific species.

[Table 2-5] Seasonal changes of ecological indices of different habitats of the survey sections

Survey section	Habitat	Diversity index (*H'*)[5]			Homogeneity index (*J*)			Simplicity index (*P*)		
		Sp	Su	Au	Sp	Su	Au	Sp	Su	Au
A	M	1.12	1.28	1.25	0.48	0.55	0.62	0.50	0.46	0.49
	Lu	1.45	1.69	1.58	0.48	0.53	1.00	0.48	0.39	0.33
	Ll	1.28	1.55	0.66	0.50	0.67	0.33	0.50	0.38	1.00
B	M	1.32	1.11	1.02	0.83	0.48	0.64	0.44	0.56	0.55
	Lu	0.92	0.71	2.10	0.92	0.44	0.91	0.56	0.75	0.26
	Ll	0.97	0.67	0.73	0.97	0.67	0.46	0.52	0.71	0.68
C	M	1.65	0.60	1.06	0.82	0.30	0.67	0.36	0.81	0.55
	Lu	0.20	0.40	2.38	0.13	0.20	0.92	0.95	0.88	0.21
	Ll	2.24	1.80	2.34	0.80	0.70	0.83	0.24	0.37	0.21
D	M	1.99	1.59	1.78	0.86	0.80	0.56	0.30	0.38	0.38
	Lu	1.55	1.16	1.78	0.45	0.34	0.52	0.43	0.50	0.44
	Ll	1.43	0.86	1.52	0.51	0.29	0.44	0.47	0.72	0.52
E	M	0.81	1.11	1.05	0.51	0.70	0.66	0.71	0.57	0.59
	Lu	1.92	1.13	1.10	0.96	0.71	0.69	0.28	0.51	0.51
	Ll	1.91	0.81	0.99	0.95	0.81	0.99	0.28	0.63	0.51

M: Middle tide zone; Lu: The upper part of low tide zone; Ll: The lower part of low tide zone; Sp: Spring; Su: Summer; Au; Autumn

5. Diversity index reflects the number of species in a specific habitat of a specific region. Therefore, it is also known as in-habitat diversity index. Homogeneity index reflects the distribution of the populations of all species within a particular community or habitat. It indicates how the mean organism populations are distributed. Simplicity index reflects the simplicity of species composition in the community. It has to do with the number of species and the population of each species.

2.2.3. ACTIVITY 2 (SHOREBIRD RESOURCES AND FEED STATUS SURVEY)[6]

CWYRE is an important relay station and feeding site of shorebirds in their spring migration route, as well as the northernmost stopover on the EAAF. This project involves a focused study on the species structure, populations, migration and feeding habits, energy estimates and substitution rates of prey species and feeding pressure of shorebirds.

(1) Geographic scope of the survey

The shorebird survey was conducted simultaneously with the spring survey on the benthos species. The sites of the survey overlapped with the sections of the benthos survey (see Figure 2-8).

[Figure 2-8] Sites of wading survey

Image © 2014 Digital Globe Image © 2014 CNES/Astrium
Image © 2014 TerraMetrics US Dept of State Geographer

(2) Methodology

The shorebird survey was conducted with the direct counting method. The team members would arrive at the survey site two hours before the low tide. They would first use binoculars for an overall observation. Then they will use monoculars for more accurate counting. During the process, they would categorize the statistics to avoid repeated counting of birds flying back and forth to ensure more accurate data. The evaluation involves analysis of the bird survey data in line with statistics from the benthos surveys.

(3) Findings

Our survey found the following shorebird species and their feeding habits:

The composition of migratory shorebird community

① In total, there are more than 176,000 shorebirds counted, among which, *Limosa lapponica, Calidris tenuirostris* and *Calidrisalpina* are the dominant species.

During the 10 days from 15 April to 24 April, 2010, a total number of 176,535 shorebirds of 21 species were counted, either stopping by or feeding at the 15 observation sites. The three dominant species, *L. lapponica, C. tenuirostris* and *Calidrisalpina*, jointly accounted for 92.6 per cent of the total population.

6.Song, L., Yang, G.J., Li, A. and N.B. Wang., op. cit.
Song, L., Wang, N.B., Yang, G.J. and S. Yonggang., op. cit.

[Table 2-6] CWYRE bird counts in 2010 (by Species)

Species	Count	Species	Count	Species	Count
Limosa lapponica	84,680	*Calidris tenuirostris*	53,467	*Calidrisalpina*	25,301
Limosa limosa	2	*Tringa nebularia*	50	*Charadrius mongolus*	1
Numenius	1,258	*Tringa guttifer*	15	*Charadrius alexandrinus*	1,251
Numenius phaeopus	135	*Xenus cinereus*	18	*Pluvialis squatarola*	3,001
Numenius arquata	3,039	*Actitis hypoleucos*	3	*Crocethia alba*	2
Numenius madagascariensis	3,282	*Haematopus ostralegus*	177	*Himantopus himantopus*	4
Scolopacidae	3	*Arenaria interpres*	5	*Unidentified small wading bird*	1
Tringa totanus	17	*Calidris canutus*	5	*Unidentified medium-size wading birds*	818

During the 14 days from 11 April to 24 April, 2011, a total number of 121,739 shorebirds of 19 species were counted, either stopping by or feeding at the 14 observation sites (site 1 was cofferdammed. The three dominant species, *L. lapponica, C. tenuirostris* and Calidrisalpina jointly accounted for 86.1 per cent of the total population.

[Table 2-7] CWYRE bird counts in 2011 (by Species)

Species	Count	Species	Count	Species	Count
Limosa lapponica	45,515	*Tringa guttifer*	5	*Charadrius dubius*	4
Numenius phaeopus	471	*Xenus cinereus*	3	*Charadrius dubius*	1,304
Numenius arquata	6,243	*Calidris tenuirostris*	13,791	*Charadrius alexandrinus*	1,199
Numenius madagascariensis	6,612	*Calidris ruficollis*	1	*Charadrius mongolus*	2
Scolopacidae	3	*Calidris temminckii*	3	*Charadrius leschenaultii*	59
Tringa totanus	19	*Calidrisalpina*	45,456	*Unidentified medium-size wading birds*	1,000
Tringa nebularia	10	*Haematopus ostralegus*	39		

In view of the limited days and the dispersed sites of observation, the bird counts might be lower than the capacity of the CWYRE.

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② The total number of bird species that meet the criteria of those for wetlands of international importance exceeded 90 per cent of total bird count.

In 2010, the counts of *L. lapponica, Numenius arquata, Numenius madagascariensis, C. tenuirostris, Calidrisalpina, Pluvialis squatarola* and *Charadrius alexandrinus* exceeded the criteria for bird species of wetlands of international importance. Altogether, 174,021 birds of these species were counted, accounting for 98.6 per cent of the total count. During the survey, 180 birds with colour bands were counted. They were from Australia, New Zealand and the east tidal flat of Chongming Islet, Shanghai. Two shorebirds wore bands of CWYRE Nature Reserve.

In 2011, the counts of *L. lapponica, Calidrisalpina, N. madagascariensis, N. arquata, C. tenuirostris, P. squatarola, C. alexandrinus and Tringa guttifer* exceeded the criteria for bird species of wetlands of international importance. All together, these species accounted for 93.5 per cent of the total bird count.

Dynamics of shorebirds in migration

CWYRE is the northernmost stopover on the EAAF. The peak migration periods of the three dominant species are 28 March–28 April (*L. lapponica*), 7 April–15 May (*C. tenuirostris*) and 28 March–10 May (*Calidrisalpina*). Research indicates that shorebirds tend to stay at YRE for longer periods of time. In spring, it would typically be 91 days for *C. tenuirostris*, 93 days for *L. lapponica* and 112 days for *Calidrisalpina*. In autumn, it would last 100 days for *N. arquata*, 105 days for *N. madagascariensis*, 97 days for *Xenus cinereus* and 97 days for *Calidrisalpina*. Our survey also found that some species, including *C. canutus, C. tenuirostris, T. glareola, C. ferruginea, C. temminckii* and *Himantopus himantopus*, only appear in spring.

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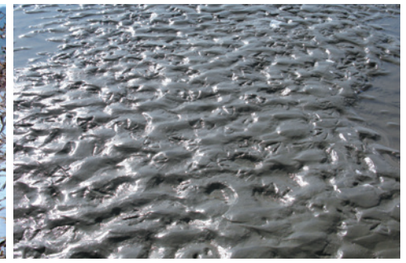

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Spatial distribution of the shorebirds in the intertidal zones

Shorebird distribution varied substantially in terms of the total number of specimens, with significantly higher numbers counted at Site 2 and Site 12. The reasons for this include the following: 1) these two sites are located at YRE or Dayang River Estuary, where the freshwater joins the saltwater, resulting in a larger amount of species that could serve as the feed for birds; and 2) on the nearby shrimp farms, there are tidal flats that can serve as the stopover and feeding sites for the birds. Of course, there are always considerations about a number of factors that would impact the accuracy of bird counts, e.g., different observation time points and weather conditions. In general, the spatial distribution of the shorebirds could be affected by that of the prey.

Feeding behaviors of shorebirds

Research indicates that shorebirds are omnivorous. In order to get fast energy supplements, they would feed on any food available at the stopover, largely depending on the density of the prey species. The ingredients and distribution of food have direct impact on shorebirds' selection of stopovers. At any given stopover, shorebirds would feed on locally available food.

Given that *L. lapponica, C. tenuirostris* and *Calidrisalpina* have the largest populations at YRE, our feeding habit analysis would focus on these three species, all of which depend on touch continuity as their primary feeding strategy and visual continuity as their secondary feeding strategy. They feed mainly on furry prey and Mollusca. They tend to take furry prey in whole, and only take smaller Bivalvia and Gastropoda prey. Research indicates that a number of benthos species at YRE, including *Moerella jedoensis, Cyclina sinensis* (larva) and *Glycera chirori*, are among the main food sources of shorebirds.

Energy estimates and substitution rates of prey species

Considering the feeding strategies of the shorebirds and prey availability, the scope of statistics include all furry prey, Bivalvia prey with shell height <15 mm and Gastropoda prey with shell width <15 mm (not including *Bullacta exarata*, which excretes a toxic viscous fluid to protect itself from the shorebirds).

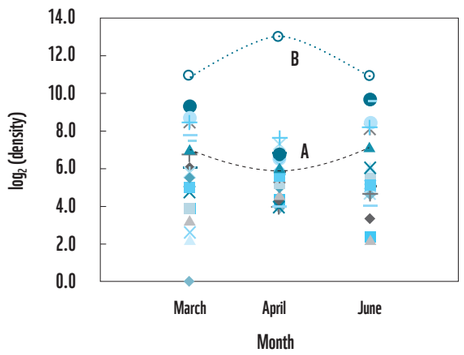
The lower part of the low tide zone has the highest secondary prey productivity (2.89±2.42) g AFDW (ash-free dry weight).$m^{-2}.y^{-1}$ and the corresponding energy value (78.67±67.68) KJ/m^2, while those of the middle tide zone are relatively low. The lower part of the low tide zone of Section D turns out to be the primary source of prey species [(12.56±2.34)g AFDW.$m^{-2}.y^{-1}$, (347.91±118.01)kJ/m^2]. Site observations prove that shorebirds are more likely to feed along the shorelines of the lower part of the low tide zone.

The average P/B[1](1.07±0.07) of the target area indicates that, in average, the annual substitution rate of prey species in YRE intertidal zones is as low as 1.07, along with 1.15 in the middle tide zone, and 1.14 in the lower part and 0.92 in the upper part of the low tide zone. In terms of specific survey sections, the substitution rates of Sections A(1.30) and B(1.18) are relatively higher, while those of Sections C(0.97), D(0.98) and E(0.94) are largely constant. The P/B values of dominant species are *Moerella jedoensis*: 1.06; Cyclina sinensis: 0.71; and Glycera chirori: 0.93.

Shorebirds feeding pressure analysis

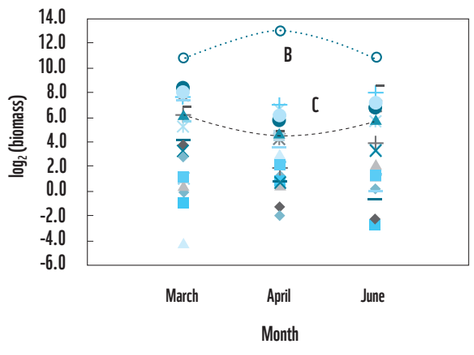
In order to gain insight in the feeding pressure of the shorebirds, we conducted continued surveys at Section D, which has the highest prey biomass, from 21–22 March (initial days of the migration), 15–16 April (peak days) and 31 May–1 June (departure) of 2011. Throughout the March-April time frame, no significant change was observed in prey abundance in the middle tide zone and the upper part of the low tide zone, while a notable decrease was observed in the lower part of the low tide zone, particularly for *M. jedoensis* (down 80.9 per cent); no significant change was observed in prey biomass in any of the tide zones.

[Figure 2-9] Trend of impact of shorebirds on the density of prey species



A: Log trend line of average density of prey species
B: Log trend line of shorebirds count determined in simultaneous survey

[Figure 2-10] Trend of impact of shorebirds on the biomass of prey species



A: Log trend line of average biomass of prey species
B: Log trend line of shorebirds count determined in simultaneous survey

The scatter plots with logarithmic (log_2) scale (Figure 2-9 and Figure 2-10) indicate that the feeding pressure created by shorebirds on the prey species of the stopover reaches the highest during the peak days of their migration (mid-April). However, both prey abundance and biomass would return to their normal levels after the departure of the birds, indicating a high resilience of prey species at the target area.

According to our survey, the biomass of prey of shorebirds at CWYRE is estimated to be 31.07 g/m^2. Given the total area of the stopover is 235.32 km^2, total prey output is estimated to be 7,311,358 kg. Given the total counts, stay time and weights gained of key shorebirds (*L. lapponica, C. tenuirostris* and *Calidrisalpina*, which weighed 240 g, 130 g and 50 g upon arrival and 480 g, 240 g and 80 g, respectively, upon departure, nearly double amounts), it is estimated that in 2010, they took 569,680 kg food in total, accounting to 7.8 per cent of the total biological resources available on the tidal flat, or 18.1 per cent of the prey biomass. In 2011, they took 355,889 kg food in total, accounting to 4.9 per cent of the total biological resource available on the tidal flat, or 11.3 per cent of the prey biomass.

2.2.4. ACTIVITY 3 (SHELLFISH FARMING STATUS AND CAPACITY ASSESSMENT)

(1) Target area and methodology of the survey

The shellfish farming survey was conducted through document review and site survey. The target area is CWYRE.

(2) Findings

Shellfish Farming Status

According to the documents, the total shellfish farming area on the tidal flat at YRE, Dandong, is currently 143.95 km^2, accounting for about 60 per cent of the total area of tidal flats in the intertidal zones. Major shellfish species cultivated include Manila Clam (*Ruditapes philippinarum*), *Hard clam* (*Meretrix meretrix*), *Duck clam* (*Mactra veneriformis*), *Mud snail* (*Nassarius variciferus*) and Razor clam (*Sinonovacula constrica*). In 2010, the total shellfish output was 101,800 tons, and gross revenue was 572 million RMB. Specifically, for *R. philippinarum* alone, the output totaled 43,800 tons (42.9 per cent of the total), and farming area totaled 4,667 hectares, distributed in the middle and low tide zones. In 2010, input shellfish larvae totaled 33,540 tons, including 28,900 tons of *R. philippinarum*, accounting for 86.2 per cent of the total (see Table 2-8).

[Table 2-8] Shellfish output and larvae input in Dandong CWYRE in 2010

Type	R. philippinarum	*Meretrix meretrix*	*Mactra veneriformis*	*Sinonovacula constrica*	Potamocorbula amurensis
Shellfish output (t)	43,750	6,800	5,600	4,200	4,300
Larvae input (t)	28,900	3,500	320	820	

Source: Ocean & Fishery Department of Dandong City

Findings of Farming Capacity Assessment

Based on parameters obtained through the Trophic Dynamic Model, assuming a total shellfish farming area of 143.3 km² (215,000 mu) and 1.05 trophic levels, it is possible to estimate the farming capacities of various types of *R. philippinarum* at CWYRE in different seasons by deducting those of other benthos species (*M. jedoensis*: 852.83 ton; and *M. iridescens*: 278.21 ton) (Table 2-9).

Given that the waters at YRE are frozen in winter (December-March), the yearly total of the *R. philippinarum* farming capacity is the sum of those of spring, summer and autumn. The annual capacities of three types of *R. philippinarum* with shell lengths of 1.5 cm, 2.0 cm and 2.5 cm are 189,356.60 ton, 221,970.71 ton and 249,717.05 ton, respectively, resulting in an average capacity of 220,348.12 ton. In terms of seasons, capacities are at their highest in spring, up to 96,599.12 ton (1.5 cm), 11,237.01 ton (2.0 cm) and 127,391.64 ton (2.5 cm), averaging 112,409.26 ton; lowest in summer, down to 20,743.16 ton, 24,315.88 ton and 27,355.37 ton for the above three types, averaging 24,138.14 ton. Statistics show that an annual output of 100,000 ton does not exceed the capacity limit of the area.

[Table 2-9] Ruditapes philippinarum farming capacities at YRE in spring, summer and autumn (by types)

Type	Annual	Spring	Summer	Autumn
	Capacity (t)	Capacity (t)	Capacity (t)	Capacity (t)
Shell length 1.5 cm	189,356.60	96,599.12	20,743.16	72,014.32
Shell length 2.0 cm	221,970.71	113,237.01	24,315.88	84,417.82
Shell length 2.5 cm	249,717.05	127,391.64	27,355.37	94,970.04
Average	220,348.12	112,409.26	24,138.14	83,800.73

According to the research of Qiao Xi, the survival rate of cultivated *R. philippinarum* averages 53.1 per cent in tidal flat areas and 67.2 per cent in deep water areas (8-13 m). That allows the estimation of the adequate densities of different types of *R. philippinarum* (Table 2-10). The adequate densities are the highest in spring (tidal flat: 1.48 kg/m³; deep water: 1.17 kg/m³), and the lowest in summer (tidal flat: 0.32 kg/m³; deep water: 0.25 kg/m³). The fact that the actual farming densities are far above the adequate ranges in each season is the main reason for the high fatality rate and frequent epidemics of *R. philippinarum* observed in the area.

[Table 2-10] Estimated adequate ruditapes philippinarum farming densities at YRE in spring, summer and autumn (by types)

Type	Spring		Summer		Autumn	
	Tidal flat (kg/m³)	Deep Water (kg/m³)	Tidal flat (kg/m³)	Deep Water (kg/m³)	Tidal flat (kg/m³)	Deep Water (kg/m³)
Shell length 1.5 cm	1.27	1.00	0.27	0.22	0.95	0.75
Shell length 2.0 cm	1.49	1.18	0.32	0.25	1.11	0.88
Shell length 2.5 cm	1.67	1.32	0.36	0.28	1.25	0.99
Average	1.48	1.17	0.32	0.25	1.10	0.87

Located at the northernmost point of the Yellow Sea, YRE waters are typically frozen in winter (December-March). Therefore, this study only covers the primary productivity of plankton and benthos in spring, summer and autumn. The result shows that, thanks to the nutrients carried by the river and the nutrient recycling effect of the tides, the YRE waters are different from other sea waters. Their primary productivity is very high, with a pattern of "high-low-high" in the spring-summer-autumn time frame, amounting to 1,404.46 mgC/m².d, 227.58 mgC/m².d and 783.54 mgC/m².d respectively. There are distinct seasonal differences in shellfish farming capacities as is the case of the primary productivity.

In view of the unique ecological features of the YRE area, estimates were made on the *R. philippinarum* farming capacity by season. The result indicates that, in spring, the farming density should be controlled within the range of 1.00–1.67 kg/m³, and larger larvae should be used to the extent possible to leverage the abundant prey resources available to enable fast growth in spring and an early time to market in summer. Minimal or zero larvae input should be made in summer to prevent the shellfish from getting thin or the eruption of epidemics due to prey shortage or high temperature. Farming density should be controlled at 0.22–0.36 kg/m³ during this time frame. In autumn, the density could be increased to 0.75–1.25 kg/m³ to achieve the goals of both optimized farming and eco-environmental protection.

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2.2.5. DISCUSSIONS

(1) Analysis on the ecological linkage among the benthos ecosystem, shorebirds and shellfish farming

The results of our surveys on the benthos ecosystem, shorebirds and shellfish farming activities indicate that benthos species, birds and cultivated shellfish are interconnected, as discussed below:

[Figure 2-11] Ecological linkage between benthos ecosystem and shellfish farming

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① Ecological linkage between the benthos ecosystem and shellfish farming

Using SPSS 16.0 data analysis software, we analyzed the linkage between the average species density at the survey sections and the total output of cultivated shellfish of local towns, and found a significantly positive correlation ($r=0.964$, $P<0.01$) indicating that, to a large extent, the density of benthos species would affect the site selection for shellfish farming. Currently, the interruptions on the benthos species by shellfish farming activities remain the biggest challenge of the YRE ecosystem. As a result of the boom of shrimp farming during the early 1980s–late 1990s, most of the tidal flat areas in the high tide zones have been exploited. What's more, the abusive use of shellfish as the feed for shrimps has led to notable shift of the role dominant species from prey species of shorebirds to non-prey species. In addition, the massive invasion of external shellfish species, the mono-species structure of individual cultivation sites and inadequate distribution of the sites have severely affected the natural distribution, breeding and growth of local shellfish species, and even the healthy development of the entire benthos ecosystem and its energy flow.

② Ecological linkage between the benthos ecosystem and shorebirds

As an important food supply site and stopover, CWYRE plays an important role in the conservation of shorebird species. Our research shows that the shorebirds' prey species in the YRE intertidal zones have high resilience, with both abundance and biomass recovering to the normal levels shortly after the peak days of shorebird migration. In addition, considering the fact that the total number of migratory birds has been increasing over the years, there are sufficient prey species in the intertidal zones to meet the feeding requirement of the shorebirds. In other words, the impact of shorebirds on the benthos ecosystem has been marginal. However, due to continued development and more and more farmers choosing to cultivate sea cucumber, the total area of coastal wetland has been diminishing. Given the continued decrease of food supply sites and stopovers, we must consider whether shorebirds could find enough places to stop by and whether they could find enough food in the future.

③ Ecological linkage between shorebirds and shellfish farming

Major cultivated shellfish species in YRE intertidal zones include *Sinonovacula constrica, Meretrix meretrix, Cyclina sinensis* and *Mactra veneriformis* (*Ruditapes philippinarum* being the prime cultivated specie at the low tide zone). Currently, none of these shellfish farming sites is of mass scale. The threat of shorebirds is primarily realistic for their larvae (shell height <15 mm). With hard shells and low biomass, *M. meretrix, C. sinensis* and *M.* veneriformis are among the less desired prey. On the other hand, with thin shells and adequate sizes (shell height <5 mm), *S. constrica* larvae are the preferred prey of shorebirds. The *S. constrica* larvae input period (early April) typically coincides with the peak days of shorebird migration. Local farmers tend to scare away the birds with crackers until the larvae get deep enough into the slurry (the process would take about one tenth of the shorebirds' stay time). Currently, in the YRE intertidal zones, *S. constrica* farming is still in its pilot stage, with small-scale farming sites located mainly in Changshan Town, Beijingzi Town and Yiquan Town. So far, the conflict of interest between farmers and shorebirds has been marginal due to two reasons: 1) shorebirds' feeding sites are concentrated in the lower part of the low tide zone, where the prey species are very resilient; and 2) *S. constrica* farming activities are concentrated in the upper part of the low tide zone and the middle tide zone, with a relatively small farming area and short larvae input period. With the continued expansion of the sea cucumber farming business, most of the existing *S. constrica* farming fields have been rebuilt for sea cucumber cultivation. The decrease of cultivated *S. constrica* output would inevitably drive the expansion of *S. constrica* farming sites toward the intertidal zones, leading to sharper conflict of interest between the farmers and the shorebirds.

