3RD YSLME SCIENCE CONFERENCE
15-19 JULY 2019
QINGDAO, PR CHINA

Improving the effectiveness and impacts of coastal restoration projects

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Qingdao, 2019

CONTENTS

01 **Background**

02 **General process of Restoration project**

03 **Wetland restoration**

03 **Future challenges**

Background

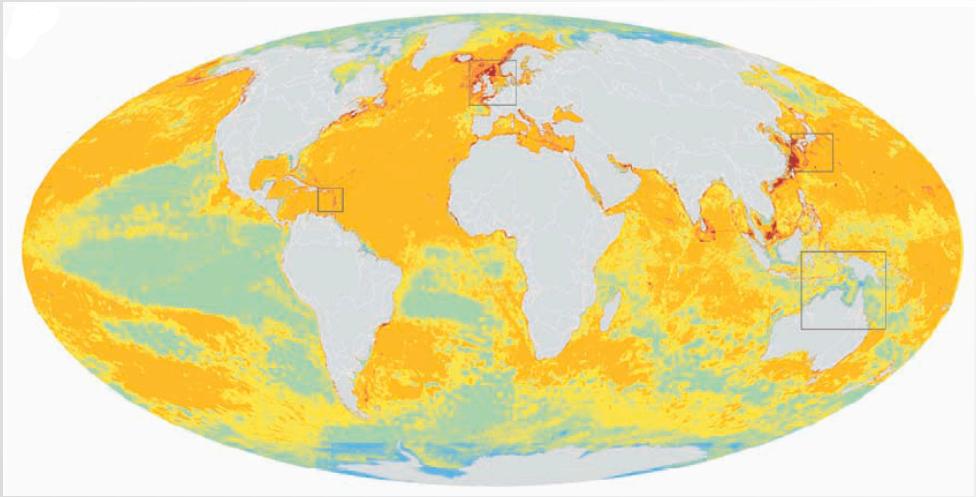
The ocean is the largest ecosystem on our planet, regulating change and variability in the climate system and supporting the global economy, nutrition, health and wellbeing, water supply and energy.

Background

A Global Map of Human Impact on Marine Ecosystems

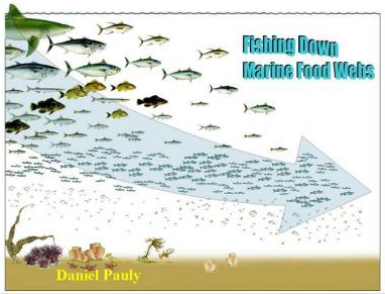
- 41% ocean in the status "medium high to high impact" (I_C>8.5) ,
- ~ 0.5% in "very high impact" (I_C > 15.5) , including the Yellow Sea

— Halpern et. al., 2008, *SCIENCE*



I_C
(cumulative impact scores)

- Very Low Impact (<1.4)
- Low Impact (1.4–4.95)
- Medium Impact (4.95–8.47)
- Medium High Impact (8.47–12)
- High Impact (12–15.52)
- Very High Impact (>15.52)



Ecological restoration

"Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (SER 2004).

Ecological restoration can be divided into four categories:

① Natural recovery from a natural or anthropogenic change (whether adverse or otherwise);

② Anthropogenic interventions in response to a degraded or anthropogenically changed environment;

③ Anthropogenic responses to a single stressor;

④ Habitat enhancement or creation

------ Elliott et al., 2007

The ultimate goal of restoration is to create a self-supporting ecosystem that is resilient to perturbation without further assistance (SER 2004).

CONTENTS

01 **Background**

02 **General process of Restoration project**

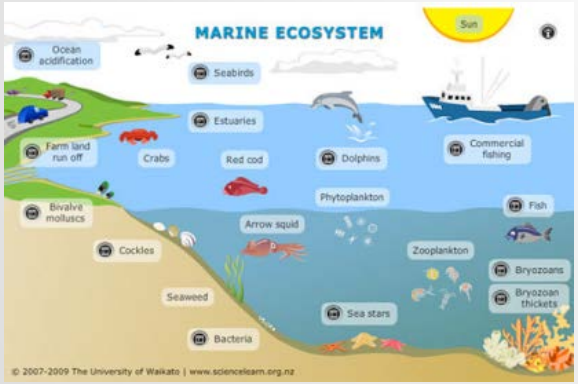
03 **Wetland restoration**

03 **Future challenges**

General process of the restoration project

Planning, Feasibility Studies, Design Engineering, and Permitting

Project planning, feasibility studies, engineering and design studies, and permitting activities are conducted before implementing restoration projects to characterize the environment, determine the best restoration approach from an engineering standpoint, and predict and compare results and conditions with the project and without it.



