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Baseline Mapping of Phragmites australis (Common Reed) In Three Coastal Mississippi Estuarine Basins

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Baseline Mapping of *Phragmites australis* (Common Reed) in Three Coastal Mississippi Estuarine Basins

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Abstract - Over the last two decades, the northern Gulf of Mexico has undergone tremendous growth and development that has resulted in extensive and ongoing habitat modification. We had the opportunity to survey the main channels and bayous of three coastal estuarine basins for the presence and coverage of the invasive *Phragmites australis* (common reed). The occurrence and area of *P. australis* was highly variable among the lower Pascagoula River, Back Bay of Biloxi, and St. Louis Bay basins, with the largest amount of coverage (0.489 km^2) found within the lower Pascagoula River basin and the smallest in Back Bay of Biloxi (0.0056 km^2). Monospecific-stand coverage (47.2%) dominated both mixed-tree (27.2%) and mixed-marsh (26.6%) coverages in the lower Pascagoula River basin, whereas in the Back Bay of Biloxi, mixed-marsh coverage (71.4%) was greater than monospecific-stand (25.0%) and mixed-tree (3.6%) coverages. The only portion of St. Louis Bay containing *P. australis* (0.069 km^2) was near the mouth of the Jourdan River, with monospecific-stand (62.3%) dominating the mixed-marsh (36.2%) and mixed-tree (1.5%) coverages. Although we were not able to survey all possible areas of each estuarine basin, the information gained in this study provides baseline data on the occurrence of this invasive species in the three main Mississippi coastal basins. Future monitoring of the spread of common reed, especially in the light of continued coastal development, is necessary if resource managers are to make informed decisions about which management action (water diversions and restoration scenarios) might positively influence this highly invasive native species.

Introduction

Like many coastal regions in the US over the last decade, the northern Gulf of Mexico (GOM) has undergone tremendous growth and development, resulting in extensive and ongoing habitat modification. Worldwide, invasive species have had direct and indirect effects on native coastal biota. In New England, *Phragmites australis* (Cav.) Trin ex Steud. (common reed), has been shown to quickly replace *Spartina alterniflora* Loisel. (smooth cordgrass) and *Juncus* spp. (needlerush) and ultimately form dense monoculture stands (Able et al. 2003).

Common reed is typically associated with disturbed marsh areas (modified plant communities, hydrology, or topography) altered by storms or humans (Marks et al. 1994, Roman et al. 1984, White et al.

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2004). In fact, Burdick and Konisky (2003) showed common reed had the highest growth in low salinity/high elevation sites (mean = 14 practical salinity units [psu] and above mean high tide) compared to mid- (mean high tide) or low (below mean high tide) elevation sites in mean salinities of 18 psu and 23 psu, respectively. Common reed has the ability to germinate in salinities up to 20 psu and water depths to 5 cm (Marks et al. 1994), but germination increases as salinity decreases, and is not affected at salinities below 10 psu. Finally, once established, *P. australis* can modify the area into conditions highly conducive to its further propagation and establishment (Bart and Hartman 2000).

Common reed historically has occurred in North America (Saltonstall 2002), but the 11 native haplotypes once common across North America have been replaced in a number of areas with a European haplotype (Saltonstall 2003) that is competitively superior. The Gulf coast region has a distinguishable haplotype, which differs from all other North American types, and it has yet to be resolved if it is native to the region (Saltonstall 2002, 2003). Saltonstall (2003) and White et al. (2004) noted some morphological differences among clones of this population in Louisiana that appear diagnostic.

Modification of estuarine habitat leads to an increase of monospecific stands of common reed at the expense of other salt marsh vegetation (Havens et al. 2003). Establishment and spread of common reed in some regions directly or indirectly influence community structure and habitat use by a myriad of estuarine species (Marks et al. 1994, Warren et al. 2001, Bart and Hartman 2002, Hanson et al. 2002, Raichel et al. 2003). Finally, disturbance in the form of experimentally increased nutrients and alteration of the surrounding brackish and salt marsh vegetation matrix enhanced the expansion of common reed in Rhode Island (Minchinton and Bertness 2003). Although there has been much research recently, scientific uncertainties remain, and we do not have a clear understanding of the short- and long-term impacts of common reed on salt marshes and their communities.