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(2) Socio-economic surveys and management experiences

Two local government bodies in the region, the Dandong Municipal People's Government and the Dandong Municipal Administration of NYREWRA, have attached great importance to the protection of the wetland nature reserve. Since its founding, RMB 10 million has been invested to develop the infrastructure in the nature reserve. In 2001, Gushan Management Station was established, with the Donggang Management Station following in 2006. A habitat was set up covering an area of 0.83 km^2 (approximately 1,200 mu) as a way to strengthen the protection of shorebirds. In order to maximize the quantity of wetland resources, follow the scientific protocol on development and respect the principles of protection and development working hand-in-hand, a bird-watching park was established in the Donggang City wetland in 2006, adding a popular spot to the city's tourism industry.

Since its establishment in 2006, the annual Donggang Bird-Watching Festival has received a highly positive response among attendees from all walks of life. The spectacular festival falls in late April every year, attracting many bird experts, bird lovers and tourists. Both the birds and the festival act as a "matchmaker" for the city, allowing it to draw new visitors. The festival incorporates the special tourism resources while catering to local history and culture, playing a positive role in promoting the area's rich natural resources. It also helps arouse the awareness of environmental conservation and coordinate the development between environmental protection and economic development. The CWYRE has inspired both foreign and domestic tourists and experts to come and visit, bringing abundant income to the tourism industry of Dandong City. According to a 2012 Dandong Statistical Bulletin on National Economy and Social Development, it was estimated that the city received 30.128 million tourists from both home and abroad, including 29.636 million domestic tourists and 492,000 foreign tourists. The tourism-generated revenue for the whole year was RMB 33.55 billion, including RMB 31.89 from domestic tourists and USD 266 million from foreign tourists.

Over the years, the Liaoning Provincial Administration for Ocean and Fisheries and the Dandong Municipal Administration for Ocean and Fisheries have worked hard to further improve ocean and fishery ecosystems by implementing conservation measures, such as advancing fishery resource protection and recovery and enhancing marine environment monitoring and management. The first of the specific measures was a call to strictly abide by the requirements for fishing moratorium. According to the document, fishers are required to "anchor their ships, go to bank, seal up fishing nets and hand in licenses." Further enforcement is established by the following tasks: "educate people on land, control at port, arrest lawbreakers on the sea, detain ships to look into the case, crack down in accordance with laws and make comprehensive adjustment." In 2013, a total of 2,747 fishing ships stopped fishing during the three-month fishing moratorium, achieving the target of "zero major violations of rules, zero mass incidents and zero accidents." The second measure outlined by the regulating bodies was a push to increase the breeding and release of aquatic organisms in the area. It was estimated that a total of 100 million aquatic organisms living in seawater and freshwater were bred and released in 2013, including 70 million *Penaeus chinensis*, 1.1 million *Fugu rubripes*, 1.3 million bastard halibut and 10 million shuttle crab released into seawater ecosystems, as well as 17 million silver carp, grass and Wuchang bream, plus 4.5 billion fish eggs released into freshwater ecosystems. The third measure was to build more artificial reefs. Nearly 3700 artificial reefs were used over the course of the year, covering an area of 6.7 km^2 (approx. 10,000 mu), the largest amount ever in Dandong. This brings the total number of artificial reefs to 4,991 with a total area of 8.3 km^2 (approx. 12,443 mu), significantly improving the fishery ecosystem. In addition, Dandong City carried out marine environmental monitoring projects including land-sourced pollution drain outlets and a review of neighboring waters, aquiculture areas and Yalu River waters. Over 30 monitoring expeditions being completed at more than 60 locations, with 2,400 records of various data were obtained and archived. This information will help enrich the database of marine environmental monitoring and provide valuable reference material for maintaining and improving the marine environment in Dandong.

The existing problems in ocean and fisheries administration are as follows: 1) Ocean and fisheries monitoring forces need strengthening. Dandong City administrates 3,500 km^2 of seawater and has a coastline of 126 km, with 88 fishing ports, docks and mooring points. Even without the fishing moratorium, the existing fisheries enforcement forces are already overloaded, but in light of the current ban, the efforts are shortstaffed, making it impossible to give the necessary attention to all issues. 2) the environmental protection of ocean and fishing area is highly difficult. Conflicts between economic development and environmental protection have not been entirely resolved, and the land-sourced pollution remains a major source of ocean contamination. There is over-standard discharge of varying extents at some drainage outlets near the sea, putting a large amount of pressure on the marine environment; the quality and safety of aquatic products becomes increasingly problematic due to a lack of awareness among some farmers who use illicit agrochemicals and/or additives.

(3) CWYRE management plan

Identification of specific ecological challenges

① Notable substitution of dominant species in the intertidal zones has been observed over the last three decades.

Through the comparison of the results of the current survey with those of the survey conducted in 1980-1981, it can be seen that many species are diminishing fast or have totally disappeared. For example, many of the dominant species observed in the 1980s, including *Dosinorbis japonica, Dosinia laminata, Scapharca subcrenata* and *Solen strictus* are barely visible now, while *Nassarius succinctus* and *Umbonium thomasi* have been diminishing at annual rates of above 3.3 per cent. Currently, the benthos species (AD) with the largest niche breadth, *Bullacta exarata*, has become the primary dominant species. As a result of the boom of shrimp farming during the early 1980s through to the late 1990s (1985–1997), most of the tidal flat areas in the high/middle tide zones have been exploited, resulting in structural changes to the benthos community. What's more, the abusive use of shellfish as the feed for shrimp led to significant decrease of the populations of some species. Large-scale use of pesticide and drainage from the shrimp farming sites caused severe damage to some benthos species. With little economic value, few natural enemies, strong reproductive ability and a high niche breadth, *B. exarata* managed to gain the room for their breeding in the years to follow. From a biological perspective, the coexistence of communities with identical or similar niche widths is deemed impossible, as the weaker species will eventually be driven out of the stage. This tendency is the crux of Gause's principle. As the primary dominant species in the YRE intertidal zones, *B. exarata* excretes a toxic, viscous fluid, which it uses to protect itself from the shorebirds. As can be expected, this structural change of the species communities has had a negative impact on the health development of the ecosystem at YRE.

② Significant changes to the dominant species of shellfish farming in the tidal flats have been observed in the recent years.

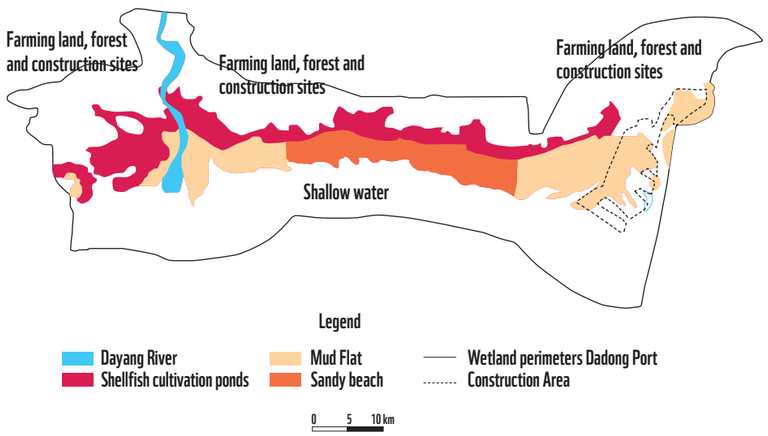
Significant changes have taken place to the CWYRE shellfish farming resources in the tidal flats during the recent years. Many dominant species are diminishing, while some are already on the verge of extinction. Currently, cultivated shellfish species with sizeable output include *R. philippinarum, M. meretrix, M. veneriformis, N. variciferus* and *S. constrica*; species with marginal output include Solen grandis (in the low tide and subtidal zones), *S. strictus, Barnea davidi* and *B. dilatata*; species on the verge of extinction include *Crassostrea gigas*, *C. rivularis* and *Ostrea talienwhanensis*. The massive invasion of external shellfish species, the mono-species structure of individual cultivation sites and inadequate distribution of the sites have severely affected the natural distribution, breeding and growth of local shellfish species.

③ Coastal habitats are being damaged.

Mud flats are the primary feeding habitat of shorebirds, followed by shellfish cultivation ponds. The survey shows that most of the mud flats are located along both sides of YRE and Dayong River Estuary. Between the two estuaries is a sandy beach, which is not a feeding habitat of the birds due to the scarcity of benthos species. See Figure 2-12 for the relations between feeding habitats of shorebirds and the Dadong Port area. The areas of the mud flats and shellfish cultivation ponds along both side of YRE are 95.58 km² and 16.93 km²; those along both sides of Dayang River Estuary are 51.18 km² and 75.11 km²; those between the two estuaries are 79.12 km² and 44.91 km², respectively.

The development of Dadong Port area has occupies a total tidal flat area of 34.72 km² at CWYRE and an offshore water area of 18.43 km². Actions should be taken to compensate for the severe damage to the feeding habitats of the 30,000 affected shorebirds.

[Figure 2-12] Geographic relations between feeding habitats of wading/shorebirds and Dadong port area



④ Local eco-environment has been deteriorating.

With poor stability, the biological community off the coast of YRE has been vulnerable to external interruptions. Our environmental stress factor filtering indicates that the primary factors impacting the stability of the biological community of the YRE are inorganic nitrogen and phosphor in the saltwater, mostly from seven local rivers, including Yalu River and Dayang River, and the drainage network of the saltwater aquaculture sites. Excessive discharge of nutrients has resulted in frequent red tides. Toxic red tide in particular leads to the accumulation of shellfish toxin through species in the higher positions along the food chain, causing a direct threat to the lives of wading birds and human beings.

⑤ Imperfect System of Laws and Regulations and Management Mechanism

In the experimental area of the national-level nature reserve in CWYRE, an area of 27.73 km² has been set aside in order to build Great Donggang Zone, forcing the nature reserve to adjust accordingly. In a similar chain of events, Moon Island (China) in the Yalu River downstream channel, an island that was otherwise unfrequented by human visitors and had remained intact, used to be an ideal place for birds to stop when migrating. More recently, however, it has been converted into a residential area, with the original ecosystem being supplanted by so-called short-term benefits. The inborn profit-driven nature of businesses and the local pursuit of economic development often cause environmental protection to give way to economic development. This imbalance underscores the larger problem facing the management mechanism for CWYRE, suggesting that it is unsound and therefore cannot fulfill its ecological protection mandate.

At present, the Chinese government has not created specific laws or legislation regarding the protection and rational utilization of coastal wetland. The articles that address the protection of costal wetland in the existing relevant policy are discrete and repetitive – difficult to enforce in real-life scenarios. For local law enforcement, regulative powers are segmented and lack the necessary technical equipment, communication devices and transport vehicles, hindering their influence.

The conservation, development and utilization of the coastal wetland involve such a wide range of issues and departments that a sound coordination effort is yet to be developed; different departments operate in relation to different targets and interests, acting in their own ways. This affects the scientific management of coastal wetland. In addition, there is a lack of communication and collaboration between businesses and regulatory authorities, resulting in inefficiency. In particular, large ports and breeding enterprises have had a serious effect on the estuarine wetland ecosystem. New management patterns need to be established to help businesses engage in the ecological management of the region.

⑥ Inadequate Publicity and Education on Estuarine Wetland Ecosystem and Marine Environment Protection

Publicity and awareness regarding the coastal estuarine wetland ecosystem, especially its service value and functions, are currently inadequate. Despite the fact that great efforts have been made to strengthen both aspects of the local environmental conservation movement, public consciousness of the coastal estuarine wetland efforts is generally inadequate, and a similar case can be made for the understanding of wetlands' scientific value. So far, the publicity and awareness campaigns for wetland protection and rational use lag behind the requirements

for both economic development and resource protection. In addition, the forms of publicity and education currently being used are not varied enough. One such example is the publicity slogans, which are difficult to find anywhere in the city, or even on the road leading to the estuary and nature reserve. An atmosphere of conservation, development and rational use of wetland must to be created as a part of society as a whole.

Development of the CWYRE management plan

① Setting long-term goals for protection and monitoring

Set long-term protection goals: continuous maintenance and protection of environmental quality at YRE; maintenance and recovery of the local marine ecological system; protection of wildlife resources, especially maintaining stability and diversity of ecological environment in the habitat of migratory birds; and promoting harmonious development between human and nature.

[Table 2-11] Biodiversity conservation objectives

Object of Assessment	Bio-quality Element	Biodiversity Conservation Objective
Species	Threatened or endangered species	Ensure continued existence of species; increase their populations and expand their habitats
Habitats	Nature Reserve	Forbid new development activities in the Nature Reserve
	Threatened or endangered habitats	Ensure continued improvement; alleviate the stress and habitat damage
	Eutrophia status	Alleviate eutrophia and contain toxic red tides
	Structural changes to the benthos community	Basic recovery of community structure
Environmental variation	Nutrient density (N and P)	Shall not exceed the nutrient density of similar background/regional conditions by 50%
	Phytoplankton, chlorophyll a	Maximum and average values shall not exceed background values by 50%
	Water quality	Shall meet Class II saltwater quality standard across the waters (except at the sewage discharge outlets), and Class I standard at some places
	Phytoplankton as an indicator of eutrophia status	Below the red tide criteria
	Death of benthos	No benthos death caused by lack of oxygen or by toxic phytoplankton
Management systems	Improvements to existing laws and regulations	Establish powerful marine biodiversity conservation laws/regulation systems
	Establishment and management of natural reserves	Build a competent team to drive continued improvements in marine biodiversity
	Monitoring, control and assessment	Improve the monitoring, control and assessment system

The objectives also include setting long-term monitoring targets: identifying key pressure elements that tend to cause biodiversity degradation, generalizing and making hierarchical divisions from the perspectives of chemistry, physics and biology (Table 2-11) as a way to reflect the biological bearing capacity and suitability that a marine habitat should possess.

[Table 2-12] YRE Marine Biodiversity Conservation Metrics System

Objective layer	Standard layer	Metric layer
Stress	Physical damage to the habitat	Natural landscapes
		Fragmented landscapes
		Excessive shoreline development
	Environmental pollution	DO in saltwater
		Active phosphate
		Sulfide in sediment
		Specific pollutants
	Invasion of external species	Risk level of external species invasion
		Percentage of area with external species invasion
	Fishery	Fishery stress index
Status	Ecosystem integrity	Trophic level of the sea
	Biodiversity of habitat	Habitat type
	Species diversity	Shorebirds
		Wetland vascular plants
		Phytoplankton
		Zooplankton
		Benthos in the intertidal zones
		Benthos in the subtidal zone
	Rare and endangered species	Abundance and distribution of rare and endangered species
Response	Environmental response	Nature Reserve development
		Habitat recovery
		Coastal pollution treatment
	Economic response	Environmental protection investment
	Social response	Public awareness

Marine biodiversity stress metrics include physical damage to habitat, environmental pollution, invasion of external species and fishery, which can be categorized into three

groups: physical factors, chemical factors and biological factors. Monitoring plans should be developed in accordance with the properties of specific factors.

Status monitoring metrics include four groups: ecosystem integrity, biodiversity of habitat, species diversity and rare and endangered species.

Marine biodiversity response monitoring metrics include three groups: environmental response, economic response and social response. The targets of the monitoring activities are identified on the basis of biodiversity stress and monitoring. Field surveys are conducted once a year.

It is suggested that the CWYRE Ecological Conservation and Monitoring System be applied across the Yellow Sea Ecoregion, with follow-up public awareness programmes to be implemented throughout the world.

② Biodiversity and habitat protection

The fragmentation, degradation and disappearance of habitats have been among the major reasons for the endangerment and extinction of many species. Sea enclosure, sea route dredging and saltwater pollution have direct or indirect impact on a lot of habitats. Enhancing the conservation of habitats and minimizing the impact of human activities on biodiversity are among the key actions needed to ensure species survival and biodiversity.

In-depth surveys shall be conducted to gain insight on the local plant species at CWYRE and their abundance. In order to ensure the diversity of plants at the YRE, a germplasm resource bank should be established to collect plant species with distinct local identities, e.g., *Phragmites australis*, *Glycine soja*, *Suaeda pterantha*, *Typha orientalis* and other wetland plants, to enable exploitation and conservation of the rich plant resources available in China. In addition, microbe resources with distinct local identities in estuarine wetland play an important role in the recovery and sustainable development of the ecosystem. Leveraging traditional and modern molecular biological techniques, surveys should be made to understand the interaction between microbe species and dominant plants in the wetland. A microbe germplasm resource bank should be established to enable microbe resource conservation and long-term, healthy development of the ecosystem.

③ Habitat Restoration

Given that typical benthos feed on sea bottom sediments, Nereididae are a key link in the energy flow and matter cycle of the marine ecosystem and food chain. Research indicates that hairy Nereididae are able to accumulate large amounts of heavy metals and toxic pollutants due to their strong resistance to pollution. In addition, they can consume organic particles in the sediment at a massive rate. Therefore, Nereididae play a proactive role in eliminating sediment pollution and improving the saltwater environment, both of which help restore the function of the marine ecosystem. The population of Nereididae, the primary prey of migratory birds on the wetland, has been dropping significantly, leading to the degradation of the tidal flat sediment quality and a series of consequent ecological challenges. The researchers attempted to find effective ways to eliminate environmental pollution from the aquaculture sector, provide migratory birds with sufficient food and restore and optimize the aquaculture environment. This has obvious significance, from both theoretical and practical view points, to the healthy development of the tidal flat aquaculture sector and the sustainable exploitation of the tidal flat, shallow water and wetland resources.

In line with the functional planning, wetland plants (e.g., reeds) should be planted along the seven rivers in CWYRE. These plants would be able to absorb nutrients (including nitrogen and phosphor) into their root systems to help improve the water purification ability of the wetland, as well as contribute to the environmental protection initiatives at CWYRE. Technologies available for use include wetland saltern reclamation technology, wetland substrate restoration technology, wetland pollution control technology, artificial plant breeding technology, artificial plant seeding technology and plant community health maintenance technology.

④ Standardize Zone Management

There are many central islands in Yalu River estuary wetland where reed and osiery are lush. The area here is unfrequented, with well-kept natural conditions and is thus an ideal place for migrant birds to have a rest. The existence of the green block is absolutely important for biotope diversity, man-made pressure mitigation and attractive landscape. Therefore, the overall plan for fishing and aquaculture in the YRE wetland must be enhanced. At the core area of the important biological habitat, artificial breeding must be forbidden; aquaculture and proliferation in buffering zone needs to phase out; maintain the existing scale of aquaculture and restrict over-aquaculture in experimental zone and popularize the concepts of scientific aquaculture. Mobilize and guide fishers to develop offshore aquaculture and net cage aquaculture in open bay where water exchange rate is rather high.

Currently, *Ruditapes philippinarum* is the primary product of shallow water aquaculture. It is necessary to maintain strict control over the density of *R. philippinarum* farming density, which should be kept within the range of 1.00—1.67 kg/m^3 in spring. Larger larvae should be used to the extent possible to leverage the abundant prey resources available, carried out in such a way that enables fast growth in spring and an early arrival to market in summer. Minimal to zero larvae input should be made in summer to prevent the shellfish from getting thin or the eruption of epidemics due to prey shortage or high temperature. Farming density should be controlled at 0.22—0.36 kg/m^3 during this time frame. In autumn, the density could be increased to 0.75—1.25 kg/m^3 to achieve the goals of both optimized farming and eco-environmental protection.

⑤ Management System Construction

Management system construction, in the final analysis, is to restrict human behaviors through sound system. Based on project research contents and achievements, it is advised: 1) set forth local coastal wetland protection standard and shellfish aquaculture standard, and form management system of coastal wetland protection; 2) set out clear rules and regulations, standardize the existing fishing and aquaculture activities, forbid the practices which go against fisheries resource protection during fishing moratorium such as “all-killing net” and cause serious threats to the survival of migrant wading birds; 3) put the CWYRE in Dandong City within ecological protection redline for intensified protection, improve policies and measures for eco-compensation, protect important biological habitats in YSE effectively and avoid the disruption of human activity; 4) set explicit provisions on kinds and dosage of fishing medicines and forbid the use of medicines which may damage surrounding ecological balance; 5) strictly implement the protection goals and requirements for function zoning, and supervise law enforcement strictly.

⑥ Establish Environmental Partnership between Businesses & Administrative Departments

The establishment of environmental partnerships between businesses and administrative departments is a newly developed strategy that has been beneficial for coordinating relations between development and conservation. The research conducted at Batangas Bay in the Philippines shows that such relationships can be effective when it comes to identifying problems in the marine environment. The active participation of businesses in environmental management is not only a new thing, but also an indispensable step forward for sustainable development. In the past, it has been difficult for local governments execute such projects on their own because they have neither the experience nor the fiscal support to develop and run effective environmental facilities and services. The partnership between businesses and administrative departments helps bring businesses' initiatives into action and provide their expertise and management efficiency. On the other hand, businesses are able to acquire opportunities to make investment in environment, particularly in waste treatment, hazardous materials recovery, polluted area treatment and re-development, ecological recovery and ecological tourism industry development. This is not only beneficial for environmental treatment and ecological recovery, but also good for the development of new eco-friendly industries, driving regional industrial structure adjustment and emerging industries.

To address the ecological problems existing in CWYRE, one of the most effective approaches is for large-scale aquaculture breeding and port enterprises to participate in the ecological management of estuarine waters. To do so, partnerships between businesses and administrative departments of the protection area may be established, and volunteer groups aimed at environmental protection can be formed. In practice, this can be done through large-scale breeding and port enterprises seeking to organize businesses on relevant industry chains, which would be done to help coordinate the development and utilization of wetland resources and maintain the relationship between ecological system functions. In order to improve the recovery and protection of ecological environment in the estuarine waters, enterprises in this area should be encouraged to evolve into eco-friendly enterprises.

⑦ Organize public awareness and education programmes

To a large extent, any improvement to the effective conservation and reasonable exploitation of the CWYRE resources would depend on the public and decision makers' awareness and mindset of the importance of the wetland. Some of the longstanding, traditional ideas and mindsets are extremely negative when it comes to the conservation and sustainable exploitation of wetland resources. Therefore, it is necessary to organize a series of effective education and training programmes to improve public awareness regarding wetlands, particularly in terms of their functions and benefits, as a way to increase the sense of urgency about wetland conservation and resources are being exhausttion, and to shape a positive environment or atmosphere for wetland conservation. Preferred actions include the following:

- Routine public awareness and education programmes in a variety of forms to transfer knowledge about wetlands, their conservation and their sustainable exploitation, as well as to improve public awareness about the significance of wetland and wetland conservation;
- Public education programmes about the ecological and economic value of wetlands in conjunction with specific events, including "World Wetland Day," "Birds Week," "Wildlife Conservation Month," "No Fishing Season" and "No Hunting Zone";
- Organizing experts and specialists to develop textbooks and materials for education programmes targeted at beginners, professionals and the general public in an effort to promote knowledge about wetlands and wetland conservation, while also giving consideration to adult education;
- Incorporating contents about wetland and biodiversity conservation into curricula of elementary schools, high schools and colleges/universities;
- Development of wetland management and research professionals through a range of means; universities and research institutions may provide wetland conservation programmes and courses, including targeted overseas study, further education and scholar exchange programmes for the development of senior professionals for wetland conservation and management according to the actual situation;
- Establishing tourist education centers within CWYRE Nature Reserve to promote the significance of wetland conservation, along with wetland management professional training bases and public education bases;
- Conducting wetland conservation training requirement analysis; developing training courses, materials, programmes and instructors in line with specific requirements; providing on-job training to improve the skills of wetland management professionals; and
- Enhancing inter-agency wetland conservation and exploitation professional training and exchange; introducing relevant training and lectures from other countries; and organizing training and exchange programmes in collaboration with international peers.

