

Expansion of *Phragmites australis* in a Mississippi Estuary Determined from Aerial Image Data

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Abstract

Coastal marsh extent is a key variable in the protection of inland areas from storm surge, flooding, and erosion. Vegetation composition is also an important factor in the functional characteristics of coastal marsh areas in terms of both wildlife value and wave energy attenuation. As pressures from accelerating sea level rise and anthropogenic stressors grow, the protection of coastal wetlands will be increasingly essential in mitigating coastal change and preserving habitat to support fisheries and other wildlife. The increase in extent of the aggressive *Phragmites australis* (Cav.) Trin. ex Steud. (Common Reed) in several of Mississippi's coastal marsh areas raises questions about how these marshes may evolve in the future, in terms of both spatial extent and ecosystem function. The goals of this study were to quantify the change in extent of *P. australis* along the West Pascagoula River using aerial image data and to identify the areas of greatest expansion. To assess the possible influences of salinity and wave energy, two areas were examined: one at the mouth of the river delta as it enters the Mississippi Sound, and one more protected inland area with lower salinity. A supervised maximum likelihood algorithm was used to create land cover classifications at 1 meter GSD for calendar years 1996, 2010, 2014 and 2018, with land cover classified as *P. australis*, other marsh vegetation, marsh-upland ecotone, wooded areas, or water. Per-pixel change detections were computed among the classification images to assess areal change in *P. australis* extent as compared with other land cover types. Results show an increase in *P. australis* extent of 157 ha (approximately 1,960%) between 1996 (8 ha) and 2018 (165 ha), with greater expansion in the inland part of the study area. These land cover classifications will also be used to quantify shoreline movement for *P. australis*-dominated shorelines as compared with other marsh habitats, providing insights into past and future responses of *P. australis* to changes in sea level compared with neighboring marsh vegetation.

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I. Introduction: *Phragmites australis* in Mississippi's Coastal Marshes



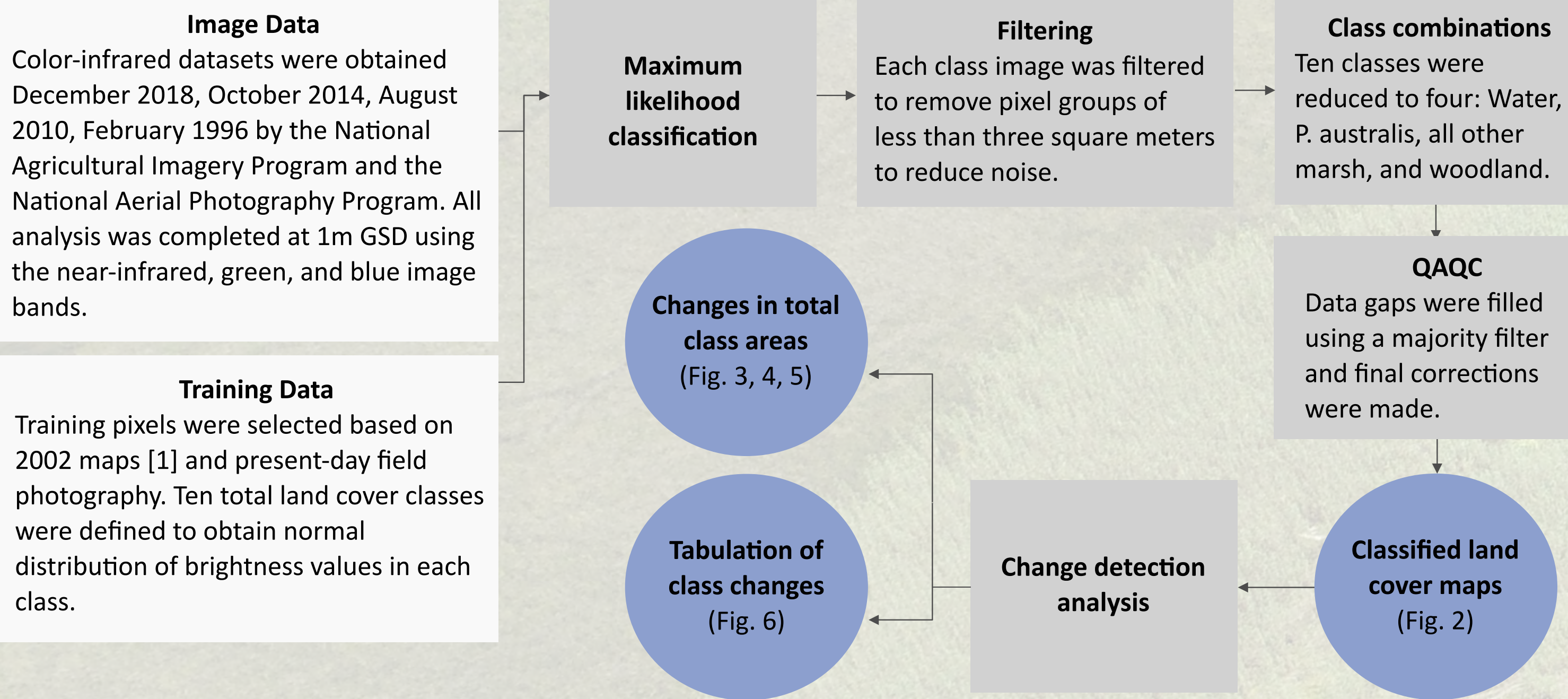
Fig. 1. The Southwest Pascagoula River Estuary. Two sites were examined within the study area: a) the Mary Walker Bayou area, in green (inland, protected from wave action, less saline) and b) the Marsh Islands at the mouth of the Pascagoula River, in yellow (exposed to greater wave action and higher salinities).