In the north-central GOM, common reed is present and appears to be expanding in areas of altered marsh and riverine habitat. This is particularly true for Louisiana and Alabama (M.S. Peterson, pers. observ.); however, in coastal Mississippi we do not know its status nor do we know how rapidly it is spreading into disturbed areas. Thus, the primary objective of this research was to develop a set of base maps of common reed distribution and coverage in representative systems in all three Mississippi coastal counties using GIS technology. These maps may serve as a baseline to track future changes in common reed distribution and abundance, allow wise management decisions on impacts to critical fishery nursery habitat, and allow resource agencies to make informed decisions about which management action (water diversions and restoration scenarios) might positively influence this highly invasive native species (*sensu* Occhipinti-Ambrogi and Galil 2004).

Materials and Methods

The presence and area of coverage by common reed was mapped within the main channels and bayous of the three major coastal basins along the Mississippi coast: the lower Pascagoula River basin, Biloxi's Back Bay, and St. Louis Bay. Smaller creeks and bayous of each basin were not mapped due to reduced access by our boats and limited funding. Quick Bird® false-color infrared satellite imagery (1.7-m resolution) taken in July 2002 was obtained, and images were combined to create composites of each basin. The occurrence and area covered by common reed was determined *in situ* using these composites as base maps. Patches were classified into three categories: 1) monospecific stands; 2) mixed marsh, or patches with an understory of other marsh species; and 3) mixed trees, or patches where the canopy was taller than the common reed. A general description of habitat conditions and alterations of each basin is provided in Table 1.

Due to the low band number (4 bands) and large spatial coverage of the imagery, full extraction of pixels containing common reed was impossible. Accuracy assessments of the above method revealed large discrepancies, and, consequently, a combination of field sampling and image analysis proved to be the most accurate method of mapping this species. The imagery initially was analyzed using ERDAS Imagine® 8.6 software to distinguish pixels most likely to contain common reed based on information obtained *a priori*. Unsupervised classifications were performed and non-target pixels masked out through an iterative process until the closest approximation of field conditions was obtained. The resulting image was

Table 1. Summary of the general habitat modifications within the three Mississippi basins evaluated in this study.

Basin	Subsystem	Modifications
Pascagoula River	East	Lower portion of river from immediately north of Highway 90 south to Mississippi Sound, there are significant bulkheads and rip-rap, marinas, ship building, and the Navy homeport facility. Salinity wedge moves markedly upestuary due to channelization.
	West	Mainly housing developments and associated piers, docks and bulkheading.
Back Bay of Biloxi	East-West	Mainly marinas, bulkheading, causeway construction, piers, and docks.
	West	All of the above plus a power plant and industrial park complex.
St. Louis Bay	Jourdan River	Well developed with homes, filled and bulkheaded marsh, piers, and docks.
	Wolf River	Mainly natural and state-protected system.

converted into a vector file and exported as arc-interchange files (.eoo). This format then was used as the baseline from which shape files of each patch category were created.

The actual mapping of common reed patches was carried out using ESRI™ ArcInfo® 8.3. The composite base-map images were overlain with the .eoo files for visual reference. Using the editor, new polygon shape files were created for each patch category by tracing the .eoo files pixel by pixel to match what was seen in the field. The areas of each polygon for each category were calculated once all patches had been rendered and confirmed against the field data.

