Restoring Canebrakes to Enhance Water Quality Along the Upper Pearl River

Rachel Jolley, Mississippi State University
Diana Neal, Mississippi State University
Brian Baldwin, Mississippi State University
Gary Ervin, Mississippi State University

Large stands of rivercane [*Arundinaria gigantea* (Walt.) Muhl.], called canebrakes, initially covered millions of acres in the southeast US, playing a pivotal role in the hydrology, landscape ecology, and the cultural history of the First Nations of the Southeast. Because canebrakes are composed of very dense stands of rivercane, they act as ideal riparian buffers, dispersing overland flow, increasing soil porosity, and stabilizing streambanks. Unfortunately, large canebrakes have all but disappeared from the landscape due to overgrazing, agriculture, altered fire and flood regimes, and urban encroachment. In an effort to enhance water quality and wildlife habitat along the upper reaches of the Pearl River, a rivercane restoration project was initiated in June 2008. Over 1,200 rivercane seedlings were planted at eleven locations along a half-mile stretch of the Pearl River on land belonging to the Mississippi Band of Choctaw Indians (MBCI). Planting sites were selected as those susceptible to erosion (outer bends) and deposition (inner bends) in order to monitor the effect of canebrake establishment on stream bank stabilization. An additional nine sites were chosen along this same stretch for comparison (three sites with established rivercane and six without). Sediment markers were installed to monitor sediment depths within and outside of planting areas. Additional sediment markers were also inserted horizontally into eroding banks to monitor bank-sloughing along planted areas. Preliminary data indicate low survivorship in plantings at elevations susceptible to extended periods of inundation (less than 3 m above normal flow). Both planted and unplanted banks show moderate rates of erosion. Due to slow initial growth, rivercane seedlings may require several years to form effective riparian buffers.

Key words: conservation, sediments, water quality

Introduction

Early explorers and settlers in the southeastern US often noted the huge expanses of "cane", which dominated areas along streams and rivers (Harper, 1998; Platt & Brantley, 1997; Platt et al., 2002; Stewart, 2007). Rivercane, or giant cane [*Arundinaria gigantea* (Walt.) Muhl], was once a dominant feature along rivers and streams in the southeastern US, forming dense stands referred to as canebrakes. These habitats were sought after by hunters, herdsman and farmers for wildlife abundance, nutritious grazing, and rich soils (Rhodes, 2004; Stewart, 2007). Today, remnant canebrakes are valued for the ecological services they provide, including streambank stabilization, water filtration, and increased soil porosity. Although rivercane is still a common component of the forest understory, it is rare to find dense stands of any significant size (Noss *et al*., 1995). The demise of canebrakes has been attributed to grazing and agriculture activities, changes in fire frequency, alteration of natural flooding regimes, and land development projects (Brantley & Platt, 2001; Platt & Brantley, 1997; Platt *et al.*, 2002; Stewart, 2007) and has likely contributed to increased erosion and non-point pollution in streams and rivers.

The effectiveness of rivercane as a riparian buffer has been demonstrated in a mature canebrake in southern Illinois. On-going studies at Southern Illinois University show that a mature canebrake (30 year-old) was found to reduce groundwater nitrates by 99% (Schoonover & Williard, 2003), reduce nutrients in surface runoff (nitrate-N, dissolved ammonium-N, total ammonium-N, and total orthophosphate masses) by 100% (Schoonover *et al.*, 2005), and reduce sediments by 100% (Schoonover *et al.*, 2006) within a 10 m buffer. In all cases, the canebrake was a more effective buffer than the adjacent forest.

The objective of this study is to restore rivercane along the banks of the upper Pearl River and determine how rivercane establishment affects rates of sedimentation and erosion. We expected to see greater sediment retention and streambank stability in areas planted in rivercane compared with unplanted areas.