⑧ Carry out Ecological Protection from the Perspective of Comprehensive Management of Yalu River Basin

Located downstream of the Yalu River Basin, the coastal wetland at the YRE passively receives the domestic sewage and industrial wastewater discharged from the upstream area. In other words, the upstream area has a considerable impact on the CWYRE, and it is impossible to protect the estuary without coordinating efforts with other areas. Instead, its ecological protection should be considered from the perspective of the larger comprehensive management of the Yalu River Basin. As the boundary river between China and North Korea, the Yalu River originates from the southern foot of Bailou Peak of Changbai Mountain, which divides Jilin province and North Korea. The Yalu River flows through five cities in two provinces, including Baishan City and Tonghua City in Jilin province and Fushun City, Benxi City and Dandong City in Liaoning; it then moves onward into the Yellow Sea within the territory of North Korea nearby Dadonggang. The river trunk is 795 km long and its basin covers an area of 61,900 km^2, 3.25 km^2 of which is within the territory of China. The Yalu River basin has a large area of forests, also known as the"green screen" of Liaoning and Jilin provinces, rich mineral resources with large reserves and a wide variety of plant and animal species, making it a transition zone between Changbai and North China plant flora and an important species gene bank in Northeast China.

The characteristics of the natural ecological environment along the Yalu River Basin, especially the uncontrolled development and extensive, predatory management practices, have caused some environmental problems such as serious soil erosion,

degradation of the plant community, a population decrease among wild plant and animal species, environmental pollution caused by discharge of industrial wastewater and domestic sewage and a decreasing area of arable land due to human activity such as mining, road construction and house building, as well as water washing and desertification. In order to protect the ecological environment in the Yalu River Basin and promote the sustainable economic development in the area, it is advised to set up an Integrated Administration Committee for the Coordination and Cooperation for the Yalu River Basin ecological protection and development, which is to formulate a plan for ecological protection and development along the Yalu River Basin; to coordinate between the upstream and downstream ecosystems and those between right bank and left bank; and to communicate, exchange ideas, consult and cooperate for resource development and utilization, environment monitoring, administration, treatment, ecological protection and development.

(4) Evaluation by experts

In April 2013, 10 researchers and experts were invited to review the draft report of the YSESP Yalu Project and provide overall project assessment. In summary, the experts provided following comments:

① The YSESP Yalu project selected three communities — the benthos community, the migratory bird community and the cultivated shellfish community — in CWYRE in an attempt to clarify the ecological linkage among its key components, identify major ecological challenges and propose an adaptive management plan for the CWYRE ecosystem. This study could serve as a useful reference to the effective assessment and conservation of the ecological functions of the migratory bird stopover and the sustainable development of the wetland.

② The locations of the survey sites listed in the project report are reasonable and typical, capable of reflecting the reality of the entire CWYRE. The selection of benthos, shorebird, cultivated shellfish and marine species as survey targets enabled effective description of key components of the CWYRE ecosystem. Methods used in the survey were consistent with national and industrial standards. In general, the report provides detailed data, in-depth analysis, adequate theories and models, accurate comments and targeted, actionable policy and action proposals.

③ For the first time ever, the project report specified 24 prey species for wading birds in CWYRE, including, primarily, *Moerella jedoensis* and *Glycera chirori*. It concluded that migratory bird species that meet the criteria of those of wetlands of international importance and their populations have been relatively stable. The natural prey species at CWYRE are capable of meeting five times the demands of existing shorebirds, effectively mitigating the threat to the cultivated shellfish products. Aquaculture activities have resulted in the degradation of biodiversity. However, they also helped satisfy the demand for premium sea food. With a relatively vulnerable structure, the biological community off YRE tends to be small-scale, and for this reason, long-term environmental treatment and fishery management are necessary. The management plan and actions proposed in the report have taken into consideration local realities, particularly the balance between economic development and ecological conservation. Properly implemented, they will help effectively protect the ecological functions of the CWYRE stopover, while facilitating the harmonious development of the entire ecosystem, including human beings.

④ The YSESP Yalu Project has an innovative nature, a profound scientific significance and an extensive applicability. In fact, it is the first case to combine mankind, birds and benthos ecosystems into a single ecosystem management study. It is necessary to convert the research findings into management actions.

⑤ The project has yielded fruitful results, including a number of essays published on major Chinese and international periodicals, which increase the influence of the YSESP Yalu Project.

⑥ Government agencies involved are advised to take actions to enhance publicity, including the promotion of project experience in the North China Sea, Yellow Sea and even the Southeast Asian regions, and seeking international certification.

(5) Self-evaluation

The indicators were applied to assess the results of the three-year YSESP Yalu Project. Each category was give one of five ratings as listed below.

[Table 2-13] Possible assessment ratings

Goals were generally met and activities went as planned	Excellent
Some failure to achieve goals	Good
Failure to achieve goals or deviations from initial expectations	Average
Serious failure to achieve goals or carry out activities as planned	Poor
Goal achievement could not be judged because monitoring plan was inadequately developed, monitoring was inappropriate or monitoring did not place	No rating

Based on three years of research activities, the YSESP Yalu Project indicators were applied to assess key performance.

[Table 2-14] Assessment results

Category	Average Rating
1. Prepare a technical report based on the results of the three-year research programme.	Excellent
2. Provide a policy proposal to decision makers based on the results of the research programme.	Excellent
3. Publish one to two essays on the project.	Excellent
4. Organize two to three exchange forums, training programmes and project experience sharing seminars in China or elsewhere in the world.	Excellent
5. Organize one to two publicity and education programmes.	Excellent

① The YSESP Yalu Project report was prepared on the basis of the research results of the past three years. Ten experts from this specific field were invited to assess and discuss the report. The research findings were included in the report and shared with relevant institutions, universities and government agencies. An electronic version will be published for online sharing.

② Based on the findings of the three-year research project, the YSESP Yalu project team submitted a policy proposal for the Conservation of YSE, which included specific suggestions for the OFDLP to enhance YSE environment protection planning and marine bio-resource maintenance. In addition, it is suggested that regulations be developed to guide sustainable growth of the aquaculture sector on the coastal wetland. The OFDLP acknowledged that they will consider the proposals submitted.

③ Using conclusions drawn from the research findings, three essays have been published in Chinese and international periodicals, with another two submitted and pending publishing. These essays helped lay a solid scientific foundation for the coastal wetland conservation in YSE.

④ The YSESP Yalu Project team organized and implemented a series of exchange forums and training programmes. Specifically, they organized the following:

- Benthos survey training; project team members who are responsible for programme design and survey experts of this field participated in the training in order to accurately describe the status of benthos species at the project site;
- A field training at Maipo coastal wetland, Hong Kong, to learn from its leading management experience. OFDLP officials, management members from CWYRE Nature Reserve Administration Committee and project team members participated in the training to be able to develop a better plan for the management of CWYRE;
- A field visit to Kumamoto, the famous shellfish farming base in Japan, to learn about leading shellfish farming and management practices and share the results of the YSESP Yalu Project
- Routine exchange programmes with the YSLME Project and the Marine Protected Area Network on a regular basis to share the latest progress and results of the project, and to keep track on those of similar projects across the YSE;
- Exchange forums among Chinese, Japanese and Korean coastal wetland and marine reserves; participants included government officials, researchers and experts from related fields.

In addition, they participated in a number of domestic and international meetings, including the first World Parks Congress and an East Asia-Australia Flyway Partnership meeting to share the results of the project and its implementation plan in the future.

⑤ The YSESP Yalu Project team implemented publicity and education programmes. The project team implemented a series of publicity and education programmes to enhance public awareness of the ecological functions of the wetland, of the necessity for wetland conservation and of the pressing challenge of resource shortage. Specifically, these programmes included the following:

- Distribution of 200 copies of public education materials to key stakeholders in Dandong in order to improve their awareness about the biodiversity and biological functions of the YSE;
- An ocean-topic education programme held by LOFSRI (undertaker of the YSESP Yalu Project) on the campus of the Fourth High School of Dalian in June 2013; members of the project team and guests they invited gave lectures about commercial ocean fishing and coastal wetland conservation, and even held a quiz for the students, receiving satisfactory results;
- A campaign on the topic of “protect coastal wetlands, take care of marine life and conserve marine ecosystem” was organized by LOFSRI in August-September 2013; the campaign presented the results and underlying ideas of the YSESP Yalu Project and received more than 10,000 visitors, including local citizens and elementary/high school students; and
- A documentary titled *The Sea Rush* that discussed ecodiversity and shellfish farming in YSE was created in 2012; it aired on Dandong TV to help the public understand the ecological functions and importance of the coastal wetland in the YSE, and to showcase the life of local shellfish farmers.

2.2.6. LESSONS LEARNED, RECOMMENDATIONS

Based on the findings and results of the study, the YSESP Yalu Project team has set the direction for future work and research activities from both the policy and research perspectives. This was done in an attempt to ensure effective conservation of the coastal wetland both in the YSE and in similar wetlands across the world, allowing humans and birds alike to benefit from the ecological resources of these coastal wetlands. Specifically, the YSESP Yalu Project team proposed to do the following:

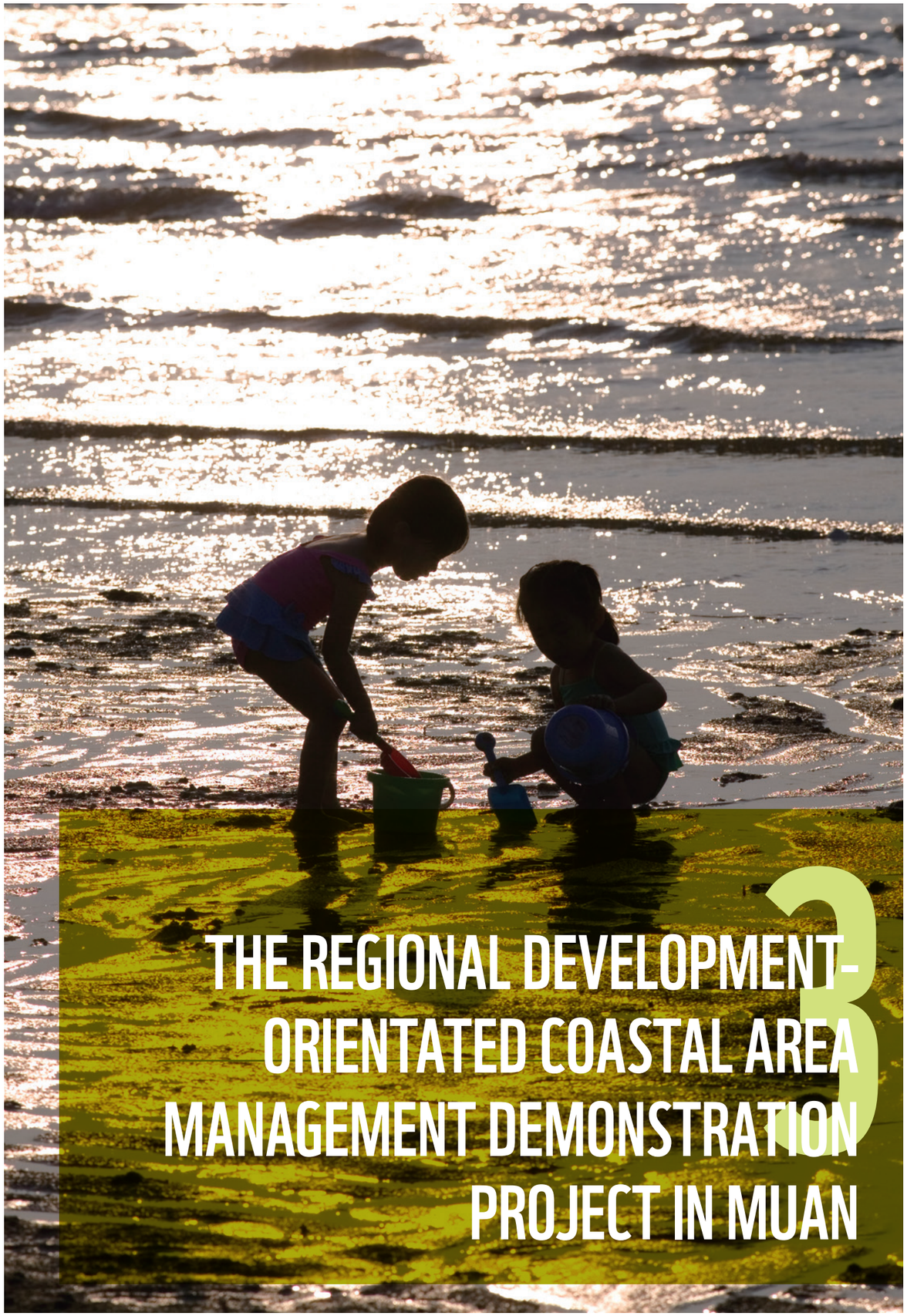
- Establish and improve the monitoring and assessment mechanisms for biodiversity and key species in CWYRE and other major coastal wetlands based on the results of scientific screening and assessment of key coastal wetlands along the YSE.
- Promote the results of the YSESP Yalu Project across Chinese and international MPA networks; and take actions to conduct the capacity building works regarding EBM in MPAs;
- Develop a government decision making support system to incorporate the results of the YSESP Yalu project into government decision making about coastal wetland management;
- Include CWYRE (Dandong National CWYRE Nature Reserve) into the ecological red lines; establish an expert review mechanism involving experts from different fields during the ecological red line identification process;
- Develop the medium- and long-term development plan for Liaoning’s coastal wetland aquaculture sector to ensure a reasonable percentage of key protein sources for animals, including shellfish, in the entire aquaculture sector; conduct scientific planning for the aquaculture sector, taking into consideration the general laws of ecology and the distribution of germplasm resources;
- Promulgate local standards and establish a local coastal wetland conservation and management system. Based on the content and results of the project, it is

suggested to create and issue local wetland and aquaculture standards, including coastal wetland conservation standards and shellfish health and farming standards, to build an integral mechanism for coastal wetland conservation;

- Develop detailed rules to regulate commercial fishing and aquaculture activities; prohibit activities that are against the goals of fish resource protection during the fishing period, e.g., the setting of nondiscriminatory nets; prohibit fishing activities that would severely threaten the survival of migratory birds; clarify the types and amounts of fish drugs that can be administered; prohibit the use of drugs with possible risk of damaging ecological balance in the surrounding area; ensure strict supervision and law enforcement;

  - Encourage and support the development of environmentally friendly aquaculture activities, including shellfish and sea cucumber farming; explore and promote trusted international standards for sustainable business activities; and develop ecological aquaculture, production, processing and trade models to encourage environmentally friendly consumption in the domestic market and export market; and

- Work with domestic and international stakeholders to create more environmental education opportunities to promote marine environmental protection knowledge, and provide the public with more opportunities to access coastal wetlands.



3 THE REGIONAL DEVELOPMENT-ORIENTATED COASTAL AREA MANAGEMENT DEMONSTRATION PROJECT IN MUAN

3.1. PROJECT OVERVIEW

3.1.1. PROJECT DESCRIPTION

(1) Background/baseline

As recently as the 1990s, the Republic of Korea was losing much of its tidal flat environment to reclamation efforts. The flats themselves were seen as useless, and many believed that they would better serve the national economy if they were filled in to become "useful land" for the nation. Muan was the subject of one of these plans, carried out in the form of the Yeongsan River Reclamation Effort. Launched in 1972, this was a five-stage plan to fill in 33,560 hectares of land in the areas of Mokpo, Muan, Hampyeong, Yeonggwang and Sinan at a total cost of KRW 1,960 billion. The government plan triggered a campaign of opposition by Muan residents, and as environmental issues in other reclamation zones rose to the fore, the Ministry of Agriculture finally decided to cancel the efforts in 1998 (Kang Dae-seok, 2006).

Following the cancelation in 2001, the Muan Tidal Flat was designated as the nation's first Wetland Protection Area. In January 2008, it was named a Ramsar wetland; that same year, it received the status of Provincial Park, a recognition that made it a proud asset of South Jeolla Province. In 2009, the Muan Ecological Tidal Flat Center was founded to provide a venue for conservation research and education. It was also incorporated as a Potential Priority Area (PPA) in the Yellow Sea Ecoregion (YSE). All of this served as recognition, at home and abroad, of the natural state, biodiversity and conservation value of the Muan Tidal Flat (YSESP, 2012). From October 2007 to September 2008, Eco-Horizon Institute (EHI) conducted a programme to promote civil participation in coastal conservation of the Muan Ecological Tidal Flat Visitors' Center thorough the UNDP/GEF YSLME small grant scheme. Through this programme, local authorities has realized the importance of building civil network and of searching for material and human resources in the community with the participation of local residents in community development and environmental activities (UNDP/GEF, 2008).

[Table 3-1] Muan Tidal Flat Protection Area designation status (YSESP, 2012)

Designation	Date	Area
Muan Tidal Flat Wetland Protection Area No. 1	28 Dec. 2001	42km^2
Ramsar Wetland No. 1732	14 Jan. 2008	35.89km^2
Muan Tidal Flat Provincial Park	5 June 2008	37,123km^2

(2) Project participants

The Regional Development Orientated Coastal Area Management Demonstration Project in Muan (henceforth the YSESP Muan Project) is being carried out by the Korea Institute of Ocean Science and Technology (KIOST), Muan County Government and the EHI under the leadership of WWF, with financial support by Panasonic Corporation. During the project implementation period, a MoU was agreed upon among the Muan County Government, WWF, EHI and the Korea Ocean Research and Development Institute (KORDI), the precursor to KIOST for cooperation in the area of YSESP for three years starting in 2010.

① Korea Institute of Ocean Science and Technology (KIOST)

Established in 1973 under the name Korea Research Institute of Ocean (KRIO) as a subsidiary institute of KIOST, KORDI became the country's leading oceanic research institution, conducting the basic research needed for the development of ocean science and technology and maritime industry development. It also carried out such functions as research for practical applications, ocean- and polar-related science and policy, institutional studies, professional training and the development and management of ocean infrastructure. In 2012, KORDI was reorganized and expanded into what is now KIOST as part of an effort to strengthen ocean science and technology R&D, as well as to promote oceanic research collaboration with universities. With the YSESP Muan Project, it has been involved in managing the ROK side of the effort, liaising with relevant agencies, supporting local government and regional activities such as civil monitoring and data collection and analysis, and providing technical and financial support to improve necessary capacities of local institutions and experts in marine environmental protection. It is especially invested in the conservation of marine biodiversity in Muan through knowledge exchange training activities and international and regional study tours.

② Muan County government

The Muan County is a region of South Jeolla Province located in southwest Korea. Its municipal government took a variety of approaches the help conserve the Muan tidal flats: coastline erosion prevention, creation of weed fields, exploration roads, establishment of water purification facilities, ecology parks, etc. Among them was the Muan Ecological Tidal Flat Center, established in 2004, which greatly helps people recognize the importance of tidal flat conservation. It was renovated in 2009 with the help of the YSESP Muan Project, and it has since started providing people with more practical educational opportunities for tidal flat conservation such as civil monitoring workshops and exhibitions (EHI Pamphlet, 2012). Muan County provided YSESP with the utmost help and support for the implementation of the demonstration project, with cooperation of all relevant local government agencies as agreed on in the work plan regarding the coastal and marine conservation activities in South Jeolla Province.

③ Eco-Horizon Institute

The EHI is a private environmental research center founded in 2006. It has been working to conserve the tidal flats on ROK's southwestern coast and preserve the ecosystem in the Demilitarized Zone (DMZ). In addition, the organization has been researching alternative energy and climate change, providing environmental education and conducting a wide range of studies for the development of environmental policy in ROK. It has been particularly focused on investigating ideas for sustainable regional development including support for Wetland Protection Area administrative policy, tidal flat education programme and ecotourism product development, and international cooperation. This latter task is being carried out using a network of stakeholders to help produce a resident-based growth model to combine tidal flat conservation with local development, and its YSESP involvement in the Muan tidal flat dates back to 2008. With the YSESP Muan Project, EHI carried out the demonstration project to contribute to the conservation of the environment in the Muan tidal flat areas, which including acting as a coordinator for local efforts. More specifically, the organization developed education materials, worked with residents on marine preservation projects, communicated between local groups and citizens and facilitated cooperative efforts with the government.

④ Yongsan Village Farming Cooperative

Yongsan village is located in Yuwol-ri, Haeje Township, Muan County, and was the site of an EHI project related to the sustainable development of the Muan tidal flats. It has taken on a variety of conservation projects on its own, such as making an advanced field survey, hosting a session with local experts and establishing an agricultural association. They are also attempting to develop their area's eco-tourism industry. At present, Yongsan village is also establishing a village development plan. First, they will generate income through the sale of fresh seafood, selling it at the Muan Ecological Tidal Flat Center. Over the longer term, however, they are preparing a tour programme. The inhabitants of Yongsan village are working to incorporate tidal flat conservation work into local development. As a result, its main priorities are obtaining both material and personnel resources for upcoming projects.

⑤ The Biodiversity Foundation

The Biodiversity Foundation is a nonprofit foundation established in 2013 to promote and preserve all kinds of life and life-forms. It aims to achieve informed environmentalism by advocating a science-based approach for understanding environmental problems. By applying artistic sentiments toward nature with the passion to protect the environment, the foundation strives for a new Creativity in Caring for Nature. It also endeavours to spread Ecological Economics by encouraging a symbiotic way of living with nature. The foundation's projects include research and funding for wildlife studies, conservation projects, the Korean leg of Jane Goodall's youth environment network Roots and Shoots, eco-art exhibitions, and corporate consulting and collaborative sustainability initiatives, among other things. Under the YSESP framework, the foundation maintains the role of developing and disseminating novel ecotourism programmes focusing on marine biology. The programme's content is made up of research topics and methodology that relate to the organisms inhabiting the tidal flats. By doing so, the foundation aims to spread non-invasive ways of enjoying and interacting with the local marine habitat.

(3) Project scope and characteristics

The primary focus of the YSESP Muan Project has been the tidal flat areas in Muan's townships of Haeje and Hyeongyeong (EHI, 2009). The geographic, administrative, biological, social, political and economic characteristics of Muan and the two focus regions are outlined below.

① Geography

Muan covers a total area of 448.95 km^2, with a broad distribution of fertile red clay soil and pure wetlands covering an area of 211.1 km^2 along a 231.8 km stretch of coast. The townships of Haeje and Hyeongyeong, the two YSESP target sites in Muan County, occupy 64.44 km^2 and 55.35 km^2, respectively, making up 26 per cent of the county's total land mass (Muan County, 2012).

