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Marine Invasive Species in the Northwest Pacific Region of China

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ABSTRACT: China is a large coastal country vulnerable to invasive species. In the past decades, about 30 major marine invasive species (MIS) were recorded in the Northwest Pacific including NOWPAP region, where parts of China's marine areas are situated. MIS issues are threatening and impacting native communities and ecosystems, including the economy and public health. In this paper, the authors show the status of MIS in the NOWPAP region of China and the impacts of MIS on the country and its ecosystems. While great efforts are being made in the prevention, detection and management of MIS, more action is needed at both scientific and political levels.

KEYWORDS: *Marine Invasive Species (MIS), impact, management of MIS*

Introduction

China is a large coastal country with 18,000 km of mainland coastline. There are more than 65,000 islands over 500m² in size and about 30,000,000 km² of sea area under China's jurisdiction. The marine area of China spans a latitude of 38 degrees and three temperature zones containing rich and unique marine ecosystems. On the other hand, such features make the country more vulnerable to invasive species, as many alien species are likely to find their suitable habitat there. In recent years, the spread of alien species has accelerated because of multiple factors, such as large scale mariculture, fish trade, ornamental fish in aquarium husbandry, extensive exchange of invertebrates and algae, shipping (especially ballast water discharge), as a result of the rapid development of China's trade and transport systems in the past decades (Liang & Wang, 2001).

The NOWPAP region refers to the marine region

surrounded by China, Korea, Japan and Russia, which belongs to the temperate climate zone, with heavy shipping traffic every year. According to statistics, in recent years, there are about 30 major marine invasive species (MIS) recorded in the NOWPAP region, and China's marine ecosystem located along the Northwest Pacific coast is also effected by biological invasion.

Pathways of MIS introduction to the NOWPAP region of China include shipping and ballast water, which is the most common medium of MIS around the world, in addition to intentional introduction and aquaculture (Xu et al., 2004; Xu & Qiang, 2011). China had introduced at least ten species of fish, two species of shrimp, nine species of shellfish, one species of echinoderm and four species of algae in mariculture. Few species among them are suitable for mariculture or could bring significant economic benefits, and the introduction of these species could be potentially dangerous to the marine environment of China (Hao et al., 2005).