Phragmites australis (Cav.) Trin. ex Steud. is a highly competitive native species in Northern Gulf of Mexico coastal marshes [1,2,3]. It is associated with decreased vegetative diversity, but provides habitat for a variety of birds, insects and spiders [1, 4, 5, 6]. In Mississippi's estuaries, it has been previously documented in disturbed areas, along natural levees and at higher elevations in more saline areas [1,7]. The species can exist at wide range of elevations under various salinity and hydrological conditions [8,9]. Recent work suggests it could protect against coastal erosion by facilitating sediment deposition better than other marsh species such as *Spartina alterniflora* Loisel [10]. Our study aims to describe how *P. australis* has responded to recent changes in sea level compared with co-located marsh vegetation in the Pascagoula River Estuary, Mississippi, USA (Fig. 1).

Research Questions

1. How has *P. australis* extent changed over time (1996-2018)?
2. How does this change in extent compare to the change in extent of other co-located marsh species?
3. Is *P. australis* extent changing more rapidly in areas which are more protected and experience lower salinity levels?

II. Methods: Image Classification and Change Detection



IV. Discussion and Conclusions

Overall, *P. australis* extent increased in each year, with an increasing trend in extent and the rate of spread at both sites (Fig. 1,2,3,4,5). *P. australis* colonized areas previously occupied by both marsh vegetation and open water. When *P. australis* area is combined with other marsh areas, total marsh extent increased between 1996 and 2018 at Mary Walker Bayou area, despite the overall trend of marsh loss exhibited across the estuary (Fig. 3,4,6) [11]. This has both positive and negative implications for the future of Mississippi's coastal marshes in terms of biodiversity, species composition, and ecosystem function. In terms of marsh shoreline movement over time, *P. australis* appears to be mitigating marsh loss due to relative sea level rise. Removal of the species would have detrimental effects, including reduced coastal protection from wave action and storm surge flooding, loss of wildlife habitat, lowered carbon sequestration, and reduced ability to filter pollutants from upland runoff. As we continue the project, we are working to compute shoreline movement over time, expand the studied area to other parts of the Northern Gulf of Mexico Coast to evaluate broader trends, and quantify how certain environmental factors (e.g. wind fetch, salinity) are related to the rate of spread of *P. australis*.