Because of the effects of naturally eroded soil and dunes, the Muan tidal flat has a distinctive geology. It is an example of an infant tidal flat where both formation and destruction can be observed simultaneously. Its shallow depths, abundance of sandy sediments, ria coasts and mixture of various forms of flats make it an ideal spawning ground and habitat for a wide range of species (Muan County, 2012).

② Administration

Muan County[7] is divided into three towns and six townships. As of October 2013, its population stood at 78,929 inhabitants in 33,351 individual households. Hyeongyeong and Haeje, the target sites of the YSESP Muan Project, had populations of 5,599 and 6,039 inhabitants, respectively (Muan County homepage). Together, they accounted for 14.7 per cent of the county's total population. They also accounted for 412 and 575 of the county's 2,123 individuals employed in commercial fishing, respectively (Muan County, 2012). The wetland regions are among the county's most sparsely populated, and the total number of people employed in fishing has been declining steadily.

③ Biology

The monitoring results from 2012 documented 236 macrobenthic animal species in the ecosystem. The largest grouping was of mollusks (76), followed by 70 species each of annelids and arthropods. The region was also found to be a habitat for the *Ellobium chinense* (a type of saltmarsh snail) and *Uca lactea* (a type of sand crab), both listed as Type II endangered species by the Ministry of Environment. Their presence can be seen as a sign of the cleanliness of the local tidal flat environment (Muan County, 2013).

Monitors also observed 48 species of shorebirds. The dominant species was the dunlin, followed by the greater scaup, common shelduck, black-tailed gull and mallard. According to the findings, the tidal flat serves as both a wintering site for many shorebird species as well as a stopover site on international migratory routes (Muan County, 2013).

A total of 22 fish species have been identified to date, with inhabitants including the gray mullet, gizzard shad, ray-finned fishes, bass, bluespotted mud hopper and the common brackish goby (Muan County, 2013).

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7. The town-level administrative divisions are Muan, Illo and Samhyang. The townships are Mongtan, Cheonggye, Hyeongyeong, Mangun, Haeje and Unnam (Muan County homepage).

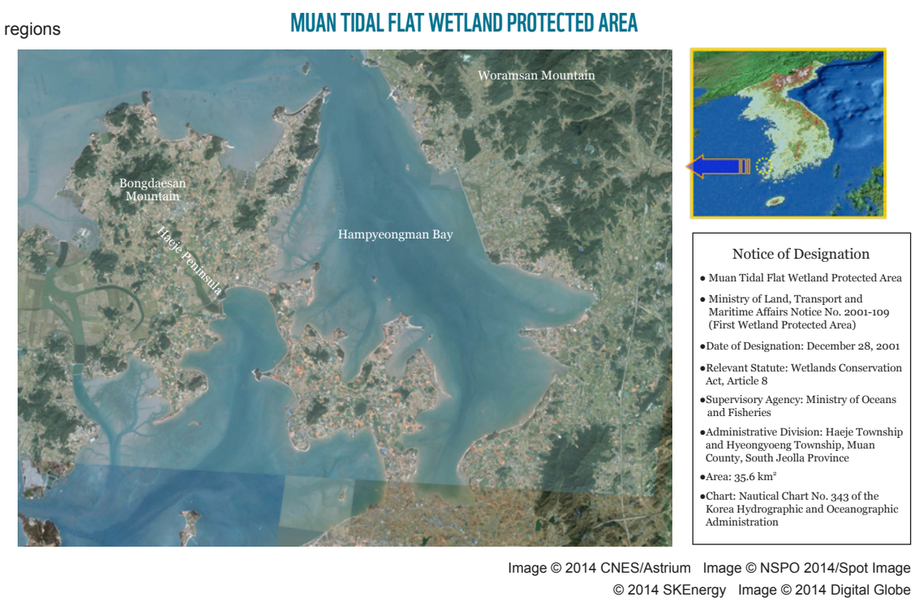
Other than those noted above, at least 153 species of small invertebrates, 95 species of large invertebrates, 79 species of plant planktons and 45 species of halophytes have been discovered. Such a biodiversity-rich environment is formed by Muan's unique geography (Muan County Homepage).

The flats offer a range of different habitats, including sand, sand flats, mudflats and gravel. This variety accounts for its broad range of halophyte (salt plant) species – 47 in total, predominantly including reeds, zoysia, green foxtail, common wild oat, curled dock, chilmyeoncho, namunjae, sea blite, sea lavender, silmangcho, perennial Artemisia and prickly sow thistle (Muan County, 2013).

④ Social economic condition

Agriculture and fishing are the largest industries in Muan County, accounting for 45.6 per cent of all employed individuals. Muan provides 300,000 tons of commercially caught fish every year, a major contributor to the local economy. One of the biggest and most valuable species is the long-legged octopus (*Octopus minor*), which live in the naturally pure and gemanium-rich tidal flats and can be caught year-round. Due to its local significance, an octopus festival is held in Muan County almost every year. Mullet and oyster are also important, and are mainly caught and harvested from winter to early spring (Muan County Homepage). Other industries include business/public services (21.7 per cent) and wholesale/retail/restaurants/accommodations (13.1 per cent). According to a 2010 study regarding the development of a Muan Tidal Flat Wetland Protection Area preservation and management plan, specialized industries in areas related to the flats included (in decreasing order) mining, agriculture/forestry/fishing, wholesale/retail, restaurants/accommodations, transportation and finance/insurance (Muan County, 2010).

[Figure 3-1]
YSESP target regions



[Table 3-2] Area and population of Muan County (Muan County, 2012)

	Muan County	Hyeongyeong Township	Haeje Township
Area (km²)	448.95	55.35	64.44
Population	78,929	5,599	6,039

[Table 3-3] Number of Muan residents employed in fishing (Muan County, 2012)

Year	No. Employed in Commercial Fishing	No. Employed per Household
2006	2,298	2
2007	2,244	2
2008	2,221	2
2009	2,217	2
2010	2,221	1.8
2011	2,213	1.8

[Table 3-4] Industry employment rates for Muan County (Muan County, 2012)

Industry	Percentage (%)
Agriculture/Fishing	45.6
Mining/Manufacturing	9.4
Construction	5.1
Wholesale/Retail/ Restaurants/ Accommodations	13.1
Electricity/ Transportation/ Communications/Finance	5.1
Business/Individual/ Public Services/Other	21.7

(4) Conservation targets

The conservation goals for the YSESP Muan Project revolve around a well-functioning tidal flat ecosystem; endangered species rely on the tidal flat for their wetland habitat, and local residents rely on the tidal flat seafood as a source of income.

(5) Stakeholders

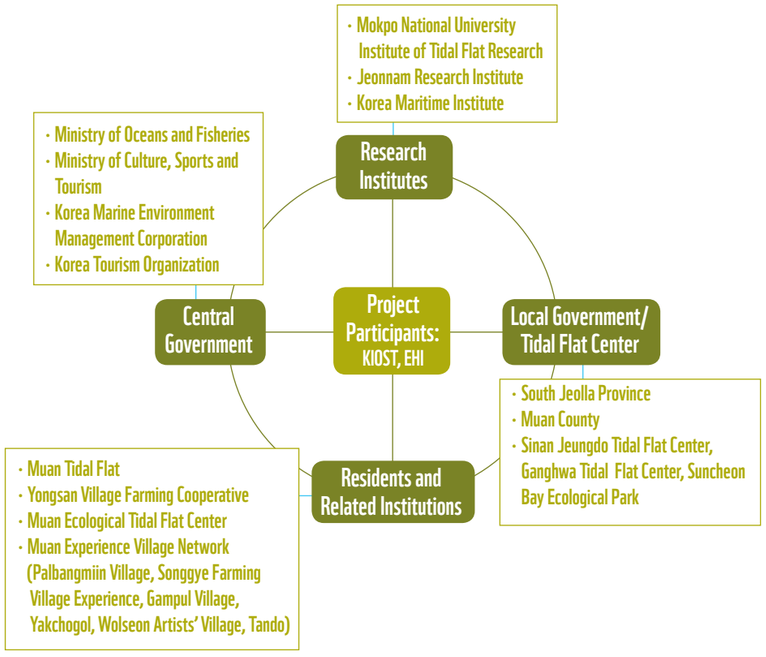
Participants in the YSESP Muan Project represent a wide range of stakeholders. The participating organizations are described below.

The Ministry of Oceans and Fisheries is the government agency in charge of state activities related to oceans and marine life in Korea. In 2008, its duties had been split between the Ministry of Land, Transport and Maritime Affairs and the Ministry for Food, Agriculture, Forestry and Fisheries, but the original ministry was ultimately restored in 2013 (Ministry of Oceans and Fisheries). The Korea Marine Environment Management Corporation was established after the enactment of the Marine Environment Management Act. It is a public corporation responsible for the conservation, management and improvement[8] of marine environments and any duties related to marine pollution prevention (Korea Marine Environment Management Corporation).

The list of associated research institutions includes the Mokpo National University Institute of Tidal Flat Research (ITFR), the Jeonnam Research Institute (JERI) and the Korea Maritime Institute (KMI). Located in the Muan Tidal Flat Center, the ITFR's duties include investigative and educational activities related to the Muan Tidal Flat's natural environment, its status in the humanities and society, its hydraulic and sedimentary environment and its health, benthic fauna, marine resources, halophytes and shorebirds. JERI conducts research and provides policy support for the development of South Jeolla, while KMI is involved in comprehensive studies and national policy development for all areas of Korea's marine environment, including shipping and harbor policy, marine policy and environmental conditions, and fishing industry and community policy (KMI). The specialized marine data produced by these institutions was put to use in the YSESP Muan Project, and their researchers have assisted the project with their professional counsel on related activities.

As the scope of the YSESP Muan Project's activities has broadened from Muan into other regions, the geographically contiguous county of Sinan and the South Provincial Office have participated closely to promote cooperation with relevant institutions. Finally, Muan residents and local fishers have contributed actively to a local, engagement-based tidal flat conservation effort. In 2009, the Muan Yellow Sea Tidal Flat Yongsan Village Farming Cooperative was established as a way of promoting the flats' abundance of marine resources and environmentally friendly agriculture and helping to put village resources to use to strengthen the local economy.

[Figure 3-2] YSESP Muan Project stakeholders



8. Duties include basic marine ecosystem studies, basic coastal wetland studies, marine ecosystem restoration, marine protection area management, marine climate change responses, water quality monitoring and management of an integrated marine environment information system.

3.1.2. ACTION PLAN

(1) Goal (long-term results)

The ultimate goal of the YSESP Muan Project is that biodiversity and ecological resilience in and around the Muan tidal flat will be well-maintained by capable local residents, academics and a government network. In addition, it is important that the local community continues to enjoy economic benefits through sustainable natural resource use.

(2) Objectives (project cycle results) and activities

In terms of objectives, the management and planning activities in Muan fall into three categories: biodiversity, governance and sustainable use. Designed for the management of species and habitats, the biodiversity component involves developing civil monitoring methodologies, manuals and research notebooks for the Muan tidal flat as a way of examining ecological connectivity through systematic monitoring by local citizens.

The governance component aims to strengthen the Muan Tidal Flat Center's capabilities through the development of tidal flat education programmes and teacher training, along with support for central and local government marine protection policy. Among other things, this includes developing teaching materials and aids, formulating ideas for linking environment education with the public school curriculum, cooperating with the three Wadden Sea nations (Germany, the Netherlands and Denmark) on tidal flat education and organizing youth tidal flat camp activities.

Finally, the sustainable use component involves tidal flat conservation plans that help generate income for local residents who use and co-manage the natural resources. This entails identifying ecotourism resources in the flats and building a model for sustainable, community-based natural resource use and management. Other efforts include investigating possible tie-ins with village resources and organizing Muan Tidal Flat Festival events, soliciting and producing original Muan tidal flat souvenir items, discovering cooking resources and providing community cooking classes and conducting exchange efforts with residents of tidal flat ecoregions in Korea and Japan.

[Figure 3-3] YSESP Strategy and activities

(3) Indicators

Prior to the YSESP Muan Project launch, indicators for the different areas were developed by WWF-Japan, KIOST and the EHI to measure results from the three-year effort. The indicators, which fall into five categories in total, are listed below; an assessment based on data for these categories is provided in Table 3-13 and Appendix 5. Self- evaluation

[Table 3-5] Indicators for assessment of the YSESP Muan Project

1. Civil Monitoring of the Muan Tidal Flat and Developing Muan Tidal Flat Institute Expertise
1-1. Civil monitoring findings (manuals, reports)
1-2. Monitoring yields for different methods of octopus harvesting
1-3. Number of participants in civil monitoring groups
1-4. Number of civil monitoring workshops held
1-5. Level of Muan Tidal Flat Center development support from Muan Tidal Flat Institute
2. Tidal flat education programmes, teaching tool development, tidal flat education in public school curriculum
2-1. Number of tidal flat education programmes
2-2. Number of teaching tools and books developed for education programmes
2-3. Number of students taking part in education programmes
3. Developing programmes for increased Muan tidal flat ecotourism awareness and 2012 Muan Tidal Flat Festival
3-1. Number of ecotourism programmes held
3-2. Number of ecotourism programme participants
3-3. Number of ecotourism programme sessions
3-4. Profits/losses for the Muan Yellow Sea Tidal Flat Yongsan Village Farming Cooperative
3-5. Number of visitors to 2012 Muan Tidal Flat Festival
4. Discovering and developing Muan tidal flat walking courses
4-1. Percentage developed from 54km proposed in project plan
4-2. Number of direction and information displays erected
5. Developing model for public-private governance
5-1. Number of local governments/specialized institutes involved in cooperative projects
5-2. Increase in budget from cooperative projects
5-3. Increase in budget for Muan County tidal flat conservation

(4) Budget

The amount used for the YSESP Muan Project represents the third-, fourth-, and fifth-Action Period budgets, or ¥31,662,000 (KRW 335,500,000).[9]

[Table 3-6] Budget for the YSESP Muan Project

Action Period		Research Budget (¥)
YSESP 3rd Action Period	1 Jan. 2010–28 Feb. 2011	10,554,000
YSESP 4th Action Period	1 Jan. 2011–28 Feb. 2012	10,554,000
YSESP 5th Action Period	1 Jan. 2012–28 Feb. 2013	10,554,000
Total		31,662,000

9. Based on November 2013 exchange rate.

3.2. RESULTS AND DISCUSSION

3.2.1. MAJOR ACHIEVEMENT

The YSESP Muan Project, South Jeolla Province, focused on three areas of administration: biodiversity, governance and sustainable use. Its achievements have been honoured with a number of awards, including one given by the Minister of Land, Transport and Maritime Affairs at a commemorative event for World Wetlands Day in May 2011. The award recognized the contributions made by residents in the Muan Yellow Sea Tidal Flat Yongsan Village Farming Cooperative toward tidal flat conservation activities and local development. The following year in May 2012, the Muan County Ocean and Marine life Division won a President's Award for its contributions to a resident-centered approach to preserving the Muan tidal flat. During the same month, the Farming Cooperative won an Excellence Award at the second annual Creative Tourism competition, an event organized by the Korea Tourism Organization to promote tourism by soliciting creative project ideas.

The awards for the activities in Muan have helped promote awareness of YSESP's activities, which involve a system co-managed by the local community and government to promote biodiversity and sustainable resource use. In addition, YSESP increased the allocation of budget to the YSESP Muan Project from that of 2012; this promoted the work of several habitat management programmes such as Integrated Coastal Management, Marine Protected Area (MPA), Ecosystem-Based Management (EBM) and community-based management (CBM). The public has taken particular note of civil monitoring, the training of experts in ecological education and the ecotourism activities. Details on the results for the biodiversity, governance and sustainable use management components are presented below.

3.2.2. ACTIVITY 1 (BIODIVERSITY MANAGEMENT)

(1) Results

Expert monitoring is conducted by Ministry of Land, Transport and Marine Affairs on a 10-year cycle. In Muan, the first Wetland Protection Area monitoring took place in 2008. The need for civil monitoring emerged due to the temporal limitations of professional monitoring that make it difficult to predict gradual environmental changes in the region. The civil ecosystem monitoring activities included the training of civil researchers, the staging of workshops and discussions with the various stakeholders regarding who will perform civil monitoring and what research methodologies will be used, actual monitoring practices in the field and other administrative and financial support. The civil research team was formed with the establishment of the Muan Ecological Tidal Flat Center in 2011. Plans have been formulated for determining monitoring methodologies that are feasible in the Muan region and for providing the necessary support. Their success has also generated a spillover effect. Beyond Muan, other regions have begun to consider conducting civil ecosystem monitoring on a regular basis. At the national level, discussion is underway on launching a sustainable, nationwide civil monitoring system (EHI, 2012).

[Table 3-7] Civil monitoring meetings and implementation status

Date	Details
6 Jan. 2010	Preparing a monitoring system for the Muan tidal flat: First expert meeting ("Civil monitoring today and its limitations")
28 April 2010	Preparing a monitoring system for the Muan tidal flat: Second expert meeting ("Benthic fauna monitoring in the Wadden Sea and ideas for future collaboration with YSESP")
29 April 2010	Preparing a monitoring system for the Muan tidal flat: Resident meeting ("An explanation of the monitoring project and request for public support")
10 June 2010	Preparing a monitoring system for the Muan tidal flat: Third expert meeting ("Discussion of civil monitoring in the South Jeolla area for relevant experts and local government officials")
22 Feb. 2011	Attending final 2010 civil monitoring report for Marine Protection Areas: Final reports on civil monitoring efforts currently under way in ROK
August–October 2011	Civil monitoring of benthic fauna in Muan tidal flat
27 Aug. 2011	Civil monitoring education to train Muan tidal flat ecosystem guides
16 Dec. 2011	First tidal flat civil monitoring expert workshop: Discussion of monitoring participants and training programmes to develop civil monitoring
2011	Publication of civil monitoring results regarding Muan tidal flat benthic fauna (Muan County)
28–29 Feb. 2012	Second Muan tidal flat monitoring workshop
18 May 2012	Third Muan tidal flat monitoring workshop: Developing civil monitoring methodology, discussing ideas for improvement, suggesting monitoring efforts for shorebirds
July 2012–April 2013	2012 Muan Tidal Flat civil monitoring: Benthic fauna and birds
20 July 2012	2012 Muan Tidal Flat civil monitoring launch report (Muan County)

Efforts to develop a sustainable civil monitoring system resulted in the publication of the Muan Civil Monitoring Report (Muan County, 2013). An additional list of benthic fauna species in the Muan Tidal Flat was drafted, with 236 types identified in the area as of 2013 — up from 209 in past years. One particularly noteworthy discovery was the presence of *Ellobium chinense*, a rare form of saltmarsh snail designated as a Level II endangered species by the Ministry of Environment. Thirty samples of benthic fauna were prepared for the purposes of exhibition and education (EHI interim report, 2012).

In addition, mud octopus monitoring was conducted in 2011 in close collaboration with local fisher Mr. Lee Won Byeong. His data showed that annual income from the commercial octopus fishing exceeded the total amount of the entrance fee from 22,157 visitors of the Muan Tidal Flat Center that year. This case demonstrates the importance of natural resource monitoring and management, and that civil monitoring is a good and effective tool for local people to objectively understand the status of the natural resources on which they depend.

Tidal Flat Civil Biologist Program

KIOST and the Biodiversity Foundation of Korea have conducted the "Tidal Flat Civil Biologist Program" as part of civil monitoring program. This program aims to invite students and citizens to participate in the biological and ecological investigation of the tidal flats' many inhabitants. Until now, the most common activities that take

place in Korean mudflats simply involve exploring the beauty of the landscape or, at best, offering a species-centered survey of some of the local fauna. As a result, the surrounding communities typically have a limited understanding and appreciation for the tidal flats and the life-forms they harbor. By introducing scientific activities and a simple methodologies for participants to use while they explore and learn about the habitat, the program has strived to develop high-quality content and more in-depth knowledge. Overall, the initiative has been successful in disseminating its resources to a wider audience in order to encourage potential students of marine biology.

In order to attract young people to become civil biologists, the following items either have been developed or are in the process thereof:

① Burrowing Shrimp Digs and Clams Clasp (Interaction between competitors): Recently, the burrowing shrimp population has dramatically increased on the west coast of Korea, a species that seems to do harm to local manila clam cultures. What has caused the burst of burrowing shrimp, and how do they influence manila clams? KIOST and the Biodiversity Foundation of Korea looked at the behavior of burrowing shrimp and did burrowing shrimp exclusion experiments to explore the effect of burrowing shrimp on survival and growth of manila clams.

② Intertidal Animals on a Starry Night (Night activity involving intertidal animals): People don't generally expect intertidal animals to be active on the tidal flats at night, but some animals definitely are. How do these animals recognize the risk of predators at night? Using both sounds and light, KIOST and the Biodiversity Foundation of Korea conducted an experiment that will help illustrate how intertidal animals escape predators after dark.

③ Don't Step on the Tidal Flat Carelessly! (Activity demonstrating the effect of trampling on intertidal animals): So many people visit the tidal flats and walk through them very casually. Though many animals may be out of sight, many are not dead — they simply burrow in the ground very quickly. Do human footsteps influence the behavior and ecology of intertidal animals? KIOST and the Biodiversity Foundation of Korea will do an experiment that compares animal activity between different plots when people walk at different paces.

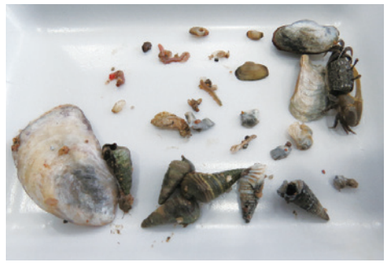
④ Away from the Predator (Predation escaping behavior of crabs): Crabs will recognize any object moving above their eye level as a predator, immediately burrowing to escape attack (Kim, etc., 2007). When people pass by, crabs hide in their burrows too. When people approach, would crabs exposed to more predation risk hide in burrows at a longer distance than crabs exposed to less predation risk? KIOST and the Biodiversity Foundation of Korea conducted an experiment on the predation escaping behavior of crabs.

⑤ Where Have All the Clams Gone? (The effects of human collection on clam population): Many people head out to the intertidal mudflats to catch clams for food. How much collection is possible before it starts to influence the population and the environment? To figure this out, KIOST and the Biodiversity Foundation of Korea will collect clams in the experimental plots and let them go in the control plots. The number and sizes of clams will then be compared after several months.

⑥ Living on Different Levels (Zonation of intertidal animals): Intertidal animals seem to live haphazardly in tidal flats. However, the way that different species live in the habitat according to the different tidal level is a phenomenon called zonation. By looking at the animals on each tidal height and describing the species and characteristics, KIOST and the Biodiversity Foundation of Korea will learn what animals live on each tidal level.

⑦ Come on Babe (Mate recognition of fiddler crabs): Male white-clawed fiddler crabs attract females using their enlarged claw starting in June each year and continue for a few months after (Kim, etc., 2003). In some instances, males misrecognize other objects as females. By making different shaped females using various materials, we will do an experiment to determine which kinds of cues are used to recognize females.

Muan Tidal Flat civil monitoring



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In the near future, KIOST and the Biodiversity Foundation of Korea intend to continue the “Tidal Flat Civil Biologist Program” and expand its scope by strengthening ties with the local fishing community. In addition to the scientific research protocols used in the program’s activities, KIOST and the Biodiversity Foundation of Korea plan to adopt an arts-science crossover approach so that wider, more varied and even aesthetic perspectives can be merged with the scientific point of view. This will allow for a deeper yet more diverse understanding of the invaluable tidal flat ecosystems of the Yellow Sea Ecoregion. The next phase of the program will address the importance of community involvement by fostering interactive platforms with the local community and promoting cultural exchange and dialogue. This will be done with the help of the regional governments’ resources in the fishing sector. Some of the scientific topics covered in the programmes will be based on the real-life issues faced by the fishers whose livelihoods rely on the tidal flat, highlighting the intricate and intimate link between human subsistence and marine ecology.