No.	Scientific name	English name	Distribution
1	<i>Laminaria japonica</i> (Areschoug, 1851)	Kelp	Most coastal areas of China
2	<i>Macrocystis pyrifera</i> (Agardh, 1820)	Giant kelp	Sea areas from Dalian (Liaoning Prov.) to Changdao Island (Shandong Prov.)
3	<i>Undaria pinnatifida</i> (Suringar, 1873)	Asian kelp	most coastal areas of China
4	<i>Desmarestia ligulata</i> (Lamouroux, 1813)	Color changer	Sea areas of Dalian, Lvshun (Liaoning Prov.), and Shandong Prov.
5	<i>Spartina alterniflora</i> (Loisel)	Smooth cordgrass	Coastal areas from Liaoning to Jiangsu Prov.
6	<i>Spartina anglica</i> (C.E. Hubbard)	Common cordgrass	Coastal areas of Jiangsu Prov.
7	<i>Haliotis discus</i> (Reeve, 1846)	Disk abalone	Coastal areas of Dalian (Liaoning Prov.)
8	<i>Haliotis gigantea</i> (Gmelin, 1791)	Giant abalone	Coastal areas of Liaoning and Shandong Prov.
9	<i>Haliotis rufescens</i> (Swainson, 1822)	Red abalone	Coastal areas of Liaoning and Shandong Prov.
10	<i>Haliotis fulgens</i> (Philippi, 1845)	Green abalone	Coastal areas of Liaoning and Shandong Prov.
11	<i>Argopecten irradians</i> (Lamarck, 1819)	Bay scallop	Coastal areas of Liaoning and Shandong Prov.
12	<i>Patinopecten yessoensis</i> (Jay, 1857)	Giant Ezo scallop	Coastal areas of north China, especially Liaoning and Shandong prov.
13	<i>Crassostrea gigas</i> (Thunberg, 1793)	Pacific oyster	All the coastal areas
14	<i>Mercenaria mercenaria</i> (Linnaeus, 1758)	Hard-shell clam	Coastal areas of Shandong Prov.
15	<i>Panopea abrupta</i> (Conrad, 1849)	Pacific geoduck clam	Coastal areas of Shandong Prov.
16	<i>Litopenaeus stylirostris</i> (Stimpson, 1871)	Blue shrimp	Coastal areas of Shandong and Jiangsu Prov.
17	<i>Litopenaeus vannamei</i> (Boone, 1931)	White shrimp	Coastal areas of Jiangsu Prov.
18	<i>Marsupenaeus japonicus</i> (Bate, 1888)	Kuruma prawn	Coastal areas of the north China
19	<i>Strongylocentrotus intermidus</i> (A. Agassiz, 1863)	Sea urchin	Coastal areas of Dalian(Liaoning Prov.) and Rongcheng(Shandong Prov.)
20	<i>Oncorhynchus Kisutch</i> (Walbaum, 1792)	Coho salmon	Coastal areas of Liaoning Prov.
21	<i>Oncorhynchus mykiss</i> (Walbaum, 1792)	Rainbow trout	Coastal areas of Liaoning and Shandong Prov.
22	<i>Salmo salar</i> (Linnaeus, 1758)	Atlantic salmon	Coastal areas of Liaoning Prov.
23	<i>Paralichthys dentatus</i> (Linnaeus, 1766)	Summer flounder	Coastal areas of Shandong Prov.
24	<i>Paralichthys lethostigma</i> (Jordan & Gilbert, 1884)	Southern flounder	Most coastal areas of China
25	<i>Verasper moseri</i> (Jordan & Gilber, 1898)	Barfin flounder	Waters to east of northern China
26	<i>Solea senegalensis</i> (Kaup, 1858)	Senegalese sole	Coastal areas of Shandong Prov.
27	<i>Solea solea</i> (Linnaeus, 1758)	Common sole	Coastal areas of Shandong Prov.
28	<i>Anguilla anguilla</i> (Linnaeus, 1758)	European eel	Coastal areas of Jiangsu Prov.
29	<i>Anguilla rostrata</i> (Lesueur, 1821)	American eel	Coastal areas of Jiangsu Prov.
30	<i>Morone saxatilis</i> (Walbaum, 1792)	Striped bass	Coastal areas of Shandong Prov.
31	<i>Sciaenops ocellatus</i> (Linnaeus, 1766)	Redfish	Most coastal areas of China
32	<i>Halocynthia roretzi</i> (Drasche, 1884)	Sea squirt	Coastal areas of Liaoning and Shandong Prov.

Table 1. Main marine invasive species in the NOWPAP region of China.

The major marine invasive species in the NOWPAP region of China include 6 plants (including phytoplankton), 13 invertebrates, 12 fishes and 1 other species (Table 1).

MIS may have huge threats and impact on native communities and ecosystems including in terms of economy and public health. Smooth cordgrass (*S. alterniflora*) distribute in almost all the coastal areas

of south China. They occupy niches of native species, and destroy the habitat of native birds and aquatic species, threatening local biodiversity. They also clog waterways, affecting water exchange and cause red tide (Chen et al., 2004). Adverse effects such as native species reduction, landscape loss, breeding degradation, diseases, frequent red tides, etc., which were possibly caused by MIS, not only result in economic loss on marine-based industry, but also trigger a series of social problems indirectly (Liang & Wang, 2001). The Ministry of Environmental Protection of China carried out an evaluation on invasive alien species during 2001-2003, and it showed that each year invasive alien species may cost about 14.5 billion dollars of loss in China, including direct loss in agriculture and indirect loss in ecosystems, genetic resources, and so on (Xu & Qiang, 2004). As an example, the mass mortality of *Chlamys farreri*, which was introduced from Taiwan Province, was considered as a major reason for the spread of shrimp viral diseases across China's aquaculture sites since 1993. Shrimp viral diseases and other invasive-species-related diseases led to a loss of more than 483 million dollars in 2002 (Zhu & Zhao, 2004).