III. Results: Land Cover Maps, Areal Class Changes and Land Cover Conversions

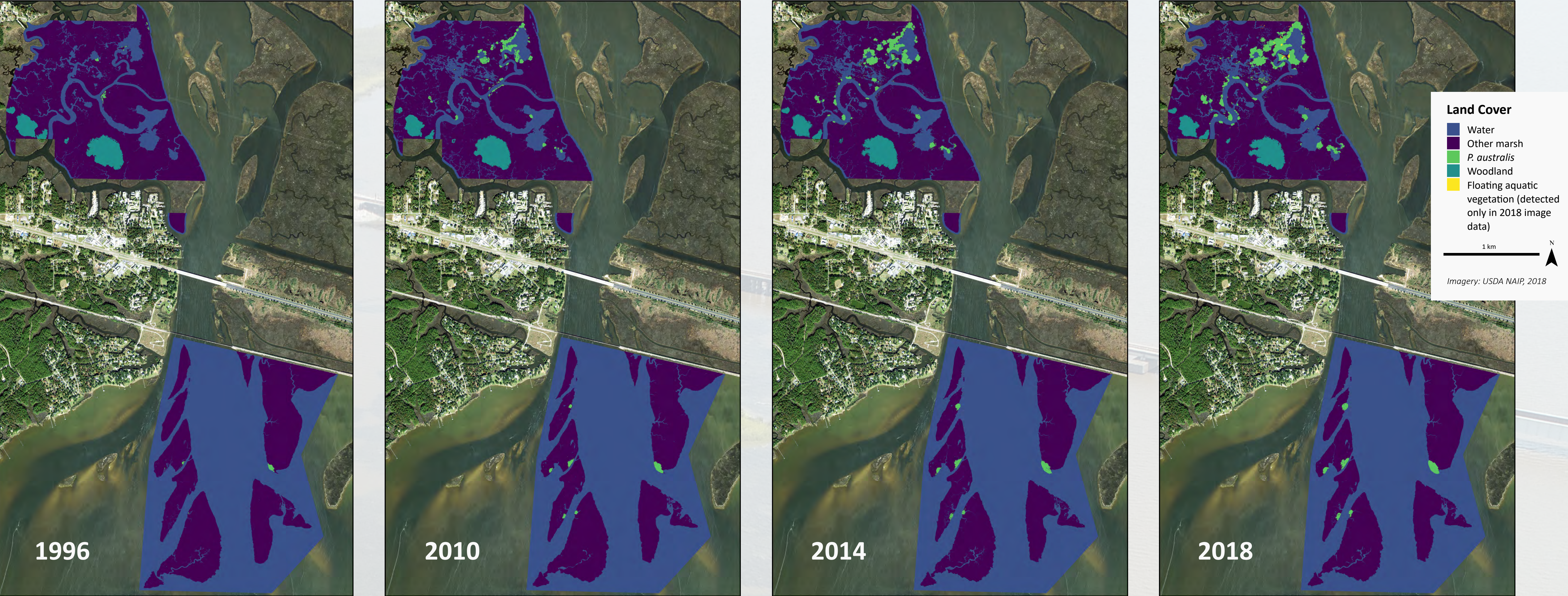


Fig. 2. Classification images for calendar years 1996, 2010, 2014, and 2018.