7.2.3. ACTIVITY 2 (GOVERNANCE MANAGEMENT)

(1) Results

① Developing the capabilities of the Muan Ecological Tidal Flat Center

The governance of management activities includes developing Muan tidal flat education programmes and training teachers to improve the capabilities of the Muan Tidal Flat Center, as well as cooperating domestically and internationally on management of the tidal flat. Preparation for the Muan Ecological Tidal Flat Center began in 2006, and a ceremony to mark its opening in the village of Yuwol in Muan’s Haeje township was held in 2011. The YSESP Muan Project provides support for its foundation, as well as assistance with the systematic preservation and management of the tidal flat and activities. Above all else, the goal is to develop the centre into a venue for information about the marine environment and offer themed activities for locals (Muan Ecological Tidal Flat Center, EHI, 2012).

[Table 3-8] History of the establishment of the Muan Ecological Tidal Flat Center (Muan Ecological Tidal Flat Center, EHI, 2012)

Date	Activity
December 2006	Completion of construction on Muan Tidal Flat Center
April 2008	Beginning of construction on Muan Tidal Flat Ecological Park
May 2009	Exhibition installation completed at Muan Tidal Flat Center
September 2009	Completion of Muan Tidal Flat Ecological Park
January 2011	Council meeting for opening of Muan Tidal Flat Institute within Muan Tidal Flat Center
March 2011	Appointment of institution director requested (Mokpo National University professor Lim Hyun-sik)
April 2011	Support for joint use of research equipment with Mokpo National University Dept. of Oceanography
May 2011	Agreement between Muan County and Mokpo National University on Muan Tidal Flat research and development; development of laboratory signboard and equipment
17 May 2011	Opening ceremony, Muan Ecological Tidal Flat Center
Ongoing	Civil monitoring of the Muan Tidal Flat, education programmes

Tidal Flat Center opening ceremony

Tidal Flat Institute opening ceremony

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② Educational programme development and ecology education specialist training

The centre’s focus on facility viewing and lack of educational programmes led some to suggest there was a need for development of such programmes. Following the staging of the Korea-Wadden Sea Tidal Flat Education Exchange Workshop in 2010, a string of programmes focused on development of Muan tidal flat ecological education programmes, an educational programme demonstration meeting and training for experts in ecological education (EHI, 2012). The result was the development of nine education programmes and a number of publications, including a collection of Muan tidal flat ecological education programme teaching plans, one set of promotional materials for preliminary education, five tidal flat education worksheets and three Muan tidal flat “fauna cards.” The process confirmed the potential to develop resident abilities through tidal flat education and transform the centre into a local base for environmental education (EHI, 2012).

[Table 3-9] Timeline for educational programme development and ecological education specialist training

Date(s)	Activity
18 May 2011	First Muan tidal flat education programme demonstration meeting • Specialized demonstration of eight education programmes for resident children and adolescents (linked to opening ceremony for Muan Tidal Flat Center) • Laying groundwork for potential programme of systematized tidal flat education at Muan Tidal Flat Center
May–August 2011	Publication of Muan tidal flat ecological education programme teaching plans • Guidebook providing general information (goals, direction and programmes for environmental education) and education methods Used as materials for training Muan tidal flat ecological education programme education specialists
October–December 2011	Training for Muan tidal flat ecology education specialists • Education programme for 14 tidal flat ecological guides from Muan and neighboring regions
21 Dec. 2011	Muan tidal flat ecological education programme for children
May–December 2012	Developing promotional materials and workbooks for tidal flat education • Five education worksheets (on tidal flat formation, benthic fauna, shorebirds, salt plants and tidal flat culture) • Five tidal flat "fauna cards" One set of preliminary education promotional materials

Training course for Muan Tidal Flat ecological education specialists

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Muan Tidal Flat educational materials

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③ Korea-Wadden Sea exchange effort

In 2010 there was the first exchange with the Wadden Sea area,[10] which is recognized worldwide as a superior example of tidal flat conservation and education. The first Korea-Wadden Sea Tidal Flat Education Workshop was held in 2010 with the aim of boosting the educational capabilities of the Muan Tidal Flat Center and developing related education programmes. Since then, the European countries have been sharing experience and information regarding tidal flat education programmes and educational training with the ROK on a continued basis. Experts from the two regions engaged in joint monitoring of representatives from the Muan tidal flat in 2011; that same year, the ROK representatives visited the Wadden Sea to observe centre management and education there. This experience provided an advanced instruction opportunity for Tidal Flat Center staff, ecology guides, educators and NGO members in the ROK, helping to usher forward qualitative improvements in the area of tidal flat education (EHI, 2013).

[Table 3-10] Korea-Wadden Sea exchage efforts

Date(s)	Venue(s)	Activity
28 Sept.-2 Oct. 2010	South Jeolla Provincial Office, Muan/Sinan Tidal Flats	Korea-Wadden Sea Tidal Flat Education Exchange Workshop: Training tidal flat education specialists • Sharing tidal flat education programmes/materials from the Wadden Sea region, experience and skills from educator training • Developing abilities of administrators and educators employed by the Tidal Flat Visitor Center
3–13 Oct. 2011	Wadden Sea (Germany, Netherlands)	Korea-Wadden Sea Tidal Flat Education Programme Field Survey • Developing education programmes through visits to superior examples of tidal flat education, studying examples of visitor center management • Sharing experience and skills with Wadden Sea tidal flat education center management • Building three-country cooperative network as part of Korea-Wadden Sea MoU effort
5–7 Nov. 2012	Suncheon	2012 Korea Wadden-Sea Tidal Flat Center Education Workshop • Presentation on Wadden Sea tidal flat ecosystem education programmes and exhibition content development and administration • Presentation on and evaluating ROK tidal flat centre education programmes and exhibition content development • Instructing on Korea-Wadden Sea tidal flat education programme development process, examples • Discussing ideas for Korea-Wadden Sea cooperation on tidal flat education and centre management

10. The Wadden Sea coast is shared by Germany, the Netherlands and Denmark, with tidal flats covering an area of 7,500 km^2, or roughly three times the area in ROK. Many tidal flats were lost due to reclamation efforts over the past 50 years. Ongoing conservation and restoration efforts, jointly administered by the three countries, were launched after the adoption of a joint statement for preservation of the sea's tidal flats in 1982. In 2009, the sea was added to the UNESCO World Heritage List. Today, the region enjoys job creation effects of roughly 37,900 positions a year (equivalent to KRW 10 trillion) from ecotourism stays (*Policy Briefing*, 2011).

Korea-Wadden Sea tidal flat education exchange and cooperation efforts

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④ Other governance activities

The YSESP Muan Project includes a number of other activities aimed at building a governance system. These include supporting administrative planning and policy efforts for the Muan Tidal Flat Wetland Protection Area, examining ideas for future community-based tidal flat conservation area efforts and tie-ins with local income, assisting with evaluations of the effectiveness of Wetland Protection Area administration and developing a Tidal Flat Center Network (EHI, 2013). A competition was held in 2011 to find original ideas for Muan tidal flat souvenirs to share the quality of the local ecosystem, and ideas were developed for producing and selling these items to raise profits at the centre (EHI, 2012).

Poster from Muan Tidal Flat souvenir competition

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3.2.4. ACTIVITY 3 (SUSTAINABLE USE MANAGEMENT)

(1) Results – Discovering ecotourism resources and building infrastructure

① Muan tidal flat food resource identification and resident cooking courses

Activities in the area of sustainable use management have focused mainly on ecotourism. The first step of this process involved identifying tourism and eco-travel resources in the Muan area. In particular, agricultural and marine resources (including onions, sweet potatoes and seafood) that could be used in local cuisine were identified, and education programmes were offered to residents as a way of helping to boost village incomes (EHI, 2011).

[Table 3-11] History of resident education programmes for tidal flat cooking resource identification and cooking classes

Date(s)	Venue	Activity
31 March–2 April, 2010	Jeju Island	Ecotourism and comparison of approaches to “resident-centered village-making”
April–May 2010	Muan Ecological Tidal Flat Center	First education programme for resident identification of ecotourism resources: Tidal flat cooking class (four sessions total)
June–July 2010	Chodang University	Second education programme for resident identification of ecotourism resources: Cooking with white lotus and sweet potatoes
June–July 2010	Muan County Agricultural Technology Center	Second education programme for resident identification of ecotourism resources: Cooking with white lotus and sweet potatoes
May–June 2011	Chodang University	2011 Muan Tidal Flats Cooking Class
May 2011	Chodang University	Publication of Muan Tidal Flat cookbook *Cooking with the Riches of the Tidal Flat* (Eco-Horizon Institute, 2011)

Muan Tidal Flat cooking class

© Eco-Horizon Institute

Muan Tidal Flat Trail

© WWF-Japan

② Discovering Walking Paths in Muan and Examining Possible Linkages to Village Resources

Because of its outstanding local scenery, the ROK Ministry of Culture, Sports and Tourism has designated a 54-kilometer stretch along the coasts of Hamhae and Tando Bays as a "storytelling cultural ecosystem exploration trail." It is now in the process of developing walking paths for the region. The paths were chosen after an examination of regional resources, with the development of GPS data and the manufacture of nine signboards for the "Muan Octopus Trail." A basic plan for Muan walking paths was developed in March 2013, and paths are now being built according to the design.

③ Ecotourism programme development and execution

Ecotourism has the aim of suggesting new ways of increasing resident incomes in order to establish those residents as agents in tidal flat conservation. As part of the attempt to boost ecotourism, a range of resources belonging to the local community and its residents are being identified, and travel programmes that were previously centred on Yongsan Village are being expanded to other communities to build a larger village network. Other methods for commercializing and encouraging Muan tidal flat ecotourism have included linkages with travel agencies and corporate study programmes. A total of 635 people took part in Muan tidal flat ecotourism programmes over the period under examination.

These efforts prompted Muan County to build caravans for a camping ground. Establishing a more fixed ecotourism presence, however, will require multipurpose spaces offering stable and specialized community-centred accommodations, eating establishments and cultural venues. Ideas for support are currently under development with the construction of a "Tidal Flat House" and the formulation of a Yongsan Village development plan.

Muan Ecological Tour

© Eco-Horizon Institute

Tidal Flat House

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④ Muan Tidal Flat Festival

The first Muan Tidal Flat Festival was staged in May 2012. It was called the Maehyang Festival, with the subtitle "a thousand-year pledge to the life of the tidal flats." Over a thousand people participated, including government agency representatives, specialists, academics, local residents, YSESP members and the general public (EHI, 2013). The name "Maehyang" referred to the burial of the tidal flat's fragrant trees, and the festival itself was a way of expressing the hopes of Muan residents and participants for the flat's eternal preservation. Events included sketching of the flat's wildlife, straw crafts and other experiences involving the local ecology, along with a resident singing contest, a tasting of sandeul bibimbap (a rice dish made with octopus from the flat) and a village market food fair. The presence of so many members of the public helped raise awareness of the Muan tidal flat, contributing to the development of the village network. Overall, the event was rated as a successful example of private-public collaboration (EHI, 2013).

2012 Muan Tidal Flat Festival

© Eco-Horizon Institute

⑤ Establishment of the network between Korea and Japan

The Korea-Japan Tidal Flat Ecozone Exchange Workshop had the goal of gathering information and experience and building a tidal flat network between the two countries. This was done by staging field trips to outstanding examples of tidal flat regions in Japan with similar ecological and socioeconomic backgrounds to those of Muan. In 2011, representative Korean stakeholders of the YSESP Muan Project visited tidal flats in Kyushu, an area in southwestern Japan, to learn from examples of sustainable use and conservation works of tidal flats. These included civil monitoring and ecotourism co-managed by local communities and the municipal government. The following year, stakeholders from Japanese cities Kashima and Okinawa paid a visit to Muan, giving them an opportunity to take part in the Muan Festival and participate in the region's tidal flat ecotourism.

Korea-Japan Tidal Flat Ecozone Exchange Workshop

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3.2.5. DISCUSSION

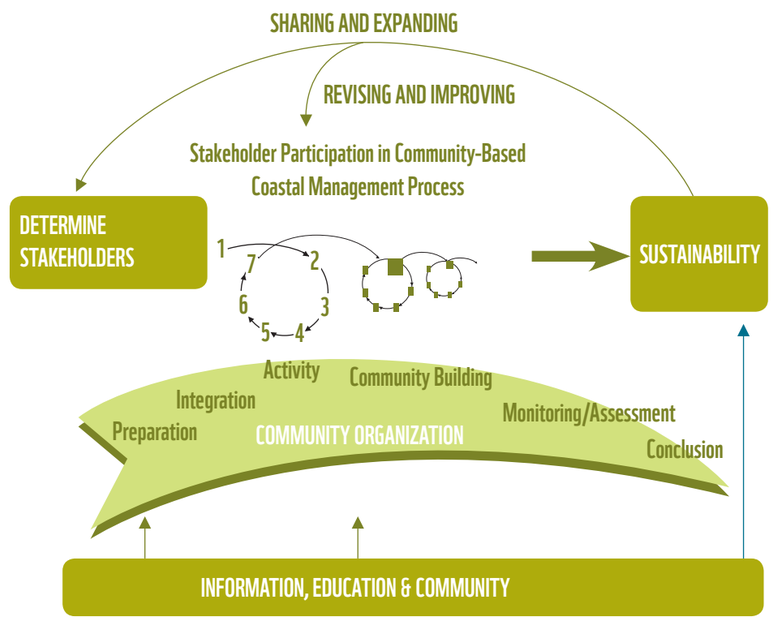
(1) Results (Community-based management modelling)

Community-based management (CBM) is known by a number of different names, including "community-based conservation" and "community-based natural resource management." It has been applied in a variety of areas, including marine resources, farming, forestry, land and water resources. The concept was first formulated by Dr. Elinor Ostrom of Indiana University, who reasoned that public assets such as forests, irrigation systems and marine resources could be depleted by overuse if left to management under market functions, and that this problem could be averted by an approach of collaborative, autonomous management by the community rather than government controls (Ostrom, 1990; Kim Gwang-tae, 2012). The strengths of the CBM approach include a stronger sense of community responsibility and ownership in project implementation and monitoring activities; when compared to the government-controlled approach, they result in greater efficiency and, in some instances, more flexible and adaptive management. Also, the participation of local residents can help in establishing a majority consensus, while also making best use of expert knowledge within the community (DENR et al., 2001).

As noted above, CBM has been applied in many different areas. "Community-based coastal resource management" is a subsidiary of CBM that is better formulated for coastal regions in particular. It has been defined as "a bottom-up approach that involves local resource users and community members in active management and responsibility for coastal resources," a concept that exists "in contrast to centralized planning and authority" (Christie & White, 1997). Because coastal resources are less easily managed than inland ones, the participation of stakeholders in the areas closest to them – that is, the local communities – is crucial. In other words, coastal resources may be said to constitute a public good that demands a CBM approach to conservation more than other resources do.

The process of community-based coastal resource management is outlined in Figure 3-5. For the first stage, the community concept and scope are chosen, a process that involves determining who the local stakeholders are, analyzing their interests and selecting chief participants to form partnerships. The second stage is community organization. Here, steps are taken to build stakeholder awareness of the coastal environment and local resources, and to promote a sense of ownership and responsibility for the region. While these activities are going on, education is also provided, including the communication of information. Information sharing and communication are used to help develop participant abilities, adding to the sustainability of both community and resources. During these activities, it is important to have appropriate internal and external monitoring and assessment of them. Once the activities are complete, the initial plan can be revised and improved, as well as shared and expanded with other regions, plans and activities. Over the course of this process, coastal resources can be preserved and their problems addressed through CBM.

[Figure 3-4] Process and components of community-based coastal resource management (DENR et al., 2011)



Viewed in these terms, the YSESP Muan Project is a prime example of community-based coastal resource management being systematically applied. The concept of community-based management was central in planning the YSESP Muan Project. The designation of the country's first marine Wetland Protection Area, which came soon after the cancelation of the Yeongsan River Reclamation Project, brought mixed reactions from the local coastal communities. While they wanted to maintain the tidal flat rather than reclaim it, they were concerned that the protection area status might impede their economic activities of fishing and mariculture. South Jeolla Province being one of the most underdeveloped regions, they were also concerned that it may preclude their communities from potential opportunities of economic growth.

Participation of local communities is perhaps the single most important element of the tidal flat conservation process, because they are the everyday users as well as managers

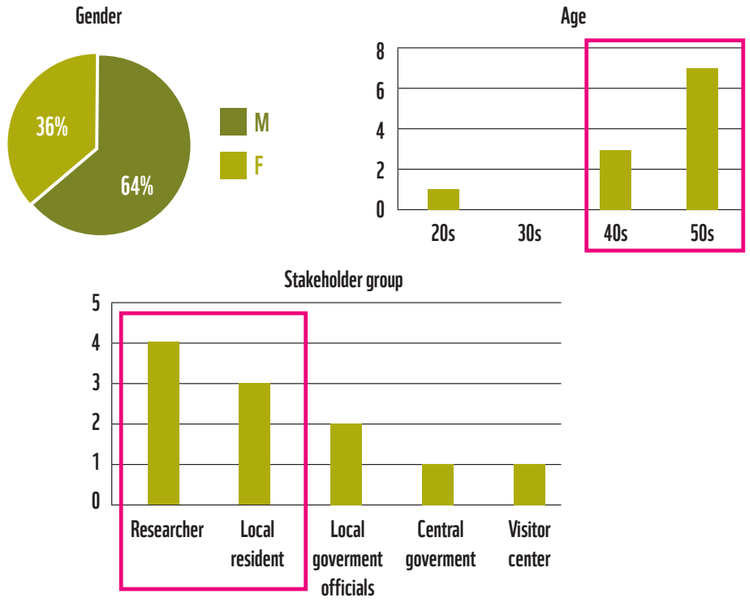
of the tidal flats. Without their presence, tidal flats may be seen as a "land of no use" and would be subject to the forms of development that are destructive to the marine ecosystem. Rather than treating the local villagers as a target of conservation, the YSESP aimed at standing them as autonomous actors of conservation and demonstrating a model in which the communities could economically prosper while sustainably using the tidal flat and its resources.

Education and publicity activities were carried out to promote awareness of the residents of coastal villages, including Yongsan, on the sustainable management of coastal resources. One of the features of "public-private governance" is self-management of coastal resources by local residents and not by government or academics. The formation of the Muan Tidal Flat Yongsan Village Farming Cooperative brought a greater sense of community. Through the sales of seafood and environmentally friendly farm product, as well as the running of ecotourism programs, it contributed to a boost in the local economy. Their success inspired the local government, which began to allocate a greater budget for tidal flat conservation and coastal management activities. It became a successful example of a "bottom-up" approach to CBM in the ROK, laying the groundwork for future efforts to share and build upon coastal CBM at the national level and demonstrating the crucial importance of local participation in coastal and tidal flat conservation and administration policy.

(2) Evaluation by local stakeholders[11]

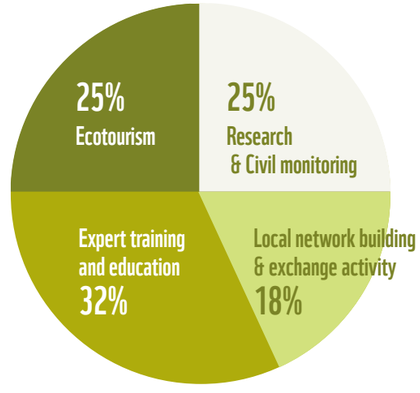
A wide range of stakeholders took part in the YSESP Muan Project, including local residents, the local government, NGOs, the central government and related research institutions. In May 2013, YSESP Muan conducted a survey to rate the awareness and satisfaction of participating stakeholders and learn areas of improvement for future tidal flat conservation efforts in Muan. Surveys were conducted by face-to-face interview and email; most survey participants were in their 40s and 50s and included residents, local and central government officials and local visitor center administrators.

[Figure 3-5] Respondent characteristics (n=11)

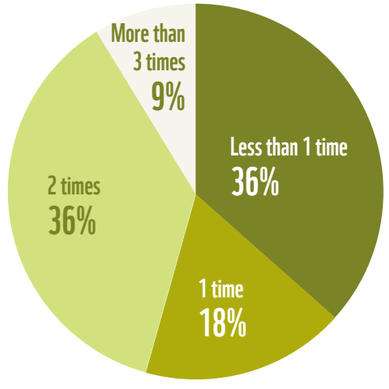


11. Sunyoung Chae et al. 2013. *Asian Journal of Climate Change and Sustainable Development: Law and Politics*. 31–49pp.

[Figure 3-6] Respondent activities (n=11)



[Figure 3-7] Frequency of participation (n=11)



The activities with the highest rates of participation, according to respondents, were the educational programmes, including specialist training sessions. Additional activities included ecotourism, civil monitoring and research and local network organization and exchange efforts. Thirty-six per cent of respondents reported participating in around two events per month, while 9 per cent reported participating in three or more.

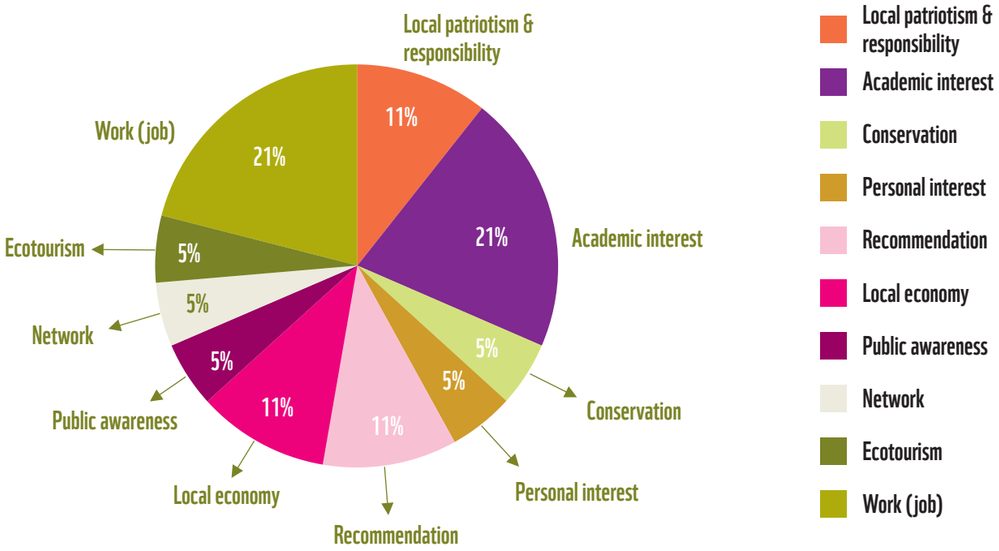
Respondents gave a wide range of reasons for their participation in YSESP Muan. The most frequently cited (21 per cent) were "professional duties" and "academic interest." Other responses such as "local patriotism and responsibility," "boosting the local economy" and "recommended by an acquaintance" were cited by 11 per cent each. Additional reasons included "environmental conservation," "boosting public awareness," "personal interest," "building a network" and "interest in ecotourism."

When asked whether they felt YSESP Muan activities were appropriate, 64 per cent said they "strongly agreed," while 36 per cent said they "agreed."

