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Native Bamboo [*Arundinaria gigantea* (Walter) Muhl., Poaceae] Establishment and Growth after the Removal of an Invasive Non-Native Shrub (*Ligustrum sinense* Lour., Oleaceae): Implications for Restoration

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ABSTRACT Giant cane (*Arundinaria gigantea*) is a native bamboo species that was once abundant in wetlands and riparian areas throughout the Southeastern United States. As part of an effort to identify competitive-dominant native species that can be utilized to maximize the restoration of riparian ecosystem functions/services and reduce non-native community invasibility, we transplanted cane clump divisions into areas either dominated by or recently cleared of Chinese privet (*Ligustrum sinense*), an invasive non-native shrub. We quantified cane survival and growth in the presence of privet and other plants including several common invasive non-natives. Removal of mature privet via a cut and paint application of glyphosate herbicide resulted in 100% mortality. Cane survival was high in both the high and low-light conditions provided by the opposing privet treatments. During the first year, there was little cane growth or expansion in either privet treatment. In the second year, cane growth and expansion in the Privet-Present treatment was also very low. However, during the second year in the Privet-Removed treatment, cane genets produced more ramets, increased in genet area, and developed ramets that were taller and thicker. Despite very high recruitment and cover of Japanese stilt grass (*Microstegium vimineum*) and other common invasive non-natives in the Privet-Removed treatment, transplanted cane genets continue to grow and expand. Our future research will continue to monitor the rate of cane growth as we investigate whether cane can compete with the common non-native invasive species that are dominant at this site and at other riparian ecosystems throughout the region.

INTRODUCTION Riparian restoration efforts have historically focused more on abiotic conditions (e.g., hydrology, topography) and less on the biotic community. In the Southeastern United States, the outcome of such efforts is often plant communities dominated by invasive non-native species such as Chinese privet (*Ligustrum sinense* Lour.), Japanese stiltgrass [*Microstegium vimineum* (Trin.) A. Camus], and Japanese honeysuckle (*Lonicera japonica* Thunb.). These three species are especially common in the region and have the potential to impede the restoration of ecosystem structure, functions, and services (Ehrenfeld et al. 2001, Morris et al. 2002, Schierenbeck 2004). Restricting the spread of invasive non-native species at the regional level is very unlikely. However, at the local level (e.g., a specific restoration site), ecologists should be able to use an understanding of ecological competition theory related to invasive species plant biology to limit non-native invasions and improve efforts to restore ecosystem structure and functions.

Since interspecific competition is recognized as one of the primary mechanisms controlling plant community composition (Harper 1977, Grime 1979, Tilman 1982), identifying and utilizing native competitive-dominant plant

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species is a reasonable starting point for restoration efforts. Competitive-dominant species typically determine ecosystem functions (Grime 1998, Walker et al. 1999, Cardinale et al. 2006) and dictate community invasibility (Crawley et al. 1999, Smith et al. 2004, Emery and Gross 2007). However, surprisingly little research has focused on identifying and utilizing native competitive-dominant species for riparian restoration purposes in the Southeast. We ask the following question: which native competitive-dominant plant species can be used during riparian restoration to maximize ecosystem functions/services and also reduce non-native community invasibility? We define non-native community invasibility as the extent to which a plant community or restored area is susceptible to recruitment, growth, and eventual dominance of non-native species.

Giant cane [*Arundinaria gigantea* (Walter) Muhl.] is a competitive-dominant woody grass (i.e., a bamboo) that was once very abundant in riparian and wetland ecosystems throughout the Southeastern United States (Bartram 1791, Platt and Brantley 1997, Stewart 2007). European settlers in the region found vast expanses of monotypic cane stands and often referred to them as canebrakes. There are three native bamboo species in the United States: giant cane (*A. gigantea*), switch cane [*A. tecta* (Walter) Muhl.], and hill cane (*A. appalachiana* Tripplett, Weakley, and L.G. Clark) (Triplett et al. 2006). This research examines giant cane and any future mention of "cane" in the text will refer exclusively to *A. gigantea*.

Giant cane is a perennial woody grass with dense mats of underground rhizomes, dense ramets, and evergreen foliage leaves. Although giant cane has the potential to expand aggressively through vegetative reproduction, cane dispersal is relatively infrequent and very understudied (Gagnon and Platt 2008b). Riparian cane buffers have been shown to reduce sediment load, groundwater nitrate, groundwater phosphate, and surface runoff nutrients (specifically nitrate, ammonium, and orthophosphate) to adjacent aquatic ecosystems (Schoonover and Williard 2003; Blattel et al. 2005; Schoonover et al. 2005, 2006). In addition to these potential water quality-related ecosystem services, canebrakes also provide habitat for a wide range of unique and obligate wildlife species (Brantley and Platt 2001).

Despite cane's historical presence in the region and its tremendous potential for vegetative expansion via clonal growth, few studies have investigated the utility of cane for floodplain restoration. Insufficient information is available regarding the transplantation, establishment, growth, and competitive ability of this species. Many bamboo species can be effectively propagated via clump division, a method that refers to the transplantation of a clump of culms and rhizomes collected from a donor bamboo stand (McClure 1966). However, previous investigations of the effectiveness of giant cane propagation via clump division have shown mixed results (Feedback and Luken 1992, Platt and Brantley 1993, Dattilo and Rhoades 2005). Furthermore, these studies typically have focused solely on cane survival and growth and have ignored or even avoided the impact of competition from other species.