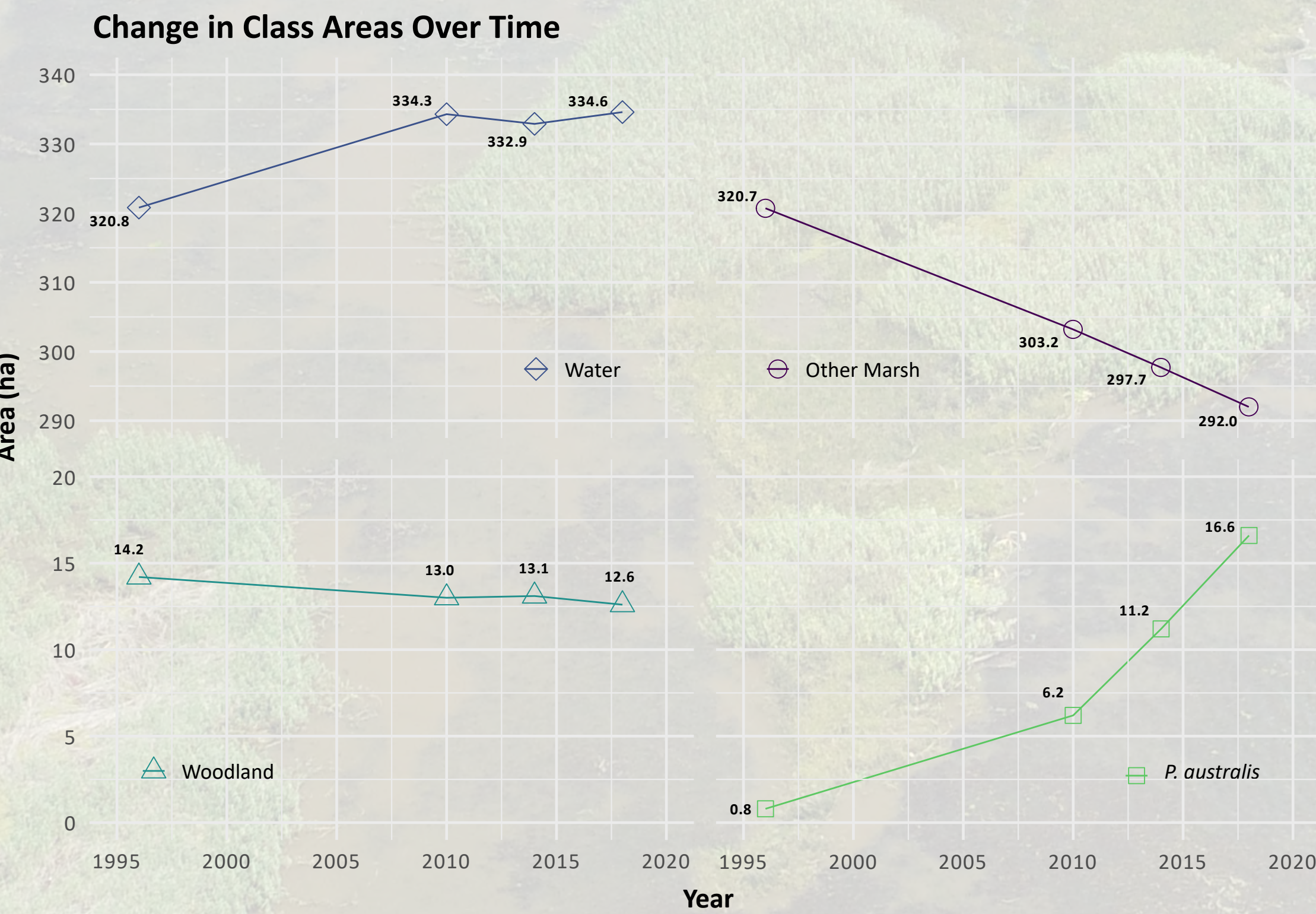


Fig. 3. Areas of each land cover class for each image date (1996, 2010, 2014, 2018).