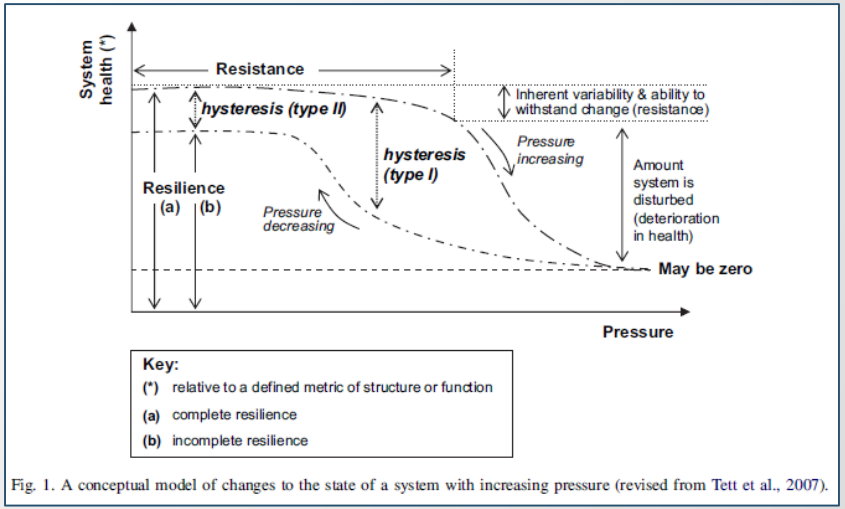
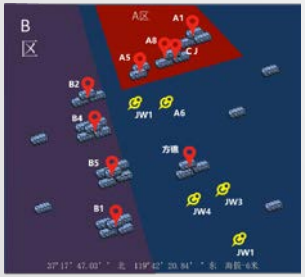


Fig. 1. A conceptual model of changes to the state of a system with increasing pressure (revised from Tett et al., 2007).

General process of the restoration project

Implementation and Effectiveness Monitoring

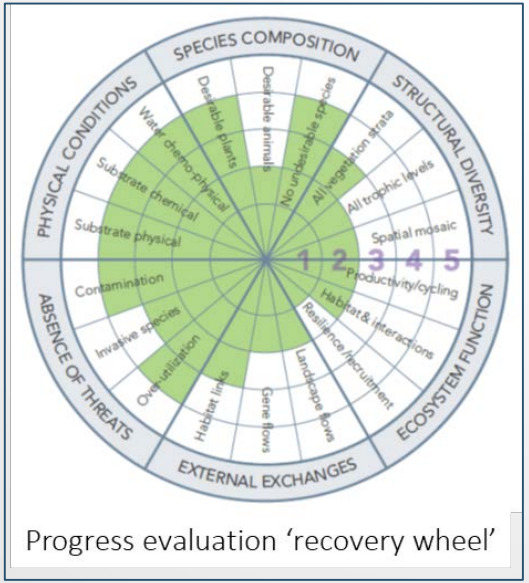
Tier I (implementation) monitoring is defined as systematic data collection to assess whether a directed restoration action was carried out as designed and, as appropriate, to determine whether the restoration action is providing a basic level of effectiveness. Examples of Tier I parameters may include as-built topography/bathymetry (e.g., width, depth, slope, height, elevation, etc.), other ecosystem structure components (e.g., survival of planted species, water stage, etc.), and/or presence/absence of target fish species.



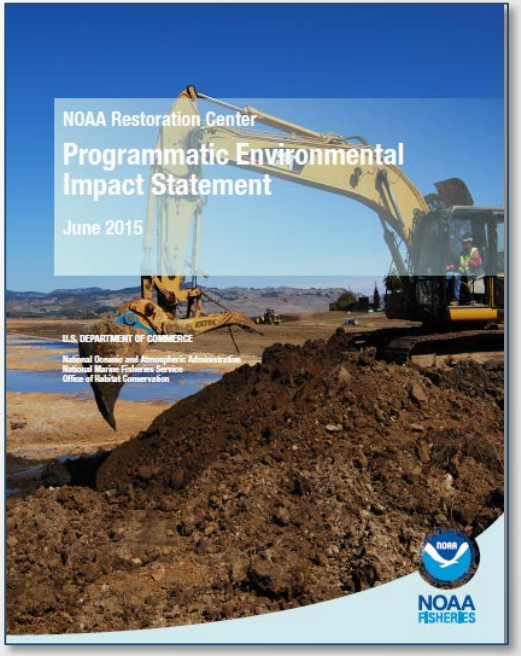
General process of the restoration project

Implementation and Effectiveness Monitoring

Tier II (effectiveness) monitoring is as systematic data collection to assess the effectiveness of restoration actions and to assess progress toward the desired goals and outcomes of a given project.