Results and Discussion

The occurrence and area of common reed was highly variable among the three study basins, with the largest amount of coverage (0.489 km^2) found within the lower Pascagoula River basin (Fig. 1). Monospecific-stand coverage (47.2%) dominated both mixed-tree (27.2%) and mixed-marsh (26.6%) coverages in this basin. The east and west distributaries of the lower Pascagoula River basin are markedly different in terms of development, with the east distributary being more developed by heavy industry and light development compared to mainly housing development in the west distributary (Table 1). The entire basin has a gradual and prominent salinity gradient (range from 0.0 to 11.7 psu upstream up to 30 psu near the mouth depending on discharge; Christmas 1973) along its length, but because of the channelization in the east distributary for shipping, the salt wedge moves markedly farther up-estuary than in the natural west distributary (Christmas 1973; Peterson et al., in press). Much of common reed occurrence in the east distributary is on higher elevation ground near the highly modified, more saline habitat. Conversely, it can be found throughout the west distributary, but mainly up-estuary in low salinity reaches of the basin. This pattern documented in the lower Pascagoula River estuarine basin is common elsewhere. For example, common reed invades natural and altered estuarine environments (Marks et al. 1994, Bart and Hartman 2002), and it is a particularly aggressive colonizer of disturbed sites (Havens et al. 2003). This is particularly true when the surrounding brackish and salt marsh vegetation matrix has been altered, further enhancing expansion (Minchinton and Bertness 2003). Typically, common reed colonizes freshwater and oligohaline marshes without site preference; however, in higher salinity sites, common reed preferentially colonizes creek bank levees and disturbed upland borders with greater elevation compared to natural salt marsh (Warren et al. 2001). Clearly, hydrologic modification (e.g., tidal restriction, increased freshwater input

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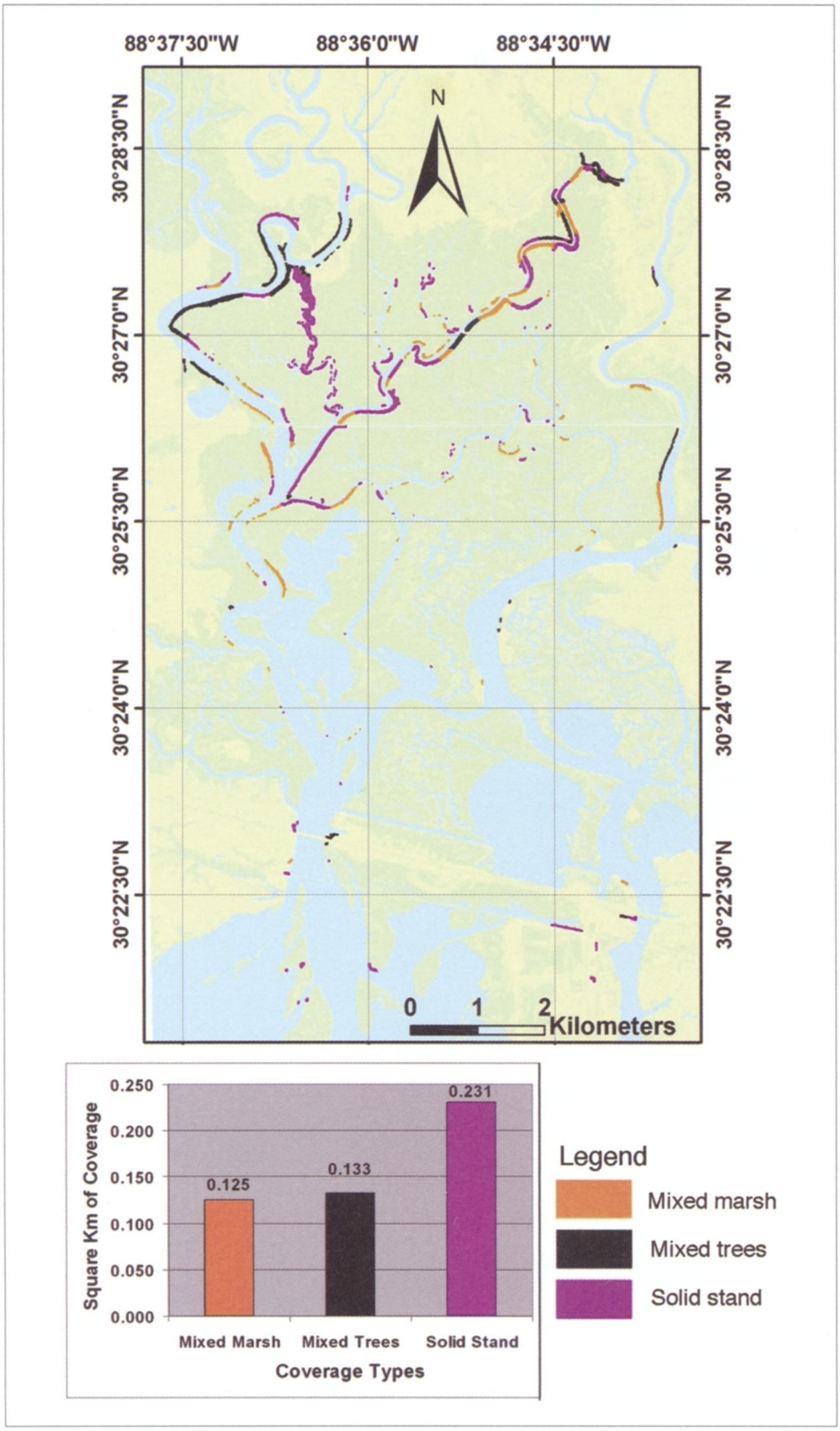
Figure 1 (opposite page). Map of *Phragmites australis* throughout the lower Pascagoula River basin with a comparison of area coverage by monospecific stands, stands mixed with trees, and stands mixed with salt marsh grass.



