available at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/ecoleng

Ecological control and integral utilization of *Spartina alterniflora*

Guang Wang, Pei Qin, Shuwen Wan, Wenzong Zhou, Xueming Zai, Daoliang Yan*

Halophyte Research Lab, School of Life Sciences, Nanjing University, Nanjing 210093, China

ARTICLE INFO

Article history:
Received 17 April 2007
Received in revised form
12 November 2007
Accepted 24 November 2007

Keywords:
Exotic species
Spartina alterniflora
Ecological control
Ecological engineering

ABSTRACT

Spartina alterniflora Loisel (*S. alterniflora*) is native to the Atlantic and Gulf Coasts of North America and was introduced to China in 1979. Over the years, *S. alterniflora* played an important role in protecting coastal banks, accelerating sediment deposition, improving local economies, and alleviating natural disasters. As an exotic species, *S. alterniflora* has a very strong capability of propagation, which has caused some negative effects, such as occupying ecological niches of some seashells and blocking harbors by fast sediment deposition. As a result, ecological control of *S. alterniflora* in some areas has drawn wide attention from biologists and ecologists in China and abroad. For this paper, we studied the technology of topography and hydrology modification to substitute *S. alterniflora* with *P. asutralis* and reported our results in a project applying this technology. Furthermore, we studied various ways to make use of biomass of *S. alterniflora* and found that such ways were a good alternative to ecological control of *S. alterniflora*.

1. Introduction

Spartina alterniflora is a perennial salt marsh grass native to the Atlantic and Gulf Coasts of North America (Qin and Chung, 1992; Daehler and Strong, 1996; Chung et al., 2004). It grows tall and dense and has very strong root systems. In 1979, Professor C.H. Chung of Nanjing University introduced *S. alterniflora* to China, and the first plantation of *S. alterniflora* was successfully constructed in Fujian province in 1980 (Chung, 1983; Xu and Zhuo, 1985; Qin and Xie, 1988). Then more and more *S. alterniflora* plantations were built in Guangdong, Zhejiang, Jiangsu and Shandong provinces in the next several years, which greatly increased the vegetation cover and biomass in coastal areas in China (Chung, 1990; Xu and Zhuo, 1991; Qin and Chung, 1992). Due to its remarkable root systems and productivity, *S. alterniflora* provided many services for ecosystems (Costanza and d'Arge, 1998; Costanza, 2000; Costanza and Voinov, 2001; Costanza and Farber, 2002; Hastings et al., 2006; Tong, 2007). It played an important role in protecting coastal banks, accelerating land reclamation, alleviating greenhouse effect, and decomposing pollutants (Chung, 1990; Fu, 1997; Qin and Chung, 1992; Song, 1997; Qin and Xie, 1998; Wan et al., 2001; Shen, 2001; Shen et al., 2002, 2003, 2006). *S. alterniflora* grows even better in China than in the United States, and normally it can reach 1.0–2.7 m and its roots extend into the soil as deep as 1.5 m. After more than 20 years of development, *S. alterniflora* now extends to more than 50,000 hm^2 in coastal areas of China (Qin and Xie, 1998). As *S. alterniflora* has occupied more and more areas, some local species such as seashells have lost their habitats (Simenstad and Thom, 1995; Daehler and Strong, 1995, 1996; Grevstad et al., 2003; Cuddington and Hastings, 2004; Rosso et al., 2006; He et al., 2007; Brusati and Grosholza, 2007). Furthermore, the rapid deposition of sediments in harbor regions has caused trouble

* *Corresponding author*. Fax: +86 25 8359 2684.
E-mail address: qinpei@nju.edu.cn (P. Qin).

0925-8574/$ – see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.ecoleng.2007.11.014

to traveling ships. In addition, the dead biomass of *S. alterniflora* was a secondary source of pollution to the sea. As a result, in 2003 *S. alterniflora* was listed as 1 of the 16 harmful exotic species by the Environmental Protection Bureau of China. The control of *S. alterniflora* has drawn wide attention from biologists and ecologists in China and abroad, and the corresponding studies were mostly physical methods, chemical methods or biological methods, such as using insects (Daehler and Strong, 1995; Farber et al., 2002; Grevstad et al., 2003; Fisher et al., 2005; Hastings et al., 2006; Thomas and Reid, 2007). However, studies using ecological engineering and integral utilization as measures of *S. alterniflora* control were rarely reported.