Methods

This study was conducted along the upper reaches of the Pearl River, Neshoba County, MS (Fig. 1). Eighteen plots were established along the banks of an approximately 800 m reach of the river. Three plots already had native stands of rivercane (natural stands), eleven plots were planted with rivercane seedlings at a density of 1 plant per m^2 (planted stands), and four plots were left unplanted for comparison (non-planted areas). Plot size varied according to the bank topography, with larger plots (averaging 100 m^2) on sandy beaches on inside bends and smaller plots (averaging 35 m^2) on steep, eroding banks of outside bends.

Restoration plots were planted in June 2008 with a total of 1,200 seedlings. Seedlings were grown in greenhouses at Mississippi State University from seed collected at Cullowhee, NC in May 2007. Seedlings were approximately 10 months old at planting. Each seedling was planted with a slow-release fertilizer pellet (Scotts Agriform™, 21-gram pellets, 20-10-5) and watered with approximately 1.5 liters of water following planting. Over 100 erosion pins, consisting of a 1.2 m rebar segment with a metal washer welded to the center (at 60 cm), were installed at each plot at a density of 1 per 8m^2. Each erosion pin also served to mark the sampling location for 1 m^2 vegetation quadrats. Sediment depth was measured seasonally from July 2008 to July 2009. Vertical cut-banks were monitored using erosion markers, consisting of a welding rod with bright yellow tape on one end, inserted horizontally approximately 30 cm into the bank.

Data were analyzed using analysis of variance (ANOVA), with repeated measures analysis (Proc GLM, SAS software, Version 9.2, Copyright © 2006 SAS Institute Inc., Cary, NC, USA.). Following significant ANOVA, Tukey's mean comparison test was performed. Differences between means were considered statistically significant at α=0.05, unless otherwise noted. Non-normal data (proportions) were analyzed using an arcsine transformation.

Results and Discussion

Planted seedlings had moderate survival through the first survey in early August 2008 (49.2%). The high initial mortality was likely due to the late planting (middle of June) and lack of rainfall during the first month following planting (0.12 cm). By fall 2008, survivorship had dropped to 23.4% and by spring 2009, survivorship was only 1.2%. Over-winter mortality was likely due to extended periods of inundation (Fig. 2). Seedlings were planted between 2.5 to 3.0 meters above gage height, while the river height was above 3 meters during much of the winter and early spring. The few rivercane survivors in the spring were those seedlings planted at the highest elevations (data not shown). Natural stands averaged 3.7-4.6 meters above gage height.

Not surprisingly, sedimentation rates did not differ between planted, non-planted, and natural sites (Table 1, Fig. 3-4) or between inside bends, outside bends, and straight segments (p=0.56 F=0.59, Fig.5-6) over the first eight months of monitoring. We expected natural stands to retain more sediment than non-planted sites, however, natural stands were found at slightly higher elevations than other areas and likely receive less sediment deposition from flood waters. Natural stands likely had little soil movement, as evidenced by the lower percentage of bare soil in these plots compared to non-planted and planted sites (Table 1). Natural stands exhibited slightly different soil composition as well, with significantly lower percentage of sand than planted and reference sites and a higher percentage of silt (Table 1). Natural stands also had no bank scars to monitor vertical bank loss. Therefore, vertical bank loss could only be compared between planted and non-planted sites (Fig. 7). Planted sites had greater bank loss during the third monitoring period ($p<0.09$, $F=3.0$). This may be attributed to greater soil disturbance associated with planting. Inside bends did exhibit greater sediment loss during the last monitoring period ($p<0.001$, $F=497.4$, Fig. 8).

Conclusion

After eight months of monitoring, areas planted with rivercane failed to establish, leading to no significant changes in sediment retention or bank stabilization. The lack of establishment was likely due to several factors, including the late planting date, the lack of rainfall following planting, and inundation by flood waters for an extended period of time. The lack of establishment suggests that perhaps future planting should be conducted earlier in the year (spring), when there is generally higher precipitation and lower evapotranspiration, and at higher elevations (similar to those of the natural stands). In an effort to repeat this study, we planted an additional 300 ramets (propagated from rhizome cuttings) in April 2009 along the upper banks of the study areas (approximately 12-15 feet above gage height). These areas will continue to be monitored seasonally through June 2010.