Progress evaluation 'recovery wheel'



General process of the restoration project

Wildlife Monitoring

Gathering observational data on the plant or animal species that use or occupy specific habitats. Such data can be used to develop baseline measurements of the species composition, diversity, and richness of a targeted habitat, which can then be used to identify changes in the ecosystem and track the progress of a restoration project.

General process of the restoration project

Public education and social communication

The public outreach project type includes implementation of projects to enhance and further public knowledge about the local environmental resources, the ecological importance of restoration activities, and the value of the environment to local communities.

CONTENTS

01 **Background**

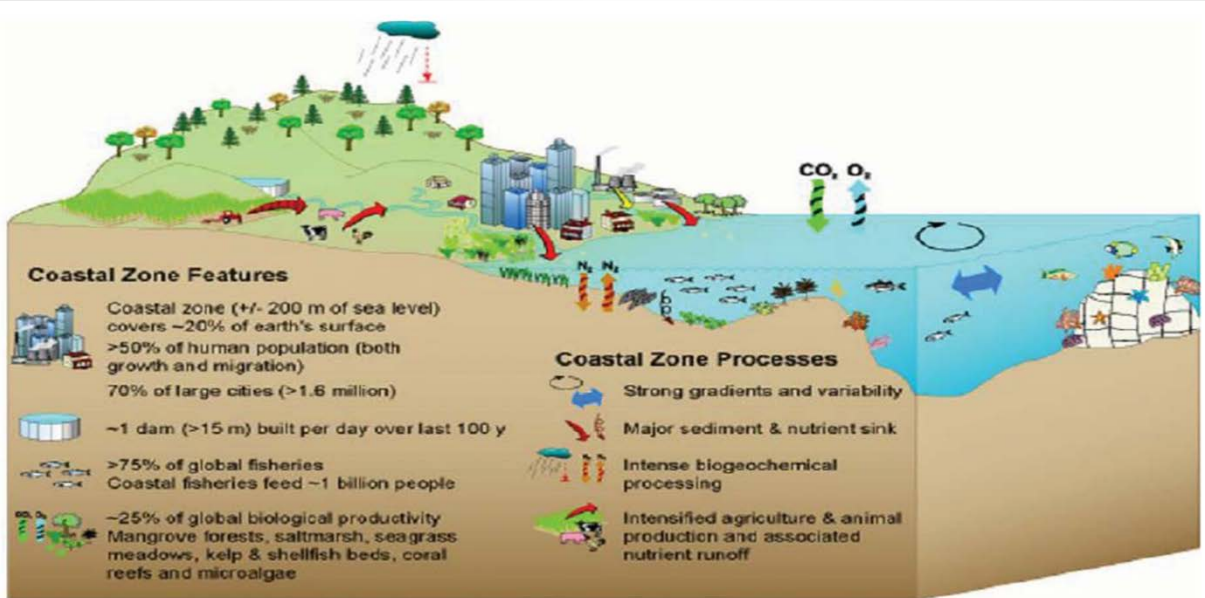
02 **General process of Restoration project**

03 **Wetland restoration**

03 **Future challenges**

Coastal wetland degradation

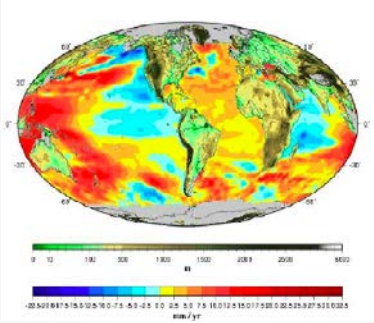
- Due to the unique geographical locations, the coastal zones are the most vulnerable ecosystems to the impacts of climate change (IPCC, 2007)
- In the past 150 years, more than half of the global wetlands have been modified or degraded due to climate changes and human activities



Coastal wetland degradation

- Climate change and Human activities

Global warming



Sea level rise

Storm

Urbanization

Reclamation

Pollution

Coastal wetland history in China and Korea

The Figures showed that both China and Korea have a long history of coastal reclamation