The Chinese government has made great effort in the prevention, detection and management of MIS. The Ministry of Environmental Protection announced the first list of invasive species in 2003, and the second list in 2010, with 35 species in total, including 1 MIS, Smooth cordgrass (*S. alterniflora*). In 1990, the concept of Pest Risk Analysis (PRA) was formally introduced into China, and China's first PRA institution, the "PRA Office" was formally established in 2000 by the Animal and Plant Quarantine Institute, General Administration of Quality Supervision, Inspection and Quarantine, as the leading institute in China's PRA work. In 2002, the PRA Office intercepted 22,448 batches of pests from 1,310 alien species. In September 2002, as part of the world's ballast water management project, the first ballast water risk assessment in China was carried out in Dalian port. The team, comprising experts from relevant departments and institutes, successfully conducted a simulation analysis of the environment and biological parameters of the port, and built a regional geographic information system. At present, similar risk assessments of ballast water have been launched in many ports in China. Furthermore, the Chinese government has also created a number of databases for the control and management of MIS. In 2012, the Atlas of MIS in the NOWPAP Region of China was developed.

With financial support from APN and human

resource support from the First Institute of Oceanography of State Oceanic Administration of China, the Regional Workshop on Marine Invasive Species Problems in Northwest Pacific Region was held in Qingdao, China, from 23-24 October 2012. The workshop was hosted by the Data and Information Regional Activity Center (DINRAC) of NOWPAP. With technical support from related organisations, the agenda of the workshop included three major topics: Current situation of MIS problems in NOWPAP member countries; impacts of MIS on ecosystems and environment in NOWPAP member countries; and current policies and measures on preventing and controlling MIS problems in the NOWPAP member countries and future needs for policies, measures and regional cooperation. Through this workshop, experts and officials from NOWPAP member countries exchanged knowledge and understandings of the current situation of MIS issues in the region, the measures to prevent and control MIS problems, and the necessary policies and measures to tackle these problems. Moreover, this workshop served as a platform to strengthen the linkage between science and policy. The workshop recommended that more investigation of and research on MIS are needed, and countries in the NOWPAP region need to provide resources to strengthen the investigation and researches on this issue, to develop regional cooperation on data sharing in the framework of NOWPAP, as well as close cooperation with other international organisations, and that increased ratification of the Ballast Water Management Convention of the International Maritime Organization is essential to prevent the further spread of MIS.

However, there are still many gaps in the prevention, detection and management of MIS, as well as in relation to the global and regional developments dealing with marine and coastal biodiversity. The current national legislations and management systems for MIS need to be utilised to further prevent and control MIS, including the control of sources of MIS introduction and spread, routine monitoring to detect and implement rapid response to eradicate or control MIS before they spread, and long-term responses to mitigate the impacts of MIS. Although more attention has been received for marine biodiversity, it is also believed that more measures need to be adopted for eliminating marine bio-invasion, including policy and legal system's improvement as well as related capacity building. As a result, the introduction of alien marine organisms and other activities such as stock enhancement releasing, religious releasing, etc., has been accelerating the pace of alien species invasion, causing

potential danger to the marine environment of China (Liu et al., 2008; Li & Huang, 2011).

As a global problem, MIS has attracted large amounts of attention from many countries as well as a number of international organisations. In order to strengthen the management of MIS, many countries including the USA, Australia and New Zealand, have developed their own strategies for the management of MIS, and also established a variety of guidelines and corresponding legislations. In accordance with international experience and practices, the Chinese Government is recommended to achieve the following aspects in the future:

- Urgently establish laws and regulations for the management of MIS.
- Strengthen institutional capacity and improve multi-sectoral coordination and management mechanisms.
- Enhance the infrastructure of MIS management systems.
- Implement appropriate measures of prevention, elimination, control and restoration for the introduction of MIS.
- Reinforce scientific research and provide a scientific basis for the management of MIS.
- Develop regional cooperation in data sharing under the framework of NOWPAP, and collaborate closer with other international organisations.
- Design education and training programmes to raise public awareness.

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