Acknowledgments

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Table 1. Mean comparison among stand type by sedimentation, bare soil, and soil particle size for study plots along the Pearl River, Neshoba Co., MS. Comparisons were made using ANOVA. Means followed by different letters represent significant differences across stand type by Tukey's HSD (a=0.05).

	Natural stands	*Planted stands*	*Non-planted*	*p-value*	*F statistic*
Sedimentation rate (cm $month^{-1}$)	0.33 ± 0.2	0.99 ± 0.4	0.56 ± 0.6	0.61	0.49
Bare soil (%)	11.7 ± 0.1 B	47.1 ± 0.3 A	50.9 ± 0.1 A	<0.001	18.49
Sand (%)	67.2 ± 3.6 B	83.4 ± 1.3 A	80.6 ± 2.4 A	<0.001	5.48
Silt (%)	29.5 ± 3.6 A	16.2 ± 2.3 B	13.6 ± 1.3 B	<0.001	5.37

Figure 1. Map of study area, showing study section of the Pearl River near Edinburg, MS.

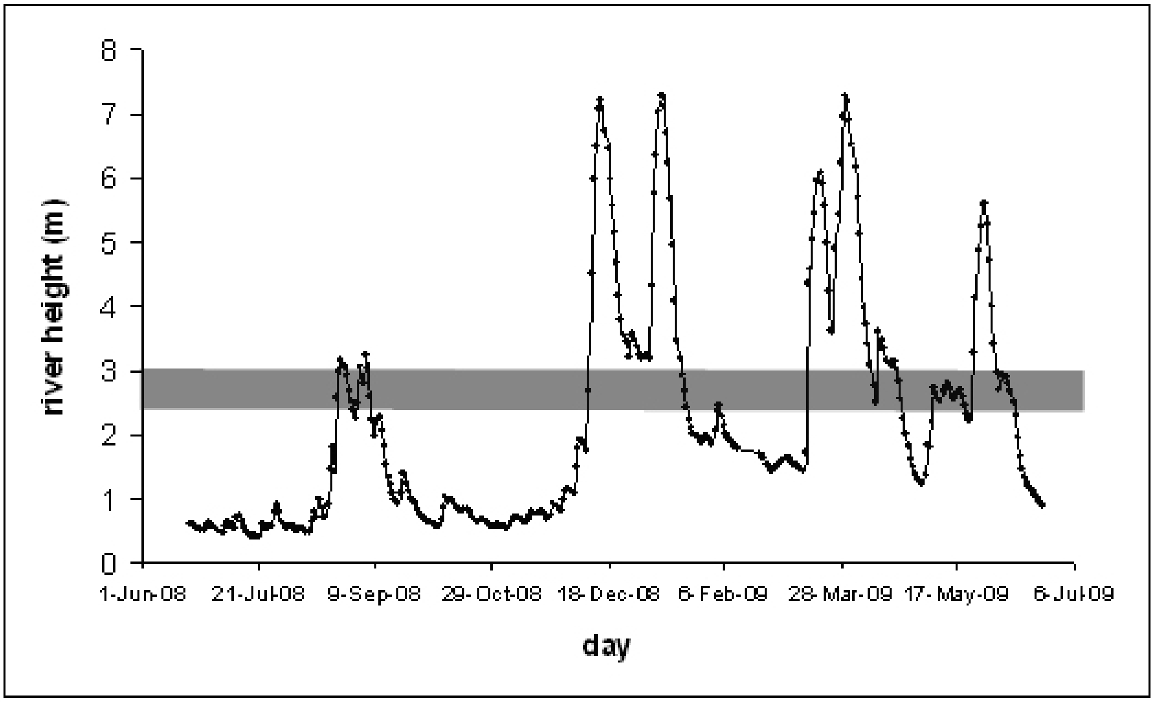

Figure 2. Pearl River water height at the Edinberg Station (approximately 1 mile downstream of study site) from mid-June 2008 to mid-July 2009. Mean planting elevation is represented by the grey band (between 2.5 and 3.0 meters above gage height).