88°37'30"W
88°36'0"W
88°34'30"W
N
30°28'30"N
30°27'0"N
30°25'30"N
30°24'0"N
30°22'30"N
0 1 2 Kilometers
0.250
0.200
0.150
0.100
0.050
0.000
Square Km of Coverage
0.125
0.133
0.231
Mixed Marsh
Mixed Trees
Solid Stand
Coverage Types
Legend
Mixed marsh
Mixed trees
Solid stand

from developments) and increased filling of marsh upland habitats (e.g., road development, dredge maintenance) enhance invasion and expansion of common reed into the lower reaches of coastal basins (Burdick and Konisky 2003).

The Back Bay of Biloxi had the lowest area of common reed (0.0056 km^2) of the three estuarine basins (Fig. 2), with mixed-marsh coverage (71.4%) being greater than monospecific stands (25.0%) and mixed trees

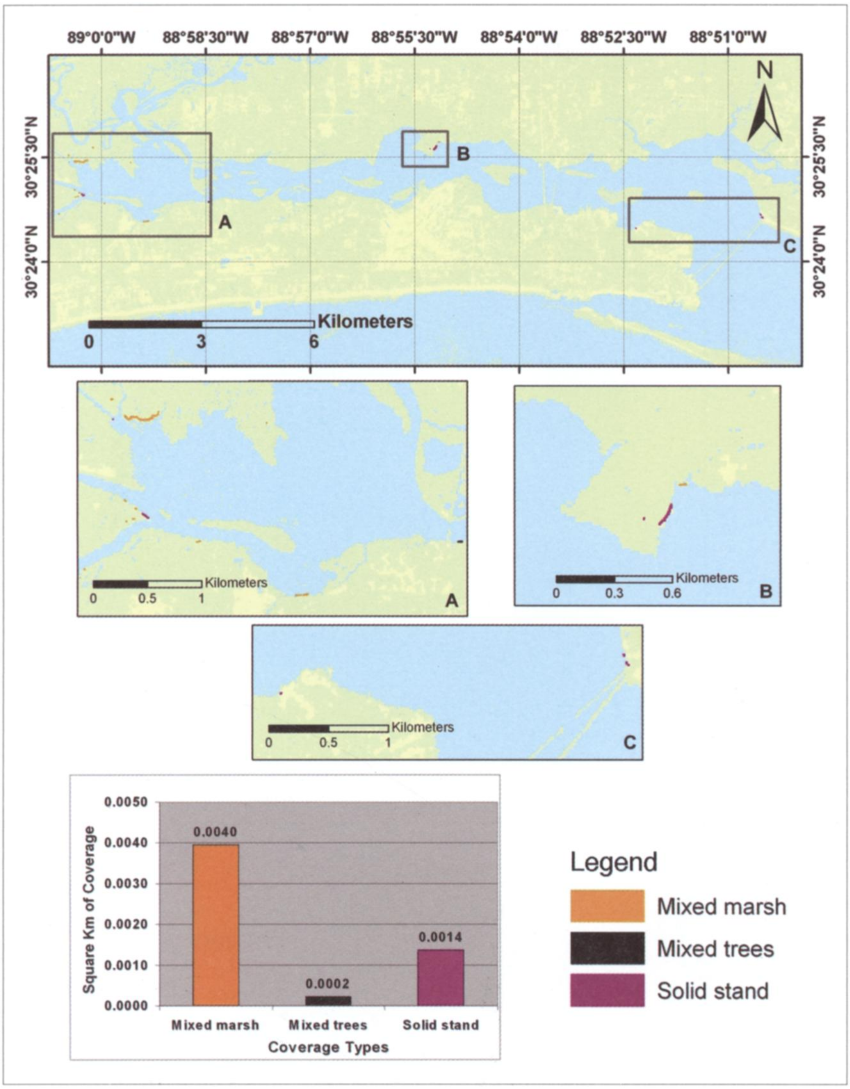


Figure 2. Map of *Phragmites australis* throughout Back Bay of Biloxi with a comparison of area coverage for the entire Back Bay of Biloxi basin by monospecific stands, stands mixed with trees, and stands mixed with salt marsh grass. Insets (A, B, and C) are enlargements of specific areas where *P. australis* occurred.

(3.6%). Common reed in Back Bay of Biloxi occurs in small patches in areas of altered elevation mainly in the western portion where the Biloxi and Tchoutacabouffa Rivers empty into the bay. Salinity in this region is typically lower and more variable (1.4–10 psu) than in the east portion (up to 18.8 psu) of Back Bay of Biloxi, and salinity overall is higher here than in the area of the lower Pascagoula River basin we examined, but varied with discharge (Christmas 1973; M.S. Peterson, pers. observ.). The entire bay system has moderate to severe alteration in addition to heavy industry in the west portion of the bay (Table 1).

The only portion of St. Louis Bay containing the common reed (0.069 km^2) was near the mouth of the Jourdan River (Fig. 3), with monospecific-stand