After China became a contracting party to the Ramsar Convention in 1992, and South Korea joined in 1997. More and more coastal wetland were protected and restored

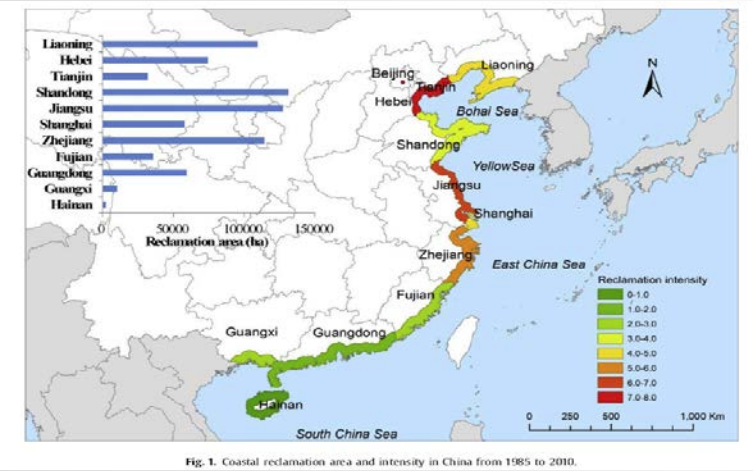
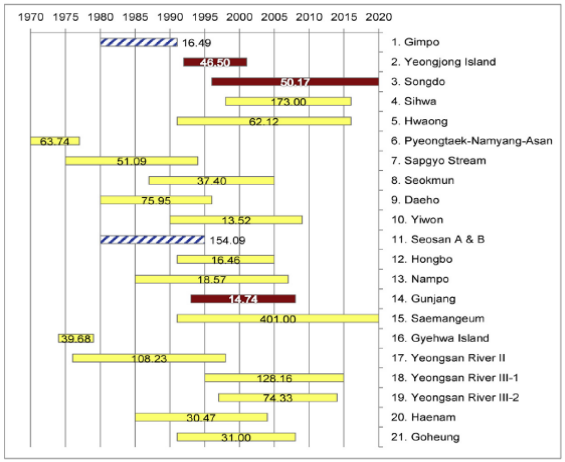
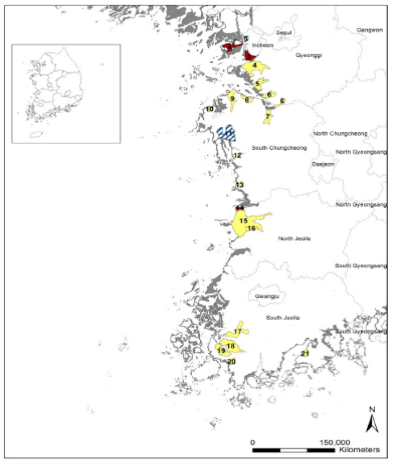


Fig. 1. Coastal reclamation area and intensity in China from 1985 to 2010.

Reclamation status in China from 1985 to 2010

(Tian et al., 2016)



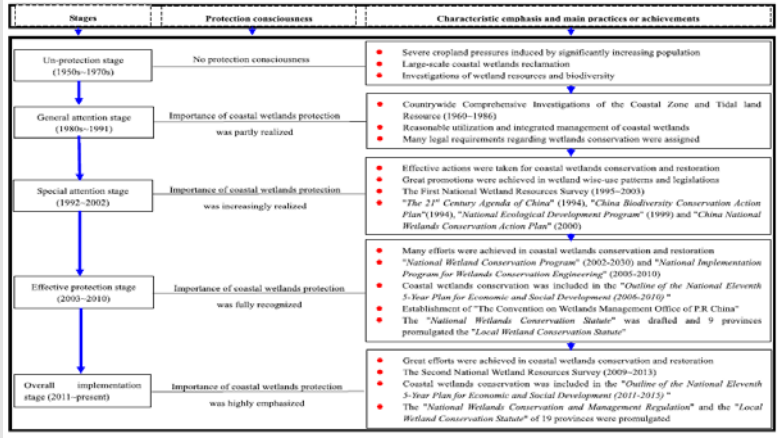


Reclamation history in Korea from 1950 to 2015

(Young, 2014)

Protection and restoration history

- The change of coastal wetland conversion plan in China and South Korea.