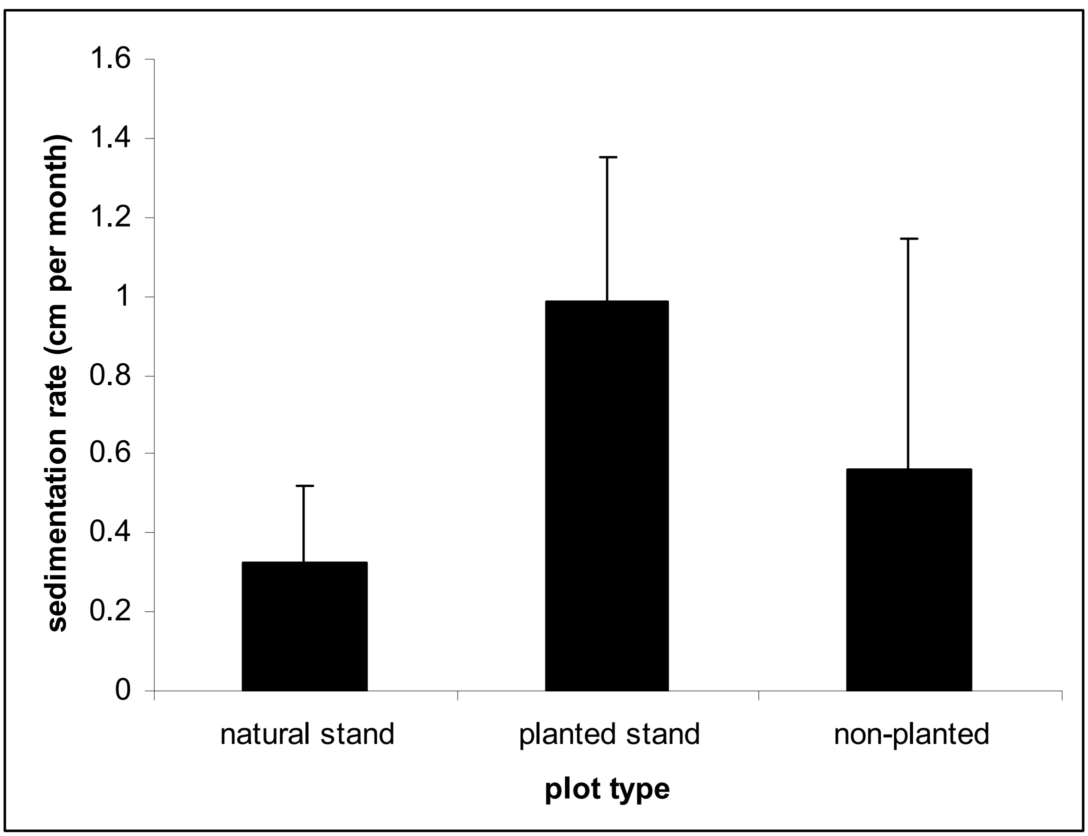

Figure 3. Mean comparison of sedimentation rate among plot types. Means did not differ by type (α=0.05).