Participants were also found to be relatively active about participating. Fifty-five per cent of respondents described their participation as "active," while 27 per cent said it was "very active" and 18 per cent rated it as "average." Major factors contributing to active participation included "motivation to help the local economy," "job creation," "local patriotism," "academic interest," "contributions to skills and knowledge" and "importance of tidal flat conservation activities." Among local residents, prioritization of work over tidal flat conservation and a lack of knowledge or interest were factors cited for less active participation. This suggests that the factors directly implicated in whether participation was active or not were purely economic.

When asked about any personal changes that they had experienced from their YSESP Muan Project activities, respondents cited greater awareness of tidal flat conservation activities and resident participation, an understanding of the importance of international cooperation and CBM, the encouragement of resident tidal flat conservation activities and improvements to the local government's administrative system. Respondents also agreed unanimously that YSESP Muan activities had helped develop a sustainable

[Figure 3-8] Reasons for participating (n=11)



network for tidal flat conservation activities in the region, and that the activities could be applied in other regions in the future. Ninety-one per cent affirmed plans to take part in similar activities at a later date.

A final category concerned areas for improvement and requirements for future tidal flat conservation activities. Follow-up projects mentioned included efforts to maintain continuity in tidal flat conservation; development of additional education and promotion programmes; international exchanges with China, Japan, Hong Kong and the Wadden Sea countries; establishment of restaurants and accommodations to promote local ecotourism industry; and development of a forum for dialogue between the local government and various stakeholders.

(3) Self-evaluation

The findings of the stakeholder service suggested that the three-year YSESP Muan Project was generally successful, generating synergy with local community, government and academics and encouraging stakeholder participation through the close linkage of its activities. At the same time, they also indicated that it was still in its beginning stages, with too much of a focus on educational programme participation, and that follow-up efforts were needed to address this. Also, the findings showed that the main reason for the relatively high frequency of participation had to do with the large percentage of respondents whose professional duties were directly connected to YSESP Muan activities. This suggests that future strategies will need to be aimed at encouraging more participation from the general public in the region and elsewhere in ROK. Economic factors were found to be a strong contributor to motivating local residents to participate actively in tidal flat conservation activities, indicating the importance of offering activities capable of generating economic incentives through sustainable

natural resource use. In any case, the universally positive feedback about local network formation, applicability of programmes to other regions and intent to participate in future activities offers proof that YSESP Muan activities in the region have been generally effective.

The indicators were applied to assess the results of the three-year YSESP Muan Project (section 3.1.2 (3) Indicators). Each category was give one of five ratings, as listed below.

[Table 3-12] Possible assessment ratings

Goals were generally met and activities went as planned	Excellent
Some failure to achieve goals	Good
Failure to achieve goals or deviations from initial expectations	Average
Serious failure to achieve goals or carry out activities as planned	Poor
Goal achievement could not be judged because monitoring plan was inadequately developed, monitoring was inappropriate, or monitoring did not place	No rating

As described previously (Table 3-5), indicators were developed by WWF-Japan, KIOST and the EHI before YSESP Muan to assess its performance over the next three years. The findings given below represent the internal assessment of the five areas under examination; assessment of project status in terms of specific criteria is given in Attachment 5.

The YSESP conservation team members from KIOST, WWF-China and WWF-Japan gave slightly lower score on the category of “execution of resident-based civil monitoring of the Muan Tidal Flat and development of Muan Tidal Flat Institute expertise” than other categories, ostensibly because the civil monitoring system is still in its preparatory stages. At the same time, many residents and local NGO representatives were in agreement as of 2013 on the need to develop a nationwide civil monitoring system, and the local government has been involved in ongoing efforts to organize on-site educational programmes in order to develop a sustainable system for the region.

[Table 3-13] Assessment results

Category	Average Rating
1. Civil Monitoring of the Muan Tidal Flat and Developing the Muan Tidal Flat Institute Expertise	Good
2. Tidal flat education programmes, teaching tool development, tidal flat education in public school curriculum	Excellent
3. Developing programmes for increased Muan Tidal Flat ecotourism awareness and the 2012 Muan Tidal Flat Festival	Excellent
4. Discovering and developing Muan Tidal Flat walking courses	Excellent
5. Developing model for public-private governance	Excellent

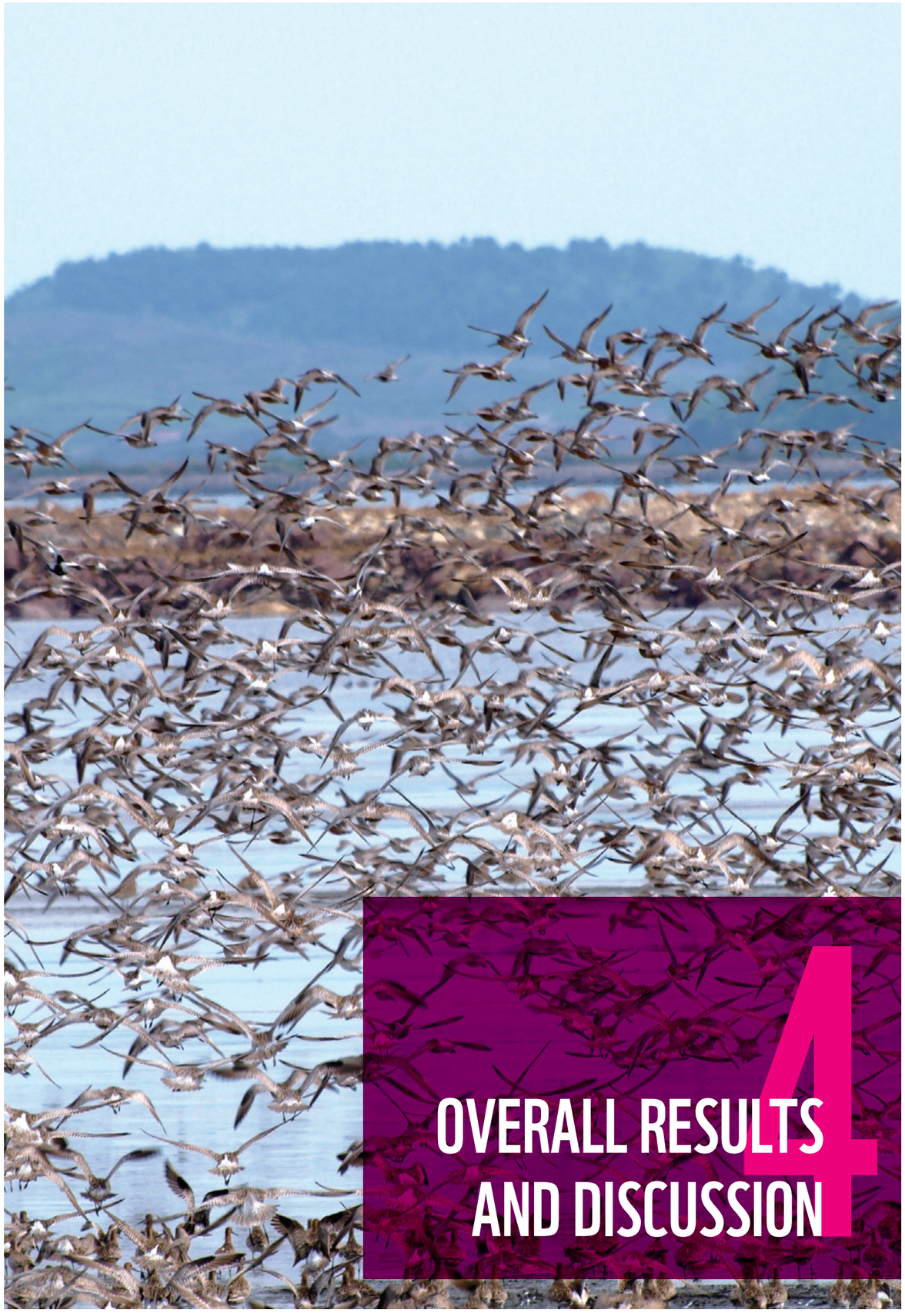
3.2.6. LESSONS LEARNED, RECOMMENDATIONS

The YSESP Muan Project, which involved maintaining biodiverse and ecologically resilient tidal flats in and around Muan by capable local residents, academics and government network, has been rated as a domestic and international success in terms of generating local participation and boosting popular awareness of marine environment conservation over a fairly short period of time. Another notable outcome is the continued and increased support for marine environment conservation from the local government, the entity responsible for financial and administrative duties related to conservation at the local level. An example of this is using the Muan Tidal Flat Festival as an effective tool for public awareness. Primarily organized by the YSESP Muan Project in 2012, the local government supervised and staged the following year's event, and will continue to support it. This can be seen as a sign that activities along YSESP lines have already taken root spontaneously at the local level.

Efforts to date have focused mainly on educating people about tidal flat conservation and promoting popular awareness. Moving forward, a more diverse approach will be needed in Muan, supplementing these activities with efforts to expand the civil monitoring project to the national level and promote ecotourism. Long-term, context-specific plans and strategies at the village county level will also need to be developed for improving and developing the current situation, contributing to the local economy and bequeathing a biologically diverse and ecologically resilient tidal flat to future generations. Muan serves as a good practice model for CBM. The outcomes and lessons of the YSESP Muan Project's approach started to be disseminated to other regions at home and abroad. Building an international network that would connect with countries such as China, Hong Kong and the Wadden Sea countries and ensuring a stable funding stream would be the next step (Chae Sunyoung, 2013; Kim Gwang-tae, 2012).

Muan is a community where opposition by local residents led to the cancelation of reclamation, and development plans and tidal flat ecosystem conservation activities have been firmly rooted in community engagement. Its success was helped by an organic, collaborative network of participating institutions, taking place over seven years of the locally grounded commitment of the Eco-Horizon Institute and local partner institutions, the good governance and leadership of WWF, the efforts of the KIOST and the financial support of Panasonic Corporation. Finally, an enormous contribution came courtesy of the EHI, which worked on the ground to facilitate local participation and helped to bring about a change in perceptions of effectiveness of CBM from the local and central governments and research institutions.

The YSESP Muan Project has been a significant achievement in terms of international cooperation as well, with parties from the ROK, China and Japan working together to conserve the marine environment at the non-governmental, grassroots level. This cooperation is a sign of great levels of environmental conservation awareness in the ROK and abroad, and of a spontaneous development of conservation abilities of individuals. Hopefully, the Muan example can be expanded into marine conservation activities in other regions as well. In the meantime, ongoing efforts are needed to develop our capabilities to preserve the value of the marine ecosystem, leaving it for future generations to enjoy.



4 OVERALL RESULTS AND DISCUSSION

4.1. ACTIVITIES

During the first stage of the project, the YSESP called for proposals regarding public awareness or habitat conservation activities within the PPAs through the small grant scheme. The project had supported 16 groups financially (five groups in China, three in the ROK in 2008; five in China and three in the ROK in 2009) and provided learning opportunities to exchange information and experience (Appendix 2) through an exchange forum. The small grant recipients reached out to a wide range of stakeholders such as students, teachers, public officials, fishers, local residents and tourists. The following activities were conducted to help propel public awareness: photo/calligraphy contests, reserve tours, workshops, lectures, performances of creative folk drama and the creation of teaching materials and pamphlets. In addition, a number of habitat conservation activities were also conducted: the implementation of civil monitoring of endangered species, provision of stakeholder dialogue, development and submission of environmental assessment reports, promotion of sustainable commercial fishing and development of conservation plans in relation to the local community revitalization were conducted. These small grant activities were carried out at 12 of the 23 PPAs.

During the second stage from January 2010 to March 2013, two demonstration sites were selected, one each in China and the ROK, based on the procedure (refer to 4.4 Site Selection) of an EBM or CBM approach. Both the EBM or CBM approaches, which are internationally recognized habitat management strategies, were demonstrated in YRE Coastal Wetland, Liaoning province, China (PPA No. 14) and Muan Tidal Flat Wetland Protected Area, South Jeolla Province, ROK (PPA No. 20). The demonstration site activity had developed an effective, realistic and achievable management plan in close collaboration with relevant stakeholders such as local governments, academic institutes and local communities by considering the characteristics of each site. The YRE Coastal Habitat Ecosystem-Based Management Demonstration Project (the YSESP Yalu River Project) carried out an investigation about ecological linkage among migratory shorebirds, local commercial fishing and benthic animals that included seafood that is economically important to the region. The project aimed to ensure that necessary measures were taken for the conservation and sustainable resource use of the YRE in cooperation with relevant members of the local government (ocean and fisheries, environmental divisions, government affiliated research institutes). The Regional Development-Orientated Coastal Area Management Demonstration Project in Muan (the YSESP Muan Project) aimed to apply a CBM strategy and evaluate its effectiveness for sustainable natural resource use and conservation. In addition, they also planned to prioritize community revitalization that focused on the local seafood industry, with close collaboration between the local government and the community. The community's participation in the management plan was characteristic of the project. Also, during the second stage, the two demonstration site activity stakeholders in China and the ROK had an opportunity to visit Japan to learn about sustainable fishery resource management and a tidal flat conservation combined with community revitalization.

The project members, including the Advisory Group Members and conservation team members as well as the experts and local stakeholders in the demonstration sites, evaluated and summarized the small grant cases during the first stage and the two demonstration site activities during the second stage. Up until the final stage, the project has been sharing the outcomes with local stakeholders in China and the ROK through the exchange forums, the YSLME MPA network and meetings with relevant concerned parties. Likewise, the YSESP has been presenting them in international meetings such as Ramsar Conventions, CBD and the IUCN Asia Parks Congress. At the IUCN WCC in Jeju, ROK, in 2012, the YSESP supported relevant motions about the conservation of the Yellow Sea.

4.2. MAJOR ACHIEVEMENT

In the previous incarnation of the project, the Yellow Sea Ecoregion Planning Project (YSEPP), 23 PPAs were selected in terms of biodiversity as the first step for effective conservation of the transboundary and broad YSE. The YSESP has been attempting to improve management measures in these places based on scientific knowledge by cooperating with regional, national and local stakeholders. In the first stage of the seven-year project, the YSESP provided financial and technical support for local groups that were expected to be at the core of conservation activities within the PPAs. In this period, the project succeeded at not only improving the capacity of each conservation activity, but also offering opportunities to reaffirm the importance of both ecological and social networking. Those executing the project could gather a variety of information about the status of high conservation value areas and key stakeholders within the PPAs. A set of conservation methodology and its effectiveness were also beneficial outputs in this stage. In the continuing second stage, the YSESP was able to promote the best practice management model of EBM and CBM, with the prospect of spreading these strategies to other PPAs. In the demonstration site in China, the project conducted ecological and socio-economic surveys as a means of conserving endangered migratory birds that use the East Asia-Australasian Flyway. The project proposed resource management policies that acted in harmony with local fisheries based on the survey results from relevant authorities. Obviously, the project confirmed that they promote environmental conservation and effective coastal management. In the demonstration site in the ROK, the project developed and carried out various action plans such as environmental education, civil monitoring and ecotourism, which led to realize the importance and potential value of the tidal flats as natural resources. Both the local government and residents began to recognize the importance and effectiveness of community participation for tidal flat resource management, and then proactively started to promote community-driven actions. This project consisted of three different levels of activities – local, national and regional. The project has aimed at enhancing conservation effectiveness by interacting with the progresses and outcomes of the activities of each level. The YSESP has specifically succeeded in providing practical knowledge about the effectiveness, importance and challenges of EBM and CBM approaches in terms of the promotion of sustainable fisheries and the participation of local community as a means of important species and habitat conservation.

4.3. DISCUSSION

4.3.1. RESULTS (EBM/ CBM MODELLING)

An EBM strategy is one that considers the whole ecosystem, including humans and the environment, rather than managing one issue or resource in isolation. Key aspects of EBM include integration of ecological, social and economic goals; consideration of ecological boundaries; accounting for the complexity of natural processes and social systems; adaptive management approach and the engagement of multiple stakeholders (Ecosystem-Based Management Tools Network, 2010).

The Yalu demonstration site activity plan was developed with a consideration for the ecological process of transboundary migration of shorebirds, the structure of intertidal biological communities and human-caused economic changes such as local fishing in the context of the above-mentioned key aspects of EBM. The three-year-long research project contributed to the provision of first-hand scientific information regarding large-scale reclamation and coastal engineering. It also addressed and the usage of drugs at ponds and beach farming, which have resulted in both a serious loss of habitat and the structural damage and changes to tidal communities since 1960s, a shift that has reduced the number of food sources available to migratory shorebirds (Song L. et al., 2011). Based on research findings and results, the YSESP proposed seven policy recommendations to local authorities (OFDLP), such as the promotion of sustainable fishing in consideration of endangered species, the introduction of zoning management and the development of regulation, which were accepted and to be considered.

The coastal area in Asia has higher population density than that of Western countries, and is now experiencing a greater economic growth. This means that the degree of dependence on coastal wetlands as natural resources in Asian countries is getting higher. It is inevitable and important in the YSE that local communities are involved in relevant wetland conservation and management initiatives. There are several tools to evaluate management effectiveness of protected areas (Leverington et al., 2010).

The World Bank/WWF Management Effectiveness Tracking Tool (METT) has adopted the concepts of “Local community” and “Economic benefit” as two of their assessment criteria. High scores are provided if local communities directly participate in all relevant decisions relating to management, as well as if there is a major flow of economic benefits to local communities from activities associated with the protected area. (Stolton et al., 2007). A global analysis of protected area management effectiveness for over 4,092 assessments from 3,038 protected areas showed the weakest aspects were typically “involvement of communities” and “appropriate programme of community benefit” (Leverington et al., 2010).

In 2008, EHI began as a small grant recipient of the YSESP and started to prepare a wetlands festival, Madangnori, where local people expressed their life in wetlands. It was organized as a part of a public awareness programme in order to preserve Muan wetlands. This event encouraged local people to actively get involved in the YSESP by recognizing local customs connected to tidal wetlands and raising awareness of wetland conservation. Festivals based on local people’s livelihoods were used as a cultural public awareness programme with regard to major villages and organizations in Muan. The Muan County municipal office, the local authority, also recognized that participatory programmes and the participation of local people are important for wetland preservation policy. The local people pooled their skills to create a network relating to tidal flat activities, further promoting community cooperation. During the second stage in Muan, local residents with the close collaboration with the Muan County government participated more actively in programmes such as civil monitoring and tidal flat festivals, which led to better conservation and sustainable resource use. The Muan demonstration site activity successfully established the basic framework for co-management mechanisms through a series of programmes, demonstrating the effectiveness of CBM.

4.3.2. LESSONS LEARNED, RECOMMENDATIONS

The EBM and CBM approaches both emphasize the recognition of ecological/social networks and the maintenance of a mutually complementary relationship. The YSESP didn’t choose this strategy to simply appeal to the protection of tidal wetlands as food sources or breeding grounds of vulnerable shorebirds. Through the demonstration site activity at the YRE, China, the LOFSRI scientifically ascertained the ecological and social network of shorebirds, benthic animals and local fishery by regarding the YSE wetland as the basis of the local fishing industry. This point of view helped to involve a wider range of stakeholders in the promotion of sustainable resource use and its objective management. The participation of multiple stakeholders is important and necessary for achieving CBM with limited resources. At the same time, however, communities do not spontaneously cooperate with such projects; the existence of a good coordinator determines a project’s success. A good coordinator is a (substantial) planner of the activity who investigates the interests and strengths of all the key stakeholders, urges participation and develops a strategy. As a coordinator of the Muan demonstration site activity, EHI have played an indispensable role. Regarding the network maintenance in the YRE, it is expected that local authorities will adopt the policy recommendations and help the local community to promote sustainable fishing. In Muan, the development and trial of various environmental education programmes for local students are expected to help impart on to the next generation the experience and know-how of co-management strategies such as civil monitoring and eco-tourism.

All countries along the YSE have adopted the CBD-COP10 Aichi Biodiversity Target 11 in October 2010, which says that, by 2020, at least 10 per cent of coastal and marine areas should be conserved through effective and equitable management, should operate with ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures and should be integrated into the wider seascape. In September 2012, IUCN WCC adopted resolution 28, which encourages governments along the East Asian-Australasian Flyaway (EAAF) to achieve effective management — that is, to develop national and international action plans by 2014 that focus on agreeing on the key sites for endangered birds before 2020 — of at least 10 per cent of the intertidal zone, designating them as sustainably managed protected areas. The YSESP expects the international conservation community to utilize the methodology, achievement and lessons learned from the two YSESP demonstration sites as models of effective management.

References

Agee, J.K. and Johnson, D.R. 1988. *Ecosystem management for parks and wilderness*. University of Washington Press, Seattle, USA.

Arkema, K.K., Abramson, S.C. et al. 2006. Marine ecosystem-based management: from characterization to implementation. *Frontiers in Ecology and the Environment 4*(10), pp 525-532.

Bao, Y.X., Ge, B.M., Xiang, Z. and H.Y. Cheng. 2006. Spatial distribution and seasonal variation of the macrobenthic community on tidal flats of Tianhe, Wenzhou Bay (in Chinese). *Acta Zoologica Sinica 52*(1), pp 45-52.

Barter, M.A. 2002. Shorebirds of the Yellow Sea: Importance, threats and conservation status. *Wetlands International Global Series 9, International Wader Studies 12*, Canberra, Australia, 104pp.

Birds Korea. 2010. *The Birds Korea Blueprint 2010 for the conservation of the avian biodi versity of the South Korean part of the Yellow Sea.*

Boyce, M.S. and Haney, A.W. 1997. *Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources*. Symposium held 3-5 March 1994, at the Univ. of Wisconsin-Stevens Point, Yale University Press.

Brey, T. 1990. Estimating productivity of macrobenthic invertebrates from biomass and mean individual weight. *Archive of fishery and marine research (Meeresforschung)* 32(4), pp 329-343.

Brey, T., Müller, W.C., Zittier, Z. and W. Hagen. 2010. Body composition in aquatic organisms: A global data bank of relationships between mass, elemental composition and energy content. *Journal of Sea Research 64*(3), pp 334-340.

Brussard, P.F., Reed J.M. et al. 1998. Ecosystem management: what is it really? *Landscape and Urban Planning* 40(1), pp 9-20.

Bursey, M. and Wooldridge, T. 2002. Diversity of benthic macrofauna of the flood-tidal delta of the Nahoon Estuary and adjacent beach, South Africa. *African Zoology* 37(2), pp 237-246.

Chae, S.Y. et al. 2013. Analysis of Stakeholders' Evaluation of the Community Based Management Model in Muan Tidal Flats for Biodiversity Conservation in the Yellow Sea Eco-region. *Asian Journal of Climate Change and Sustainable Development: Law, Economics and Politics* 2(1), pp 31-49.

Christensen, N.L., Bartuska, A.M. et al. 1996. The report of the Ecological Society of America committee on the scientific basis for ecosystem management. *Ecological Applications* 6(3), pp 665-691.

Caldwell, L.K. 1970. Ecosystem as a Criterion for Public Land Policy. *Natural Resources Journal* (10), 203pp.

Chen-Tung, A.C. 2009. Chemical and physical fronts in the Bohai, Yellow and East China seas. *Journal of Marine Systems* (78), pp 394-410.

Committee on Ecosystem Management for Sustainable Marine Fisheries, National Research Council. 1999. *Sustaining Marine Fisheries*. National Academy Press, Washington, D.C., USA.