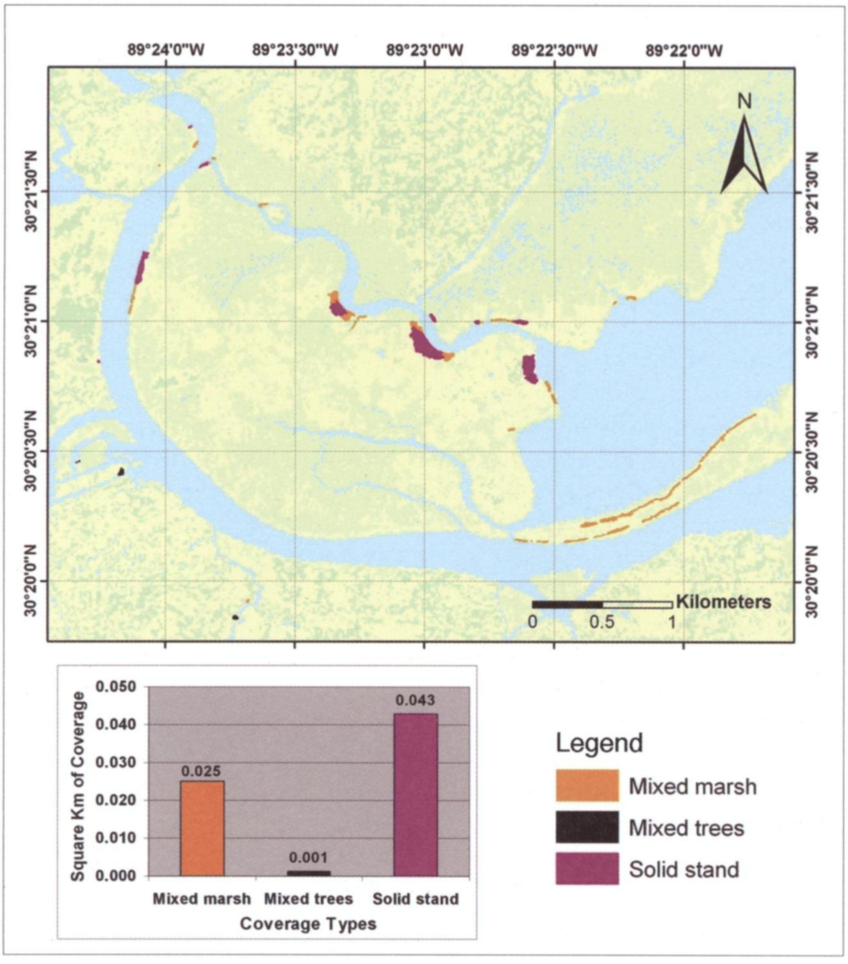


Figure 3. Map of *Phragmites australis* associated with areas of Jourdan River and St. Louis Bay, with a comparison of area coverage by monospecific stands, stands mixed with trees, and stands mixed with salt marsh grass.

(62.3%) dominating the mixed-marsh (36.2%) and mixed-tree (1.5%) coverage. In addition to the Wolf River, which empties into the northeastern edge of St. Louis Bay (7.2 km across St. Louis Bay), the Jourdan River is one of the main freshwater sources for St. Louis Bay (salinity from 0.0 psu upstream to up to 13.8 psu near mouth with St. Louis Bay depending on discharge; Christmas 1973) and has well-developed housing complexes all along the river channel and south of the terminus with St. Louis Bay. The areas in which we found common reed were associated with higher elevations than the surrounding marsh complex (Table 1), and large monospecific stands were common in this area.

Although we were not able to survey all possible creeks and small bayous of each estuarine basin as noted above, the information gained in this study provides baseline data on the occurrence of this species in three prominent Mississippi coastal basins. Though common reed is most probably a native species of the Gulf Coast, it still possesses the capability of expanding into large monospecific stands in habitats altered by development, dredging and improper spoil deposition, or natural disaster modifying natural areas. Modification of estuarine habitat leads to an increase of monospecific stands of common reed at the expense of other salt marsh vegetation (Havens et al. 2003). We predict as further development occurs along the Gulf coast post-Katrina, common reed will spread to areas of low salinity and to areas of higher salinity with higher elevations. As documented by Burdick and Konisky (2003), common reed dispersal and growth is coupled with mid- to low salinity environments and co-varies with elevation such that short-term responses like bulkheading and dredging to natural disasters like Hurricane Katrina along the Mississippi Gulf coast may have long-term consequences such as the enhancement of large monospecific stands of common reed. This structural change in salt marsh and wetland habitats may have secondary effects on the sustainability of the basin via direct and indirect influences on community structure and habitat use by a myriad of estuarine species (Bart and Hartman 2002, Hanson et al. 2002, Raichel et al. 2003, Warren et al. 2001). Thus, future monitoring of the spread of common reed, especially in the light of continued coastal development, is necessary if resource managers are to make informed decisions about which management action (water diversions and restoration scenarios) might positively influence this highly invasive native species.

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