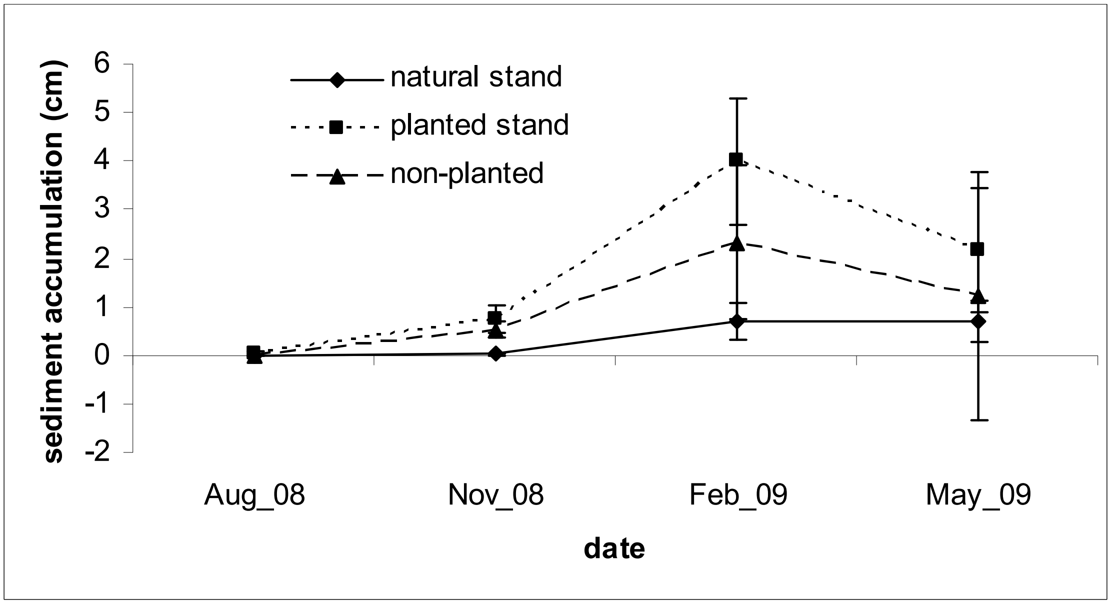

Figure 4. Mean sediment accumulation from August 2008 to May 2009 among plot types. Means did not differ by type (α=0.05).