2. Materials and methods

2.1. The ecological engineering design for control of *S. alterniflora*

As an exotic species in China for many years, *S. alterniflora* is impossible to eradicate (Qin and Chung, 1992). The only practical way for dealing with this *S. alterniflora* problem is to take measures of ecological engineering (Odum and Fanning, 1973; Chung, 1989; Barnthouse, 1990; Mitsch et al., 1993; Qin et al., 1998) to keep the population at a certain level. Ecological engineering measures are twofold in our point of view. First we can use engineering projects to take ecological control of *S. alterniflora*, in particular using *P australis* as a tool species combined with certain environmental modifications to replace the *S. alterniflora* community. Secondly, we harvest *S. alterniflora* to some extent and make integral usage of it in many ways. Both ways are discussed in detail as follows. Our study area is located in Dafeng county in north Jiangsu, China (see Fig. 1). The overall picture of the ecological engineering design for control of *S. alterniflora* is provided in Figs. 2 and 3. After years of practice, ecological benefits as well as economic benefits gained from this design showed its applicability to coastal areas in China.

2.1.1. Microtopography and hydrology modification to accelerate substitution of *S. alterniflora* by *P. australis*

In practices of restoring salt marsh ecosystems, there were successful projects to restore original vegetation and ecosystem functions by modifying topography and hydrology of the system (Mitsch, 1987; Mitsch and Jorgensen, 1989). For example, *P. australis* was brought and established in salt marsh ecosystems in eastern U.S. by modifying elements of microtopography and hydrology. Ecological restoration of the Florida Everglades, Project Vistre in Mediterranean France and restoration of Danube delta wetlands in Romania (Schmidt, 2001) are all examples of restoring vegetation and ecosystem functions by modifying system hydrology. Such examples are very valuable to restoring degraded salt marshes in Northern Jiangsu. The original niches of *P. australis* and *S. alterniflora* are on an upper-tidal area and intertidal area, respectively in our study site (see Fig. 4). In 2001 Nanjing University and Dafend Tidal Development Company undertook a project of ecological engineering to substitute 50 hm^2 of *S. alterniflora* with *P. australis* by modifying elements of local topography and hydrology. Seawater was kept from flowing into the system and freshwater accumulated in channels created in our

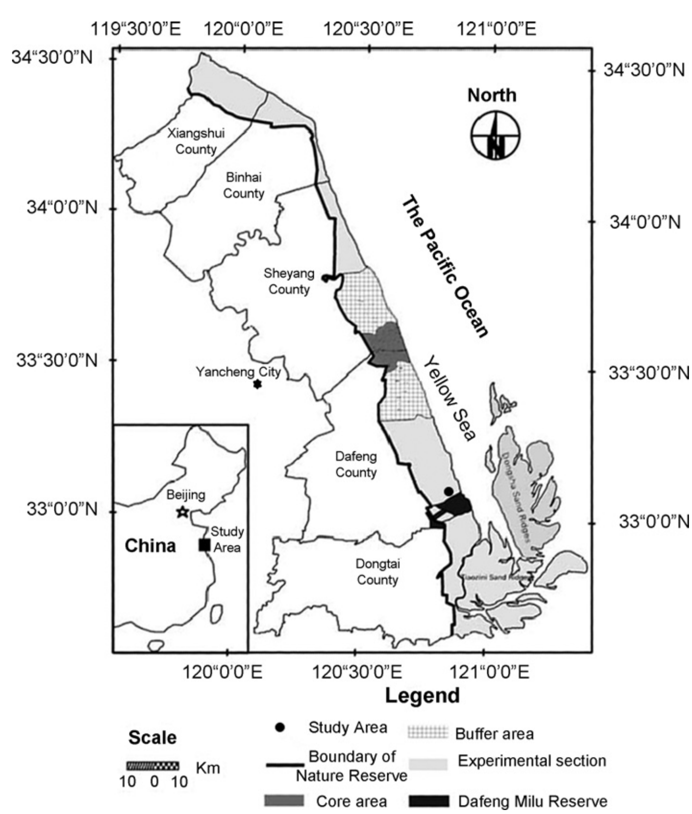

Fig. 1 – Study area is located in Dafeng county in north Jiangsu, China.