(Sun et al., 2015)

1960–1990	1991–2001	2001–present
Pre-planning period	The 1st planning period	The 2nd planning and revised planning period
- PWRA(1961) - Main causes of reclamation: Agriculture, Manufacturing industry, port developments, etc. - Korea Agriculture and Rural Infrastructure Corporation (KARICO) initiated but a few private companies participated	- PWRA revised (1986) and ordered wetland conversion planned in advance. - The 1st plan established (1991); Demand control by the plan. - Main reasons of wetland conversion: agriculture (459 cases/960.67 km^2) - Tools of project assessment; economic feasibility	- The 2nd plan established (2001–2011): 186 cases/38.23 km^2 - The 2nd plan revised (2007–2011): 46 cases/7.3 km^2 - Tools of project assessment; in the 2nd plan, used environmental assessment, and in the revised 2nd plan, used both economic and environment assessment

(Yoon et al., 2008)

China

In 1994, “China Biodiversity Conservation Action Plan” were introduced by the government.

Korea

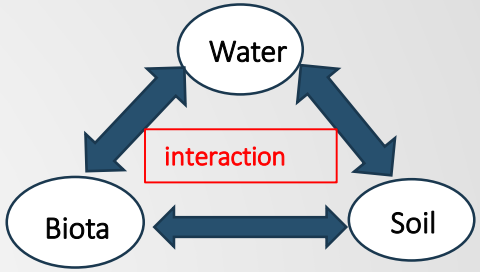
In early nineties, the Basic Act for Environmental Policy (BAEP) and the Natural Environment Preservation Act (NEPA) were introduced to preserve the important natural ecosystem.

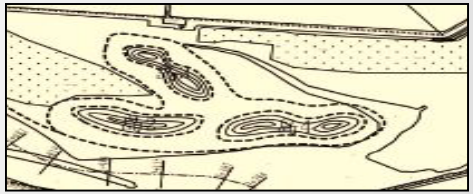
Theory of Coastal wetland restoration

1. Restoration of coastal wetlands are centered on these three constituents and the interaction of the three elements.

2. From the population to landscape scales, four important factors are significantly affected the health of wetland ecosphere, which are continuity of natural processes, ecosystem connectivity, habitat heterogeneity and food web diversity.

In the Yellow River Delta, we constructed a new restoration technology architecture based on microhabitat modification and water level control, which could improve both ecosystem function and landscape efficiency meanwhile.





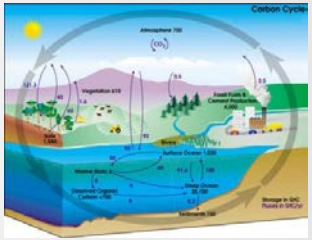
Evaluation of wetland restoration

- Currently, there is no professional consensus on the choice of ecological metrics to assess restoration success

Plant diversity
Density
Leaf area
Biomass
Physiological index
…….

Water quality
Hydrological connectivity
Salt content
Water table level
…….

Soil salt content
Nutrient content
Soil organic matter
Bulk density
Water content
Soil microbe
…….