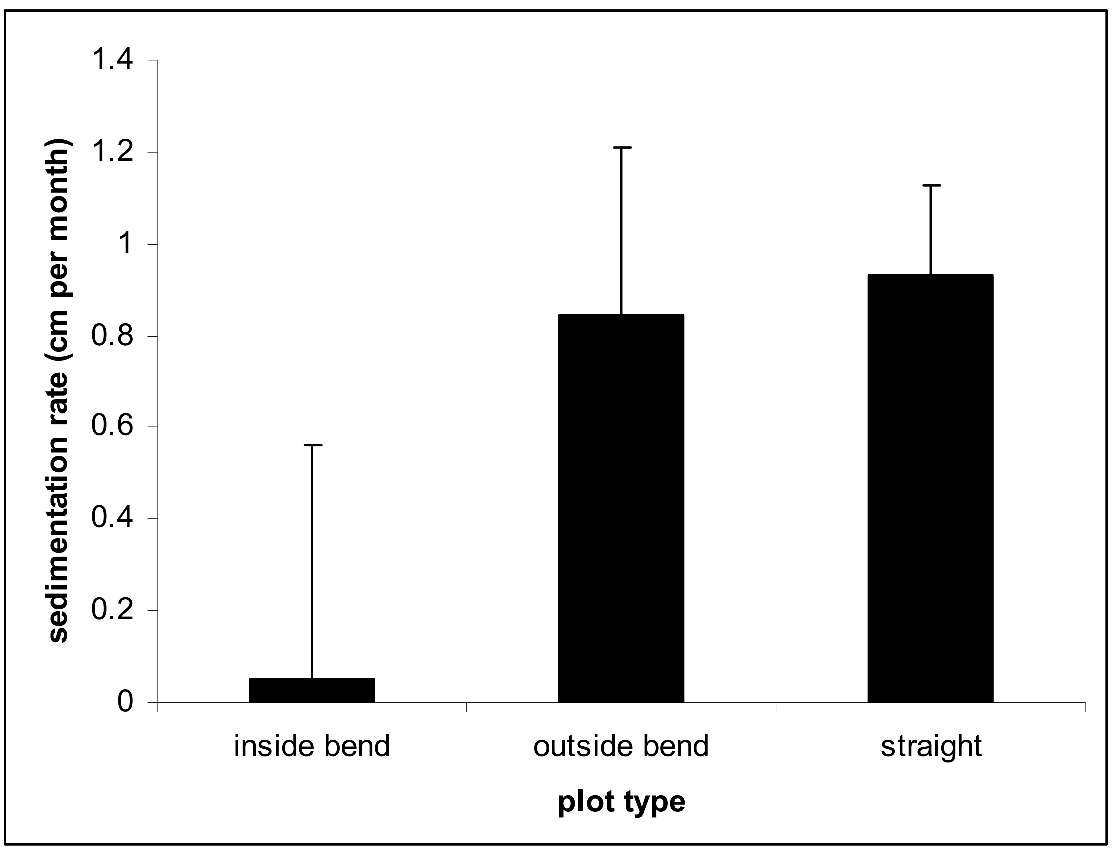

Figure 5. Mean comparison of sedimentation rate among plot types. Means did not differ by type (α=0.05).

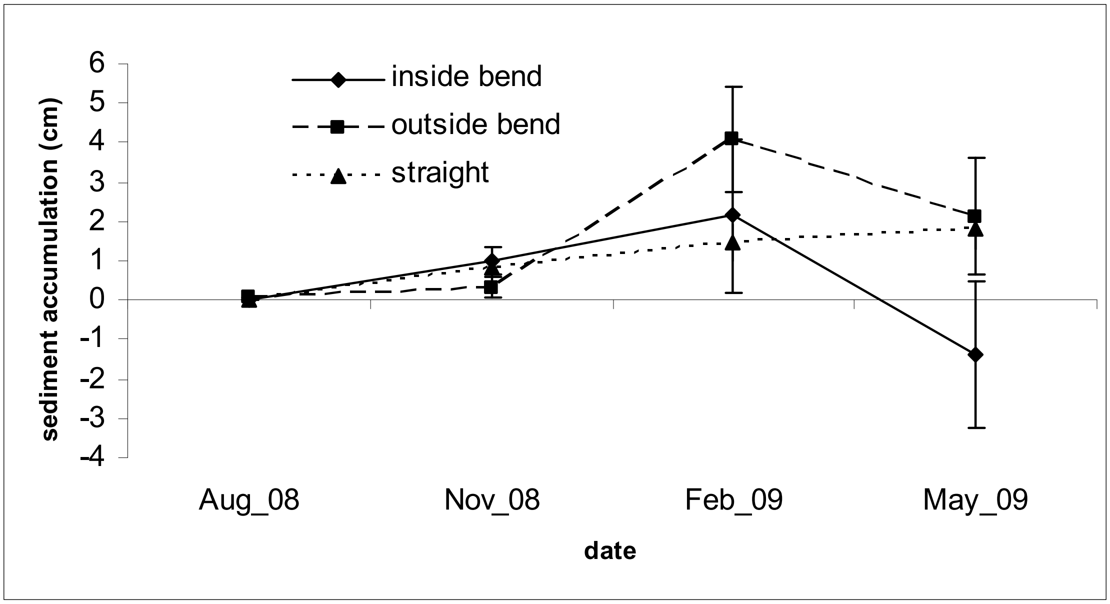

Figure 6. Mean sediment accumulation from August 2008 to May 2009 among plot types. Means did not differ by type (α=0.05).