Common Wadden Sea Secretariat. Online. <waddensea-secretariat.org>.
Cortner, H., Shannon, M.A. et al. 1996. *Institutional barriers and incentives for ecosystem management: a problem analysis*. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.
Coral Triangle Support Partnership. 2011. *Principle for Best Practice for Community Based Resource Management in Solomon Islands*, ivpp.
Craighead, F.C. 1979. *Track of the grizzly*. Sierra Club Books, San Francisco, USA.
Crisp, D. J. 1984. Energy flow measurements. In: N.A. Holme and A.D. Mclntyre (eds), *Methods for the Study of Marine Benthos*. Blackwell Scientific Publications, Oxford, UK, pp 284-366.
Dierschke, V., Kube, J. and H. Rippe. 1999. Feeding ecology of dunlins Calidris alpina staging in the southern Baltic Sea, 2. Spatial and temporal variations in the harvestable fraction of their favourite prey Hediste diversicolor. *Journal of Sea Research* 42(1), pp 65-82.
Drent, R. and Piersma, T. 1990. An exploration of the energetics of leap-frog migration in Arctic breeding waders. In: E. Gwinner (ed), *Bird Migration: Physiology and Ecophysiology*. Springer-Verlag, Berlin, Germany, pp 399-412.
Eco-Horizon Institute. 2009. *YSESP Demonstration Project Proposal*.
Eco-Horizon Institute. 2011a. *2010 Technology Performance Report*.
Eco-Horizon Institute. 2011b. *Cooking with the Riches of the Tidal Flat* (in Korean).
Eco-Horizon Institute. 2012a. *2011 Technology Performance Report*.
Eco-Horizon Institute. 2012b. *2012 Technology Performance Report*.
Eco-Horizon Institute. 2012c. *Interim Report*.
Eco-Horizon Institute homepage. Online <ecoin.or.kr>.
Eco-Horizon Institute, Park, M.S., Lee, S.H. and J.Y. Jang. *Muan tidal flat: Where various wetland creatures thrive in unsullied nature*. Muan County Office, 23pp.
Eco-Horizon Institute, WWF, KIOST and Panasonic. 2012. *Promise for the Conservation of Biodiversity in the Yellow Sea*. Yellow Sea Ecoregion Conservation Project, 12pp.
Fisher, B., Turner, R.K. et al. 2009. *Defining and Classifying Ecosystem Services for Decision Making*.
Gao, A.G., Yang, J.Y., Zeng, J.N. and C.S. Wang. 2004. Ecological characteristics of the benthic organisms in the rocky intertidal zone near the pollutant discharge orifice at Kanmen (in Chinese). *Donghai Marine Science* 22(4), pp 24-30.
Global Ocean Associates. 2004. An Atlas of Oceanic Internal Solitary Waves (February 2004). Online. <internalwaveatlas.com/Atlas2_PDF/IWAtlas2_Pg425_Yellow_Sea.pdf>.
Grumbine, R.E. 1994. What is ecosystem management? *Conservation Biology* 8(1), pp 27-38.
Gunderson, L.H., Holling, C.S. et al. 1995. *Barriers and bridges to the renewal of ecosystems and institutions*. Columbia University Press, New York, USA.
Hockings, M., Stolton, S. et al. 2006. *Evaluating Effectiveness: A framework for assessing management effectiveness of protected areas*. 2nd edition. IUCN, Gland, Switzerland and Cambridge, UK, pp xiv, 105.
IUCN. 2012. *The World Conservation Congress, WCC-2012-Res-028-EN Conservation of the East Asian-Australasian Flyway and its threatened waterbirds, with particular reference to theYellow Sea*. Online. <portals.iucn.org/docs/iucnpolicy/2012-resolutions/en/WCC-2012-Res-028-EN%20Conservation%20of%20the%20East%20Asian-Australasian%20Flyway%20and%20its%20threatened%20waterbirds.pdf>.
Jeonnam Research Institute. Online. <jeri.re.kr>.
Jing, K. 2005. *Stopover Ecology of Shorebirds in Chongming Dongtan, Shanghai* (in Chinese). PhD diss. Fudan University, Shanghai, China.
Kang, D.S., Nam, J.H. and S.M. Lee. 2006. Energy Evaluation of a Tidal Flat Ecosystem in the Southwestern Coast of Korea and Its Comparison with Valuations Using Economic Methodologies. *Journal of the Environmental Science* 15(3), pp 243-252.
Kendeigh, S.C. 1951. Nature Sanctuaries in the United States and Canada. *The Living Wilderness* 15(35), pp 1-46.
Kessler, W.B., Salwasser, H. et al. 1992. New perspectives for sustainable natural resources management. *Ecological Applications* 2(3), pp 221-225.
Kim, G., Choi, Y., Jang, J. and W. Kim. 2012. The Yellow Sea Ecoregion Conservation Project: the Present Situation and Its Implications. *Journal of the Korean Society for Marine Environmental Engineering* 15(4), pp 337-348.
Kim, J. M. and Kucera, M. 2000. Benthic foraminifer record of environmental changes in the Yellow Sea (Hwanghae) during the last 15,000 years. *Quaternary Science Reviews* 19, pp 1067-1085.
Kim, T.W. and Choe, J.C. 2003. The effect of food availability on the semilunar courtship rhythm in the fiddler crab *Uca lactea* (de Haan) (Brachyura: Ocypodidae). *Behavioral Ecology and Sociobiology* 54, pp 210-217.
Kim, T.W. , Christy, J.H. and J. C. Choe. 2007. A preference for a sexual signal keeps fe males safe. *PLoS One* 2(5), 422pp.
Korea Institute of Ocean Science and Technology. Online. <eng.kiost.ac/kordi_eng/main>.
Korea Marine Environment Management Corporation. Online. <koem.or.kr>.
Korea Maritime Institute. Online. <www.kmi.re.kr>.
Kostina, E.E., Spirina, I.S. and T.A. Yankina. 1996. Distribution of intertidal macrobenthos in Vostok Bay, Sea of Japan. *Biologiya Morya* (*Vladivostok*) 22(2), pp 81-88.
Lackey, R.T. 1998. Seven pillars of ecosystem management. *Landscape and Urban Plan ning* 40(1), pp 21-30.
Larkin, P.A. 1996. Concepts and issues in marine ecosystem management. *Reviews in Fish Biology and Fisheries* 6(2), pp 139-164.
Leverington, F., Costa, K.L., Pavese, H., Lisle A. and M. Hockings. 2010. A global analysis of protected area management effectiveness. *Environmental Management* 46(5), pp 685-98.
Leisinger, K.M., Schmitt, K.M. et al. 2002. *Six billion and counting: Population and food security in the 21st century*. International Food Policy Research Institute, Washington, D.C., USA, pp 57-76.
Liu, R. 2008. Checklist of Marine Biota of China Seas (in chinese). *Beijing Science Press*, pp 301-870.
Lubchenco, J., Olson, A.M. et al. 1991. The Sustainable Biosphere Initiative: An ecological research agenda. *Ecology* 72(2), pp 371-412.
Ludwig, D., Hilborn, R. et al. 1993. Uncertainty, resource exploitation, and conservation: lessons from history. *Science* 260(5104), 17pp.
Ma, Z.J., Wang, Y. and J.K. Chen. 2005. Physiological ecology of migratory birds during the stopover periods (in Chinese). *Acta Ecologica Sinica* 25(11), pp 3067-3075.
MacKinnon, J., Verkuil, Y.I. and N. Murray. 2012. *IUCN situation analysis on East and Southeast Asian intertidal habitats, with particular reference to the Yellow Sea (including the Bohai Sea)*. Occasional Paper of the IUCN Species Survival Commission, No. 47.

Maltby, E. 1999. *Ecosystem Management: Questions for science and society*. Thomas Reed Publications, Brookline, USA.
McNeil, R. and Cadieux, F. 1972. Fat content and flight-range capabilities of some adult spring and fall migrant North American shorebirds in relation to migration routes on the Atlantic Coast. *Naturaliste Canadien* 99(6), pp 589-606.
Menzel, S., Kappel, C.V. et al. 2013. Linking human activity and ecosystem condition to inform marine ecosystem-based management. *Aquatic Conservation: Marine and Freshwater Ecosystems* 24(4), pp 506-514.
Millennium Ecosystem Assessment. 2005. *Ecosystems and human well-being*. Island Press, Washington, D.C., USA.
Ministry of Environmental Protection. 2008. *China's Fourth National Report on Imple mentation of the Convention on Biological Diversity*. Online. <cbd.int/doc/world/cn/cn-nr-04-en.pdf>
Moores, N. et al. 2001. *Yellow Sea Ecoregion: Reconnaissance Report on Identification of Important Wetland and Marine Areas for Biodiversity Conservation Volume 2: South Korea*. WWF-Japan, Wetlands and Birds Korea and Wetlands International China Programme.
Muan County Office Homepage. Online. <eng.muan.go.kr/home/eng>.
Muan County. 2012. *Muan Statistical Annual.*
Muan County. 2012. *Research for the Development of a Muan Tidal Flat Wetland Protection Area Conservation and Administration Plan*.
Muan County. 2013. *Commissioned Study on Muan Tidal Flat Ecosystem Monitoring*.
Muan Ecological Tidal Flat Center. Online. <getbol.muan.go.kr>.
Newmark, W. D. 1985. Legal and biotic boundaries of western North American national parks: a problem of congruence. *Biological Conservation* 33(3), pp 197-208.
Mokpo National University Institute for Marine & Island Cultures. Online. <islands.mokpo.ac.kr>.
Piersma, T., de Goeij, P. and I. Tulp. 1993. An evaluation of intertidal feeding habitats from a shorebird perspective: Towards relevant comparisons between temperate and tropical mudflats. *Netherlands Journal of Sea Research*, 31(4), pp 503-512.
Pikitch, E., Santora, E.A. et al. 2004. Ecosystem-based fishery management. *Science* 305(5682), pp 346-347.
Pinkas, L., Oliphant, M.S. and I.L.K. Iverson. 1971. Food habits of albacore, bluefin tuna and bonito in California waters. *California Department of Fish and Game Fish Bulletin* 152, pp 1-105.
Policy Briefing. 2011. *Korea and Three Wadden Sea Countries Pursuing Joint Tidal Flat Research and Monitoring*. Online. <korea.kr/policy/economyView.do?newsId=148718834&pWise=www2>.
Qiu, J., Zhao, J.Z., Deng, H.B. and M.J. Deng. 2008. Ecosystem-based marine management: Principles, practices and suggestions (in Chinese). *Marine Environmental Science* 27(1), pp 74-78.
Ren, H., Qiu, J., Peng, S. et al. 2000. Concept of ecosystem management and its essential elements (in Chinese). *Chinese Journal of Applied Ecology* 11(3), pp 455-458.
Robinson, N.A. 1993. *Agenda 21: Earth's action plan*. Oceana Publications, Inc., Dobbs Ferry, USA.
Shelford, V.E. 1933. Ecological Society of America: A nature sanctuary plan unanimously adopted by the Society, December 28, 1932. *Ecology* 14(2), pp 240-245.
Schaub, M. and Jenni, L. 2001. Stopover durations of three warbler species along their autumn migration route. *Oecologia* 128(2), pp 217-227.
Sherman, K. 1994. Sustainability, biomass yields, and health of coastal ecosystems: an ecological perspective. *Marine Ecology Progress Series* 122, pp 277-301.
Slocombe, D.S. 1998. Defining goals and criteria for ecosystem-based management. *Environmental Management* 22(4), pp 483-493.
Smith, R.J. and Moore, F.R. 2003. Arrival fat and reproductive performance in a long-distance passerine migrant. *Oecologia* 134(3), pp 325-331.
Song, L., Yang, G.J., Li, A. and N.B. Wang. 2011. A study on bio-ecology of the stopover site of waders within China's Yalu River Estuary wetlands. *Acta Ecologica Sinica* 31(24), pp 7500-7510.
South Korean Ministry of Oceans and Fisheries. Online. <mof.go.kr>.
Stolton, S. et al. 2007. *Reporting progress in protected areas: a site-level Management Effectiveness Tracking Tool*, 2nd Ed. IUCN: The World Conservation Union.
Szaro, R.C., Sexton, W.T. et al. 1998. The emergence of ecosystem management as a tool for meeting people's needs and sustaining ecosystems. *Landscape and Urban Planning* 40(1), pp 1-7.
The Convention on Biological Diversity. 2010. *Aichi Biodiversity Target* 11. Online. <cbd.int/sp/targets>.
Tian, T., Wei, H., Su, J. and C. Chung. 2005. Simulations of Annual Cycle of Phytoplankton Production and the Utilization of Nitrogen in the Yellow Sea. *Journal of Oceanography* 61, pp 343-357.
UNDP/GEF. 2007 a. *The Yellow Sea: Analysis of Environmental Status and Trends, Volume 2, Part I*. National Reports – China.
UNDP/GEF. 2007 b. *The Yellow Sea: Analysis of Environmental Status and Trends, Volume 2, Part I*. National Reports – Republic of Korea.
UNDP/GEF. 2007 c. *UNDP/GEF Reducing Environmental Stress in the Yellow Sea Large Marine Ecosystem*. Transboundary Diagnostic Analysis.
UNDP/GEF. 2008. *Small Grants Programme 2007: Final Reports*. UNDP/GEF Yellow Sea Project, Ansan, Republic of Korea
UNDP/GEF. 2009. *UNDP/GEF Reducing Environmental Stress in the Yellow Sea Large Marine Ecocystem*. Strategic Action Programme.
UNDP/GEF. 2013. *Reducing Environmental Stress in the Yellow Sea Large Marine Eco system*. Special Meeting of the Project Steering Committee for the UNDP/GEF YSE Project.
Warwick, R.M. and Price, R. 1975. Macrofauna production in an estuarine mud-flat. *Journal of the Marine Biological Association of the United Kingdom* 55, pp 1-18.
Water, T.F. 1977. Secondary production in inland waters. *Advances in Ecological Research* 10, pp 91-164.
Weber, L.M. and Haig, S.M. 1997. Shorebird diet and size selection of nereid polychaetes in South Carolina coastal diked wetlands. *Journal of Field Ornithology* 68(3), pp 358-366.
Wijusma, G., Wolff, W.J. et al. 1999. Species richness and distribution of benthic tidal flat fauna of the Banc d'Arguin, Mauritania. *Oceanologica Acta* 22(2), pp 233-243.
Worster, D. 1994. *Nature's economy: a history of ecological ideas*. Cambridge University Press, Cambridge, UK.

WWF, KORDI and KEI (Yellow Sea Ecoregion Planning Programme). 2008. *Biological As sessment Report of the Yellow Sea Ecoregion: Ecologically important areas for the Yellow Sea Ecoregion's biodiversity*, 240pp.

WWF-Japan. 2007. *WWF International Project/Programme Proposal: Yellow Sea Ecoregion Support Project (2007-2014)*. Unpublished report to WWF International.

Xu, Z., Wang, Y. and Y. Chen. 1995. An Ecological Study on Zooplankton in Mazimum Tur bid Zone of Estuarine Area of Changjiang (Yangtze) River (in Chinese). *Journal of Fishery Sciences of China* 2(1), pp 39-48.

Yaffee, S.L. 1999. Three faces of ecosystem management. *Conservation Biology* 13(4), pp 713-725.

Yellow Sea Ecoregion Planning Programme. 2008. *Biological Assessment Report of the Yellow Sea Ecoregion: Ecologically important areas for the Yellow Sea Ecoregion's biodiversity*, pp 11-232.

Yonhap News. 2012. Park Han-il Appointed First Chairman of KIOST. Online. <news.naver.com/main/read.nhn?mode=LSD&mid=sec&sid1=101&oid=001&aid=0005653189>

YSESP. 2007. *Project Agreement between WWF-Japan and KORDI*.

YSESP. 2012. *A Pledge to Preserve the Yellow Sea's Biodiversity*.

Yuan J., Dong Y., et al. 2001. *Yellow Sea Ecoregion: Reconnaissance Report on Identification of Important Wetland and Marine Areas for Biodiversity Conservation, Volume 1: China*.

Yuan, X. and Lu, J. 2002. Ecological characteristics of macrozoobenthic community of tidal flat wetland in the Changjiang estuary (in Chinese). *Resources and Environment in the Yangtze Basin* 11(5), pp 414-420.

Yuan, X. and Lu, J. 2001. Preliminary Study on Macrobenthic Community of the Creek in the Tidal Flat of the Changjiang Estuary (in Chinese). *Zoological Research* 22(3), pp 211-215.

Yuan, X. and Lu, J. 2002. Influence of Characteristics of Scirpus mariqueter Community on the Benthic Macro-invertebrate in a Salt Marsh of the Changjiang Estuary (in Chinese). *Acta Ecologica Sinica* 22(3), pp 326-333.

Yu, G. 2001. A conceptual framework and the ecological basis for ecosystem management (in Chinese). *Chinese Journal of Applied Ecology* 12(5), pp 787-794.

Zhao, H. and Li, D. 2007. The Current Situation and Protection Measure of Wading Birds Resource in Yalujiang River Wet Land (in Chinese). C*hina Resources Comprehensive Utilization* 25(6), pp 31-33.

Zhu, J., Jing, K., Gan, X.J. and Z.J. Ma. 2007. Food supply in intertidal area for shorebirds during stopover at Chongming Dongtan, China (in Chinese). *Acta Ecologica Sinica* 27(6), pp 2149-2159.

Additional Readings about YSESP

Choi, Y.R., Han, D.U., Zi T.H. and Ji Young Jang. 2009. *Assessment of Management Effectiveness for Korean Ecologically Important Areas of the Yellow Sea*. WWF/KORDI Yellow Sea Ecoregion Support Project, UNDP/GEF Yellow Sea Project. 80pp.

EHI, WWF, KIOST and Panasonic Corporation. 2012. *Promise for the Conservation of Biodiversity in the Yellow Sea*. Yellow Sea Ecoregion Conservation Project. 12pp.

EHI. 2011. *Tidal Flat Cookbook* (in Korean).

Liu, G., Wang N., Wan L. and Y. Bin. 2012. Determination of Fluoroquinolone Residues in Penaeus Japonicus by Microwave-assisted Extraction and Ion-pair High Performance Liquid Chromatography. *Journal of Liquid Chromatography & Related Technologies* 35, pp 1270-1282.

LOFSRI. 2010. *Yalu River Coastal Habitat Ecosystem-based Mangement Demonstration Project 实施方案* (in Chinese). 20pp.

LOFSRI. 2013. *Yalu River Coastal Habitat Ecosystem-based Mangement Demonstration Project Technical Report* (in Chinse). 67pp.

Moores, N. et al. 2001. *Yellow Sea Ecoregion: Reconnaissance Report on Identification of Important Wetland and Marine Areas for Biodiversity Conservation, Volume 2: South Korea*. WWF-Japan, Wetlands and Birds Korea and Wetlands International China Programme.

Muan County. *Educational materials* (in Korean)

WWF. 2012. *Manage the Yellow Sea Coastal Wetland in a Sustainable and Ecosystem Based Way*, 176pp.

WWF, KORDI and KEI. 2006. *Yellow Sea Ecoregion — A Global Treasure*.

Song, G.J., Zhang X., Song L., Wang N.B. and L. Ai. 2013. Aquaculture carrying capacity of Ruditapes philippenarum in shallow sea area of Yalu River Estuary (in Chinese). *Fisheries Science* 32(1), pp 36-40.

Song, L., Wang, N.B., Song, Y.G. and L. Nan. 2013. Characteristics of particle size of structure of plankton community in turbidity zone of nearshore oceanic waters, Liaoning Province of Northeast China (in Chinese). *Chinese Journal of Applied Ecology* 24(4), pp 900-908

Song, L., Wang, N.B., Yang, G.J. and S. Yonggang. 2013. The stress response of biological communities in China's Yalu River Estuary and neighboring waters (in Chinese). *Acta Ecologica Sinica* 33(9), pp 2790-2802.

Song, L., Yang, G.J., Li, A. and N.B. Wang. 2011. A study on bio-ecology of the stopover site of waders within China's Yalu River estuary wetlands (in Chinese). *Acta Ecologica Sinica* 31(24), pp 7500-7510.

Song, L., Yang, G.J., Wang, N.B., Li, Y., Wang, Z.H. and Z. Hai-bo. 2012. Effects of suspended matter on marine Bio-ecology (in Chinese). *Fisheries Science* 31(7), pp 444-448.

Wang, K., Liu, G.Y., Wang, N.B. and Z. Yufeng. 2011. *Well Simulated Distribution Situation of Sea Area in Qingduizi Bay Nutrients*. IEEE.

WWF-Japan and KORDI. 2010. *The Yellow Sea* (in Korean).

Yellow Sea Ecoregion Planning Programme. 2008. *Biological Assessment Report of the Yellow Sea Ecoregion: Ecologically important areas for the Yellow Sea Ecoregion's biodiversity*.

Yuan, J., Dong, Y. et al. 2001. *Yellow Sea Ecoregion: Reconnaissance Report on Identification of Important Wetland and Marine Areas for Biodiversity Conservation, Volume 1: China*.