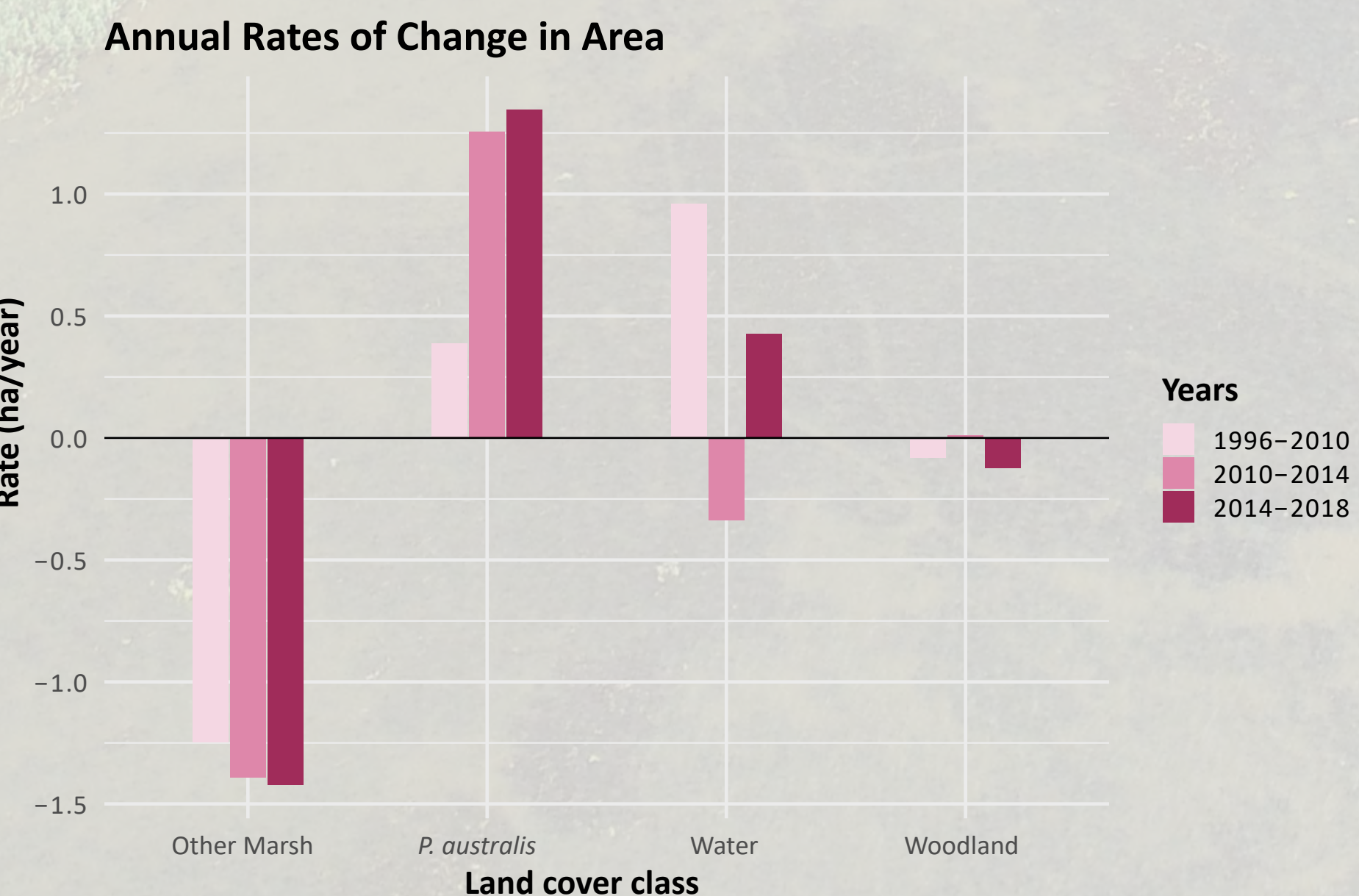


Fig. 4. Annual rates of change in area (ha/year) of each land cover class for each time interval (1996, 2010, 2014, 2018).