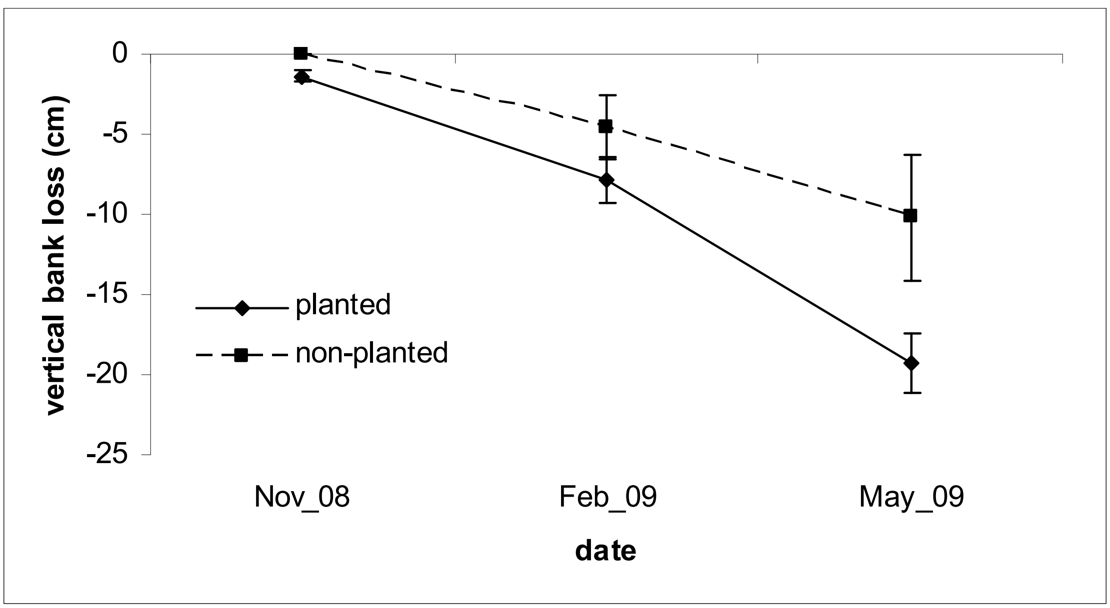

Figure 7. Mean vertical bank loss from November 2008 to May 2009 among plot types. Differences in means in May 09 were significant at α=0.09.

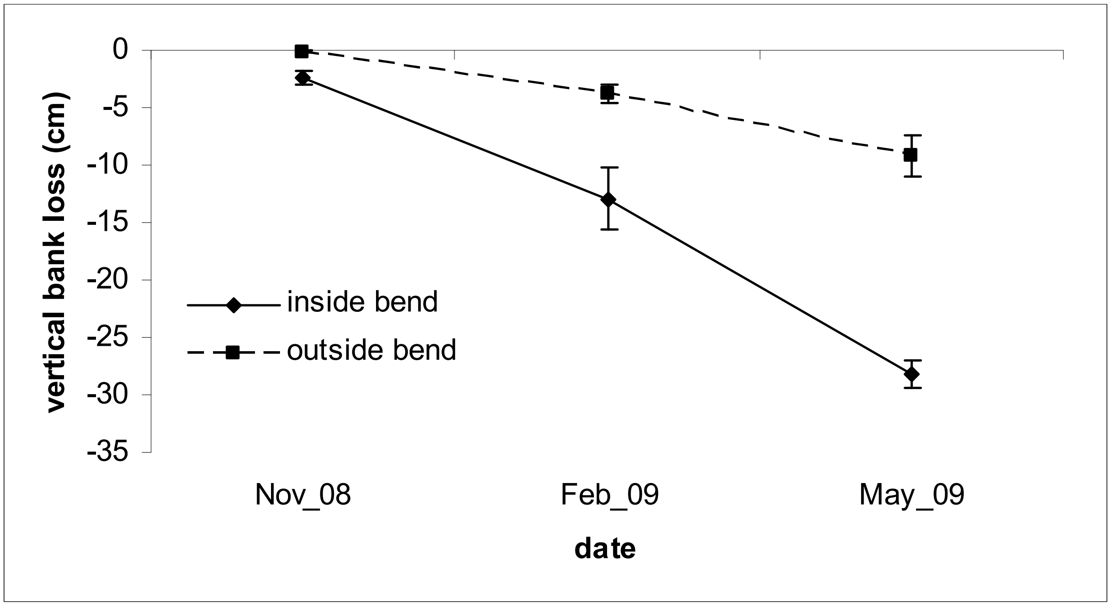

Figure 8. Mean vertical bank loss from November 2008 to May 2009 among plot types. Means differed at each date (α=0.05).