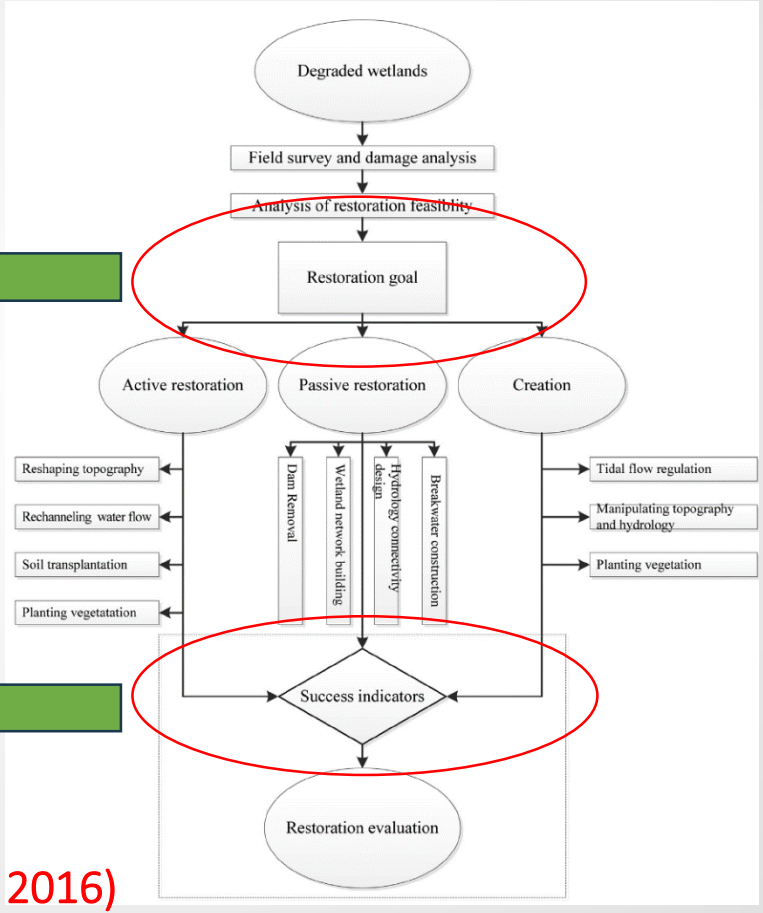


Index of biological integrity (IBI)
Habitat evaluation procedure (HEP)
Nutrient cycling
Food web diversity
…….

Evaluation of wetland restoration

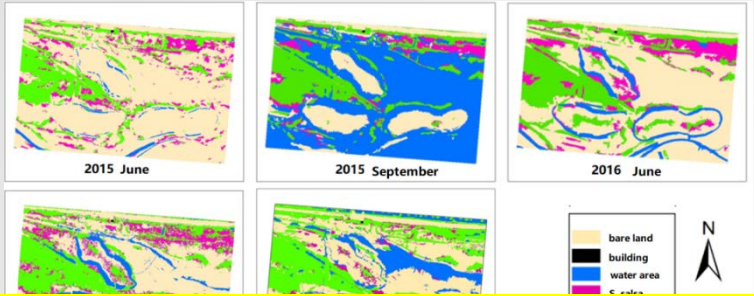
Purpose of restoration

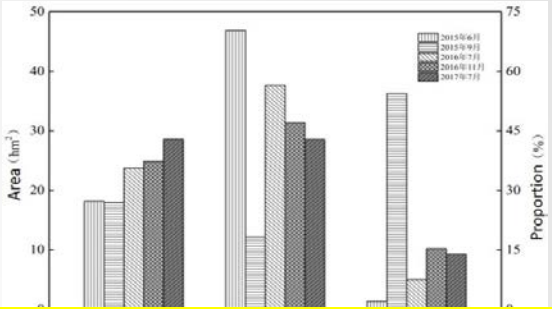
Indicators to evaluate the effects of restoration



(Zhao et al., 2016)

Evaluation of wetland restoration



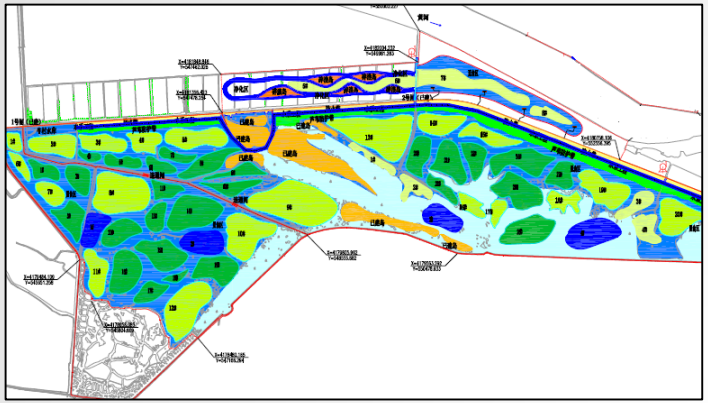


The restoration project was proved significantly improved the wetland function from the 4 aspects, such as landscape, vegetation area, macrobentic and foraging birds diversity.

14 macrobenthic species were identified.

A total of 71 species of foraging birds, including 3 National Grade I protected birds, 10 national grade II protected birds, and 8 key protected birds in Shandong Province.

Demonstration and popularization



International Important Wetland Biodiversity Conservation Project (120 million RMB)in the Yellow River Delta has been approved by the National Development and Reform Commission.

Based on the continuity of natural processes, ecosystem connectivity, habitat heterogeneity and food web diversity, we will track and monitor the restoration area and evaluate its restoration effect comprehensively.

Future challenges

1. Exploring effective measures in response to major threaten factors, such as monitoring network
2. Improving the conservation and compensation systems
3. Improve special laws and regulations
4. Enhancing the public wetlands conservation awareness

Future challenges

Restoration, protection and management of coastal ecosystem is a long-term strategic task, close cooperation and joint efforts between the government and the public are necessary.


Taken together for a beautiful coastal environment!