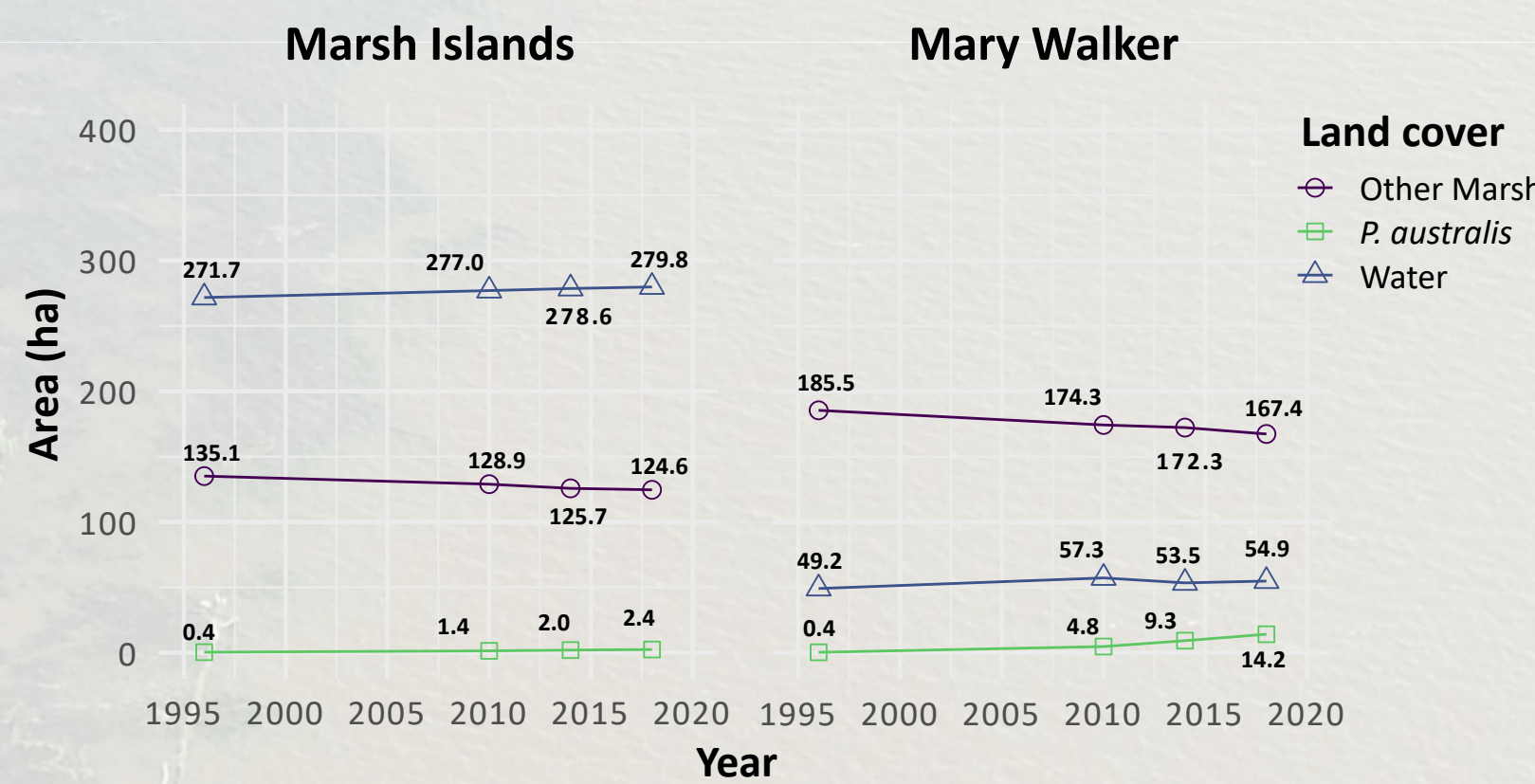


Fig. 5. Comparison of change in area of *P. australis*, Other Marsh, and Water classes over time at each site (Fig. 1).

Key Findings

- *P. australis* extent increased in each year for a total of 15.8 ha, as the area of all other marsh decreased for each image date (Fig. 2, 3, 4).
- Both sites exhibited an increasing trend in *P. australis* extent, with a 13.8 ha increase at the inland, protected, lower salinity site and a smaller 2.0 ha increase at the river mouth (Fig. 1, 5).
- *P. australis* colonized other marsh areas at a rate of 12.4 ha per year overall and open water at a rate of 3.4 ha overall, with lower but still positive rates of colonization at the exposed, higher salinity site (Fig. 6).

Land Cover Class Conversions (1996-2018)			
	Mary Walker	Marsh Islands	Total Study Area
Other marsh to <i>P. australis</i>	10.9 ha (4955 m ² /yr)	1.5 ha (659 m ² /yr)	12.4 ha (5616 m ² /yr)
Water to <i>P. australis</i>	2.8 ha (1268 m ² /yr)	0.6 ha (277 m ² /yr)	3.4 ha (1544 m ² /yr)
Other marsh to water	8.5 ha (3859 m ² /yr)	8.6 ha (3923 m ² /yr)	17.1 ha (7782 m ² /yr)

Fig. 6. Table of areal conversions between land cover classes (ha, in bold) computed between the 1996 and 2018 images, along with the equivalent annual rates of change (m² per year, in parenthesis).

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