List of Abbreviations

AGM Advisory Group Member/Meeting
BMP Best Management Practice
CBD Convention on Biological Diversity
CBM Community-Based Management
CPO (WWF) China Programme Office
CTM Conservation Team Member/Meeting
CWYRE Coastal Wetland at Yalu River Estuary
EAAF East Asian-Australasian Flyway
EBM Ecosystem-Based Management
EHI Eco-Horizon Institute
EPBDC Environmental Protection Bureau of Dandong City
EPDLP Environmental Protection Department of Liaoning Province
GEF Global Environment Facility
ICM Integrated Coastal Management
ITFR Institute of Tidal Flat Research, Mokpo National University
IUCN International Union for Conservation of Nature
JERI Jeonnam Research Institute
KEI Korea Environmental Institute
KMI Korea Maritime Institute
KIOST Korea Institute of Ocean Science and Technology
KORDI Korean Ocean Research and Development Institute
LOFSRI Liaoning Ocean and Fisheries Science Research Institute
METT Management Effectiveness Tracking Tool
MoU Memorandum of Understanding
MPA Marine Protected Area
MSC Marine Stewardship Council
NYREWRA National Yalu River Estuary Wetland Reserve Administration
OFBDC Ocean & Fishery Bureau of Dandong City
OFDLP Ocean & Fishery Department of Liaoning Province of China
PMO Project Management Office
PPA Potential Priority Area
ROK Republic of Korea
SAP Strategic Action Programme
SOA State Oceanic Administration
TDA Transboundary Diagnostic Analysis
UNDP United Nations Development Programme
WCC World Conservation Congress
WI Wetlands International
WWF World Wide Fund for nature
YRE Yalu River Estuary
YSE Yellow Sea Ecoregion
YSEPP Yellow Sea Ecoregion Planning Programme
YSESP Yellow Sea Ecoregion Support Project
YSLME Yellow Sea Large Marine Ecosystem

Appendix

Appendix 1 Yellow Sea Ecoregion and 23 potential priority areas

Number	PPA
1	Zhoushan Islands
2	Yangtze River Estuary Wetland
3	Southern Jiangsu Coast
4	Northern Jiangsu Coast
5	Haizhou Bay
6	Qingshi
7	Yanwei
8	Yellow River/ Laizhou Bay
9	Bo Hai
10	Qinhuangdao
11	Liaohe River Estuary
12	Haiyangdao/ Changxing
13	Changshandao
14	Yalu River Estuary
15	Baengnyeong Island/Yeonpyeong Island
16	Gyeonggi Bay
17	Cheonsu Bay
18	Geum/Mangyeong/ Dongjin River Estuary
19	Heuksan Island
20	Yeongsan River Estuary
21	Boseong/Yeoja Bay
22	Jeju Island
23	Yellow Sea Cold Water Mass

Appendix 2 Results Chain (Original in 2007)

Project Name: Yellow Sea Ecoregion Support Project
Start-End dates: July 2007 - September 2014
Scope: To improve effective management of habitat for conservation of biodiversity in 23 Potential Priority Areas (PPAs) of the Yellow Sea Ecoregion (YSE)
Project Budget : JPY 170,566,000

Activities	Outputs (short-term results)	Direct Beneficiaries	Indicators	Outcome/Objective (medium-term results)	Direct Beneficiaries	Indicators	Impacts/Goals on Conservation/Biodiversity Targets (long-term results)	Indirect Beneficiaries	Indicators	Vision
Activity 1: Small grant (Stage 1) - To support roughly 16 groups in China and Korea to conduct public awareness activities for biodiversity conservation of Potential Priority Areas (PPAs) through small grants (SG) and exchange forums	- Skills of public awareness activities improved through sharing and learning with other SG recipients - Improved awareness by local stakeholders	Grant recipients from local environmental groups, local government agencies, local MPA managers, universities and research institutes	- No. of recipients and completed activities, participated in forums - Quality of activity results by recipients - Examples of learning from other recipients	- SG recipients continue to use improved skills for public awareness - Users and managers of habitats and species of PPAs enhanced	Local stakeholders living in the target area of public awareness activities, participants in exchange forum, including recipients	- Level of awareness by the local stakeholders in the targeted areas - No. of stakeholders and groups reached by the public awareness activities	(Collective Impacts of all Activities) -Increased capacity to manage habitat effectively through zoning, MPAs and other identified options; - Established policies on promoting and financing habitat management;	Local communities living in the PPAs	Level of awareness about the importance of threats to, and need for conservation of habitats and species of Potential Priority Areas in YSE	Local communities to national governments around the Yellow Sea Ecoregion will continue to enjoy economic benefits and other ecosystem services by learning together how to stop further loss of biodiversity and to manage habitat effectively
Activity 2: Habitat management demonstration sites (Stage 2) - To support 2 demonstration sites in China and Korea to improve management effectiveness of integrated coastal management (ICM) zoning with PPAs	- Increased understanding of the need for incorporating PPAs into zoning system - Developed/improved zoning scheme including plans for new MPAs - Identified practical and effective options for habitat management, such as marine polyculture	Demo site local government agencies	- (qualitative) - (quantitative) - (other)	- Improved zoning scheme implemented, or a plan to implement improved zoning scheme adopted - Two visionary local leaders of the demo sites committed to implementation of improved zoning	Demo site local government agencies,	- (qualitative) - (quantitative) - (other)	(continued from above) - Reduced threats to habitats and species of PPAs (people centred impacts) - Increasing number of local city leaders with good understanding of biodiversity importance of PPAs and commitment to habitat management;	Demo site local government agencies,	No. and extent of ICM zoning plans that integrated the PPAs in the YSE	
AND/OR Activity 2 (Stage 2) - To support 2 demonstration sites in China and Korea to improve management effectiveness of existing MPAs within PPAs	- Increased understanding of the need for effective management of MPAs - Tested and locally adopted MPA management tools (scorecard/guidebook) - Developed/improved MPA management plans	Demo site local MPA managers	- (qualitative) - (quantitative) - (other)	- Improved management effectiveness of demo site MPAs	Demo site local MPA managers	- MPA management plan implemented - Score of MPA management effectiveness improved		Demo site local government agencies,	No. and representativeness of effectively managed MPAs in the PPAs of YSE	
Activity 3: Magnification of models and examples (Stage 3) - To document and disseminate effective habitat management models and public awareness examples of biodiversity management of PPAs through publication and an international forum	- A demonstrated learning centre of practitioners of marine and coastal habitat management and public awareness; - (Commitment to policies/ mechanism to sustain this learning centre)	National government agencies responsible for ICM zoning and MPA management, local government responsible for ICM zoning and MPA management	- No. and affiliation of participants in the International Forum - Level of interest shown by participants to use models and examples - Likelihood of commitment to learning centre	- Commitment to policies/mechanism to sustain this learning centre	National government agencies responsible for ICM zoning and MPA management	- Interest of relevant government agency (qualitative) - (quantitative) - (other)	(continued from above) - A sustained ecoregional learning centre of habitat management; - An operational network of practioners of habitat management and public awareness.	Local communities and users of biodiversity living in the PPAs	- No. of relevant local government offices to use a learning centre; - No. of local leaders/ practioners to use a learning centre; - Instances of knowledge learnt applied locally	
Note on activities: linked to objectives, focused, feasible and appropriate	Note: Completed activities are not short-term results or outputs. Outputs are the actual effects of completed activities.			Note on objectives: Outcome-orientated, measurable, time-limited, specific and practical			Note on goal: Desired impacts of a project, desired future status of a target, target-linked, impact-oriented, measurable, time-limited, specific, include benefits for people and nature			Note on vision: Desired state that the project will work to achieve together with other stakeholders, relatively general, visionary and brief

Appendix 3 Assumptions (Original in 2007)

Activities	Outputs	Outcome (Objective)	Assumptions and Risks	Evidence and Mitigation Strategies
Activity 1: Small grant (Stage 1) Support roughly 16 groups in China and Korea to conduct public awareness activities for conservation of Potential Priority Areas through small grant scheme and technical support	Sixteen unique examples of bottom-up approaches to public awareness that address importance of, threats to and need for conservation of habitats and species of PPAs in YSE (China and Korea) by 2010	Sixteen leaders, initiators, groups and teams connected via face-to-face meetings, networks and communities to communicate, publish and to create learning communities from others' and their own experiences, sharing knowledge and lessons learned	Enough number of groups (at least 30 groups) will apply for the small grant scheme, applications will have suitable public awareness activities, most of small grant recipients achieve planned outputs, all grant recipients will participate in the Exchange Forum and be willing to learn from each other	List of target audiences. Ensure effective advertising for small grants, define eligible activities clearly. Design application format with all essential information (e.g., stakeholders, past achieve ments) Regularly monitor progress. Visit grant recipient in action.
Activity 2: Demonstration sites (Stage 2) Support 2 demonstration sites in China and Korea to manage effective coastal zoning within PPAs	Two concrete examples of multi-stakeholder, multi-biodiversity targets and effective habitat management for PPAs in YSE (China and Korea) by 2013	Two visionary local and regional leaders with an authorized plan and a commitment to implement habitat management for within their local government's jurisdiction	Ecologically viable habitats will be selected as demonstration sites. Local senior MPA officials approve and actively support MPA management effectiveness improvement activities.	Construct "Scoping Studies of demonstration sites" according to an agreed procedure Conduct rapid assessment of demo site habitats' viab ility Conduct common ground analysis with MPA managers Use personal network to influence senior MPA officials
AND/OR Activity 2 (Stage 2) Support 2 demonstration sites in China and Korea to improve management effectiveness of existing MPAs within PPAs	Two concrete examples of improving MPA management effectiveness demonstrated in YSE (China and Korea) by 2013		Ecologically viable areas will be selected as demonstration sites. "Zoning (ICZM)" is deemed both a practical and acceptable solution to national and local government. Local senior government officials approve and actively support demo site zoning activities.	In China, SOA has legal instruments to promote zoning (Marine Functional Zoning) and has been implementing it actively. In Korea, (to be verified).
Activity 3: Magnification (Stage 3) Document and disseminate concrete habitat management models for PPAs to the stakeholders of biodiversity management of PPAs	Well-documented case studies of demonstration sites published and widely disseminated to relevant stakeholders	Magnification objective	YSLME project will publish the Strategic Action Plan (SAP) that promotes habitat management improvement and uses the PPAs as guidance, as well as the demonstration sites' approach. Chinese and Korean governments will approve the SAP and actively start implementing it.	Ensure the SAP promotes habitat management

Appendix 4 List of the YSESP Small Grants Recipients

KOREA

Active Year	Name of Organization	Area	Project Focus
2008	Green Korea	Baekryeong Township, Ongjin County, Incheon	The Friends of Spotted Seals: Youth Monitoring of Spotted Seals in Baekryeong Island
	Jeju Wildlife Research Center	Seogwipo City, Jeju Province	Publication of Jeju Migratory Bird Guidebook and Demonstrative Local Education
	Eco-Horizon Institute	Muan County, South Jeolla Province	Establishing sustainable development plan of Yongsan Village in Muan Tidal Flat Wetland Protection Area Local Community's Folk Festival for Tidal Flat Conservation in Muan
2009	PGA Wetland Ecology Institute	Goyang City, Gyeonggi Province	Sustainable fishery in Han River Estuary with a local community
	Korean Network for Coastal Conservation	Ansan City, Gyeonggi Province	Sihwa Lake — Daebu Island regional integration programme for production culture and tidal flat ecosystems

CHINA

Active Year	Name of Organization	Area	Project Focus
2008	China Ocean Newspaper; Oceanic and Fishery Department of Nantong City; Nantong M unicipal League; Fisheries Society of Nantong City; The Marine Environment Monitoring Center of Nantong City; Dongzaogang Primary School, Haimen City	Nantong City, Jiangsu	China's Yellow Sea, World's Yellow Sea — China's Action Plan on YSE
	Shandong Law Society-Environmental Resource Law Research Society	Qingdao City, Shandong	Coastal City & Colourful Home–Improving Public Awareness on Biodiversity and Coastal Habitats Protection in the Yellow Sea Ecoregion
	Shandong University Weihai Campus, Ocean academy	Weihai City, Shandong	The conservation and public awareness on marine biodiversity in Yantai and Weihai Eco-region of the Yellow Sea of China
	State Oceanic Administration, First Oceanic Research Center	Dongying City, Shandong	Maintaining and conserving the biodiversity, building harmonious ecosystem together
	Qinhuangdao Entrepreneurs Association-Urban Environment Development Research department	Qinhuangdao City, Hebei	Birds, beach, natural harbor
2009	Shanghai Wild Bird Society	Shanghai City	Education on conservation of biodiversity in the eastern shore area of Nanhui District
	Huaihai Institute of Technology and Undergraduate Environment Protection Association of Huaihai Institute of Technology	Lianyungang City, Jiangsu	Harmonious biosphere, magnetic Haizhou Bay
	Institute of Oceanology, Chinese Academy of Sciences	Rizhao City, Shandong	Promotion of protection on island biological resources and biodiversity
	Environmental Protection Agency of Cangzhou, Hebei Province	Cangzhou City, Hebei	Wetlands, waterbirds, environmental protection volunteers — wetland protection publicity and education activities in Cangzhou
	Ecological Research Center in Technology University of Shenyang and Dandong Municipal Forestry Bureau	Zhuanghe City (in Dalian City), Liaoning	The further survey and environmental education of a breeding population of Black-faced Spoonbill in China

Appendix 5 CTM Evaluation Indicators for the YSESP Muan Project

1. Conduct community-based Muan tidal flat civil monitoring and reinforce the professionalism of the Muan Tidal Flat Research Institute

Indicator:

1-1. The product of a civil monitoring initiative such as a manual, report, etc.

- Publication of the report of civil monitoring conducted at Muan tidal flat (jointly with Muan County)
- Renewal of the inventory of benthos species (total No. of species: 209→229)
- Discovery of a rare species: *Ellobium chinense*
- Create a fine specimen of 30 species for education and display

1-2. The result of monitoring octopus catches by various fishing methods

- The work conditions during 2012 were poor and octopus fishing was almost nonexistent in the Yongsan village.

1-3. The number of participants in a civil monitoring group (195 people)

- Research field: benthos species and birds
- Research period: 2011-2012 (two years)
- Civil monitoring group: 5-8 people each, approx. 10 times per year (based on 2012)

  Average of 6.5 people x 10 times x over 3 years (Jan. 2010-March 2013) = 195 people

1-4. The number of times being held on a civil monitoring workshop: 6 times

2010

- Jeonnam Tidal Flat Forum held
  - Cooperation plans for wetland protected area in South Jeolla Province tidal flat
- Muan tidal flat civil monitoring social meeting
  - Collect opinions from the local residents about the past and present of the Muan tidal flat

2011

- Muan tidal flat civil monitoring educational workshop
- The first tidal flat civil monitoring workshop held (16 Dec., Seoul Catholic Youth Hall)

2012

- The second tidal flat civil monitoring workshop held (28-29 Feb., Seoul Women's Plaza)
- The third tidal flat civil monitoring workshop held (18 May, Sinan County, South Jeolla Province)

1-5. The level of support for activating the Muan Tidal Flat Center by the Muan Tidal Flat Research Institute

Muan Tidal Flat Research Institute opening ceremony (17 May 2011)

- Muan County and Mokpo National University's agreement for Muan tidal flat research development business
- Muan County appointed Prof. Hynsik Lee of Mokpo National University as administrator of Muan Tidal Flat Research Institute

Implementation of Muan tidal flat civil monitoring from 2011 to 2012

- Muan tidal flat civil monitoring group organized (composed of local residents)
- Muan tidal flat civil monitoring education
- The 2011 implementation of Muan tidal flat civil monitoring for macrobenthos.
- The 2012 implementation of Muan tidal flat civil monitoring for macrobenthos and birds.

Purpose of the research institution's activities

- Establishing sustainable implementation of the tidal flat monitoring
- Establishing displays and the youth educational programmes in the Muan Tidal Flat Center
- Providing motivation for local residents to participate and increase consciousness for preservation
- Collecting scientific data for establishing new policies

2. Develop tidal flat education programme and education tools and apply plan for tidal flat education in school curricululm

Indicator:

2-1. The number of tidal flat education programmes: 9

Category	Name of programme	Content and activity
Explanatory programmes	Explanatory programmes for displays	Muan Tidal Flat Center viewing and exposition
Education programmes	Formation and evolution of the tidal flat • The tidal flat science lab	Looking for scientific principles from the tidal flat
	Tidal flat benthos species • Looking for hidden tidal flat species and their habitat	Looking for hidden tidal flat species
	Waterbirds and the tidal flat • Hi birdies! Who are you?	Observing snipes and shorebird games using cards
	Tidal flat plant investigation • The story of plants	Understanding plants living in the Muan tidal flat
	Tidal flats and culture • The tidal life	Understanding the culture of fishing villages and various fishing methods
	Tidal flats and manners	Manners in tidal flats
	Learning tidal flats through games • Let's play!	Creative activities through the tidal flat
	Tidal flats and games	Understanding the tidal flats easily through different games

The above educational programmes have been developed, but educational programmes followed by the five work sheets are in operation at the moment, mostly on the fields of benthos. It is quite challenging to implement different educational programmes due to the limited abilities of local teachers.

2-2. The number of education tools and books prepared for the education programme: 10

- Muan tidal flat ecological education programme book (2011)
- Preliminary education promotional materials 1EA (2012)
  - Hey, let's go to the Muan tidal flat!
- Tidal flat educational worksheets 5EA (2012)
  - The formation and evolution of the tidal flat, its benthos species, its birds, plants nearby the tidal flat, the fishing industry and its culture
- Muan tidal flat cards 3EA (2012)
  - Benthos species, salt plants, birds

2-3. The number of school and student participating in the education programme

2011

	Total	Kindergarten	Elementary school	Middle and high school	University
No. of schools	118	38	55	17	8
No. of students	8,796	2,686	4,587	1,243	280

2012

	Total	Kindergarten	Elementary school	Middle and high school	University
No. of schools	86	24	43	8	11
No. of students	5,920	1,623	3,051	649	597

* Due to the participation request from South Jeolla Province for Yeosu Expo, the number decreased.

2013

All elementary schools within the Muan government's educational service visit the Muan Tidal Flat Center between May and August of 2013 for field trips and education programme purposes.

3. Development and stabilization of public awareness programmes for Muan tidal flat ecotours and the 2012 Muan Tidal Flat Festival

Indicator:

3-1. The total number of times the ecotour has been run: 13 times

3-2. The total number of participants on the ecotour: 635 people

3-3. The number of operational programmes on ecotour: more than 11

Year	Category	Content
2010	No. of tours	2
	No. of participants	65 (Approx.)
	Progression of Ecotour	• The first Muan tidal flat ecotour (20-21 Dec.) • The Eco tour to learn coexistence of tidal flats and human beings (27-28 Dec.)
	Cooperating Organizations	MLTM, KOEM, South Jeolla Province, Muan County
2011	No. of tours	3
	No. of participants	210 (Approx.)
	Progression of Ecotour	• A joyful cooking experience in the clean waters of Muan tidal flat and southern parts of Korea (21-22 May) • Muan "octopus-road" ecotour with the chance to experience southern parts of Korea's culture through walking (19-20 Nov.) • Muan tidal flat ecotour with blue-textile (25-26 Nov.)
	Cooperating Organizations	MLTM, KOEM, South Jeolla Province, Muan County and relevant private sectors
2012	No. of tours	8
	No. of participants	360 (Approx.)
	Progression of Ecotours	• MAC (Marine Art Culture) camp of tidal flat culture experience for teenagers(28-29 April) • The sixth Muan "Octopus-road" ecotour (19-20 May) • Muan tidal flat ecotour with university students and "power bloggers" (17 July) • Experiencing the "carbon zero school" by walking around the Muan tidal flat (23-25 July) • Training in Chinese 芯世界 Project (7 Aug.) • Muan tidal flat ecotour with Panasonic Korea (26-27 Oct.) • Walking through the Muan tidal flat trail with teenagers (2 Dec.) • The 2012 Muan tidal flat of 3,000 years, walking through the Muan Tidal Flat Trail (8 Dec.)
2012	Cooperating Organizations	MLTM, KOEM, South Jeolla Province, Muan County and relevant private sectors
Main programmes		• The tidal flat learning experience with the "Octopus Master" • Walking through the "Octopus road" • Traditional village experience • Visiting the Muan Tidal Flat Center • Special seminars with tidal flat experts • Tidal flat stage performances • Tidal flat "Nanta" shows • Tidal flat cooking classes • Tidal flat dinners • Agro-fishery product exchange programme • Tidal flat ecological education programmes, etc.

3-4. The income variation in Muan Tidal Flat Yongsan Village Farming Cooperative

Turnover status of Yongsan Village Farming Cooperative (KRW)

	2009	2010	2011	2012
Turnover	24,700,000	191,150,000	243,530,000	Sales: 201,870,000 Profits: 30,000,000

3-5. The number of visitors to 2012 Muan Tidal Flat Festival:

about 1,000 people

3-6. The level of local community participation:

The Muan Tidal Flat Yongsan Village Farming Cooperative was formed and began contributing to a boost in the local economy through ecotourism programmes and the sales of seafood and environmentally friendly farm products.

4. Excavation and expansion of Muan Tidal Flat Trail

Indicator:

4-1. The ratio of creation sector in the whole trail, 54km, proposed at the project

- The proposed sector of the Muan Tidal Flat Trail: 54km section near Hamhae Bay and the Tando Bay coast
- Establishment plans for the Muan pedestrian roads were passed in March 2013 and enforcement plans are currently being designed. Fundamental preparation plans will soon follow as a result.

  - EHI designs the road and resource survey

4-2. The number of direction and information board installations (9)

- Production of Muan's "Octopus road" direction and information boards (9EA)

5. Building of public-private governance model

Indicator:

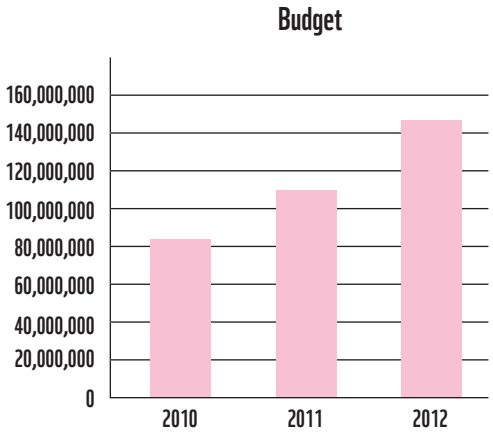
5-1. The number of local governments and professional organizations related to cooperation projects: more than 22

- Government-related: Ministry of Ocean and Fisheries (MLTM); Ministry of Culture, Sports and Tourism; Ministry of Environment; South Jeolla Province; Muan County; KOEM; Korea Tourism Organization, etc.
- Other institutes: KIOST, JERI, Tidal Flat Research Institute at Mokpo National University, KMI, Tidal Flat Center in Shinan, Tidal Flat Center in Ganghwa, Suncheon Bay Ecological Park, etc.
- Institutes related to local residents: Yongsan Village Farming Cooperative, Palbangmiin (八方美人) Village, Songgye Fishery Experience Village, Ganpul Village, Yakcho Village, Worlsunri Artist Village, Tando, Muan Cultural Center

5-2. B udget increase through cooperation projects

	2010	2011	2012
Budget (KRW)	83,200,000	109,200,000	146,100,000

* Excluding YSESP budget



5-3. The budget increase in activities of tidal flat conservation at Muan County

	2011	2012	2013
Budget (KRW)	1,152,000,000	1,416,000,000	2,214,000,000

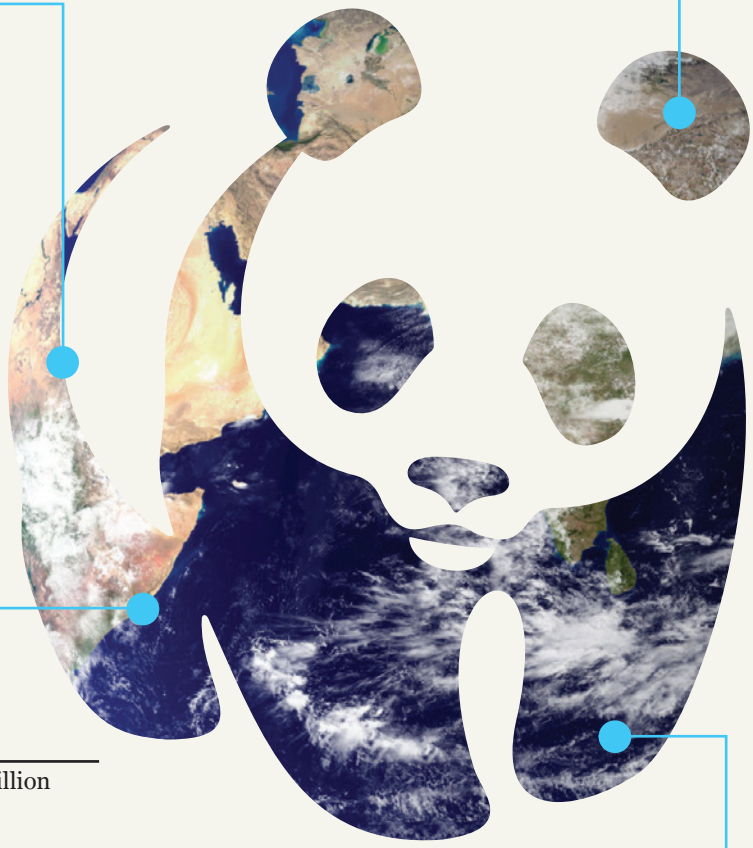
WWF in numbers

1961

WWF was founded in 1961

+100

WWFis in over 100 countries
on 6 continents



+5M

WWF has over 5 million
supporters

+5000

WWF has over 5,000 staff
worldwide

This project was certified as being endorsed by the Japan Committee for United Nations Decade on Biodiversity (UNDB-J)

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To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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