Although the focus of this experiment is primarily on giant cane survival, growth, and expansion, the experimental design specifically manipulates the presence of Chinese privet and we also investigate the effectiveness of Chinese privet removal. In riparian forests of the Southeastern United States, Chinese privet is one of the most common invasive non-native shrubs (Miller 2003, Webster et al. 2006). In this study, future mention of "privet" in the text will refer exclusively to *Ligustrum sinense*. Privet is a native of China, Laos, and Vietnam, that was introduced to the United States in the 19th century for ornamental purposes (Urbatsch 2000). It is a shade-tolerant evergreen shrub of the olive family (Oleaceae). When trained, it serves as an effective fence-like barrier due to its rapid growth and ability to reproduce vegetatively. Privet produces large quantities of fruit whose seeds are thought to be dispersed primarily by birds. Once germinated, privet can outcompete most native shrubs and prevent understory succession due to its ability to acquire and block light (Merriam and Feil 2002, Morris et al. 2002). Mature privet stands often reach heights of 6 to 7 meters or more (Brown and Pezeshki 2000, Miller and Albritton 2004). As a result, this species has successfully invaded both urban and rural riparian forests in the region. Although privet's distribution in the United States is large, it appears to be most invasive in the Southeast. Privet appears to tolerate a wide range of conditions ranging from sunny and dry to shaded and flooded. However, privet thrives in riparian areas where it often forms dense monospecific stands (Merriam 2003, Burton et al. 2005, Loewenstein and Loewenstein 2005). Privet growth is much greater under elevated CO_2 concentrations and this species is expected to become more invasive with future increases in atmospheric CO_2 (Smith et al. 2008).

The broad purpose of this investigation is to clarify the potential for using giant cane for floodplain and canebrake restoration. We specifically were interested in determining whether giant cane can compete with and ultimately replace widespread invasive non-native species like Chinese privet and Japanese stilt-grass. Our research questions were the following: (1) *Giant cane establishment and growth*. How effective is giant cane transplantation via clump division and will transplanted giant cane genets be able to grow and expand despite competition from invasive non-native species?; (2) *Chinese privet control*. How effective is the cut and paint method for removing mature stands of Chinese privet?; and (3) *Recruitment and growth of other species*. Which species will recruit and be dominant after privet removal? What portion of these species will be invasive non-natives and what will be the impact of giant cane upon post-transplantation non-native dominance and community invasibility?

METHODS

Study Site

This research was conducted within the Duke University Wetland Center's Stream and Wetland Assessment and Management Park (SWAMP) in Durham County, North Carolina (lat 35°59′27″, long 78°56′28″). The site is located within the floodplain of Upper Sandy Creek, a headwater piedmont stream within the Cape Fear River Basin. This section of Upper Sandy Creek has a drainage area of approximately 480 ha that includes much of Duke University's West Campus. The climate at the site includes a growing season of roughly 200 d. The thirty-year mean annual temperature and precipitation near the site was 15.3°C and 1090 mm, respectively [based on data from 1971–2000 (NOAA 2008); measured at the Raleigh-Durham International Airport which is 19 km away]. However, 2006 and 2007 were relatively abnormal years with annual precipitation values of 1,360 and 910 mm, respectively.

Soil series at the site include Cartecay (coarse-loamy, mixed, nonacid, thermic Aquic Udifluvents) and Chewacla (fine-loamy, mixed, thermic Fluvaquentic Dystrochrepts). Adjacent soil series that drain into the site include Mayodan (clayey, kaolinitic, thermic Typic Hapludults) and White Store (fine, mixed, thermic Vertic Hapludalfs) (Kirby 1976). The riparian forest canopy in the Upper Sandy Creek floodplain is dominated by *Acer rubrum* L., *Liriodendron tulipifera* L., *Liquidambar styraciflua* L., and *Ulmus americana* L. (Watts 2000). The specific portion of the floodplain where this experiment was conducted is also dominated by *Acer negundo* L. The understory shrub layer is dominated by dense stands of *Ligustrum sinense*.

Experimental Design

Since quantifying the impact of privet removal cannot be accomplished in small areas and requires a treatment buffer to provide relatively homogenous light conditions, a randomized split-plot experimental design was established with two factors: Privet-Presence and Cane-Planting. Privet-Presence treatments (two levels: Privet-Present and Privet-Removed) were applied as the whole-plot factor to 40-m^2 plots. The Cane-Planting treatments (two levels: No Cane and Cane) were applied as the subplot factor to 4-m^2 subplots (for an illustration of the experimental design, see Figure 1). Since the understory in a portion of the research area contains extensive coverage of the ground cover *Hedera helix* L., two blocks were established to account for potential confounding effects associated with *H. helix* presence (Block 1: *H. helix* not present, Block 2: *H. helix* present); whereas six replicates were randomly established in Block 1, three replicates were randomly established in Block 2. In total, the experimental design includes 18 whole-plots and 36 subplots. In order to minimize light variation due to edge effects, whole-plot treatments were also applied to a 1.5-m buffer around each subplot. Whole-plots and subplots were randomly assigned treatments. To facilitate sampling, paired subplots within whole-plots were separated by at least 50 cm.

Privet Removal

In the Privet-Removed treatment, privet stems were cut 3–5 cm above the ground in March 2006 and exposed stumps were immediately

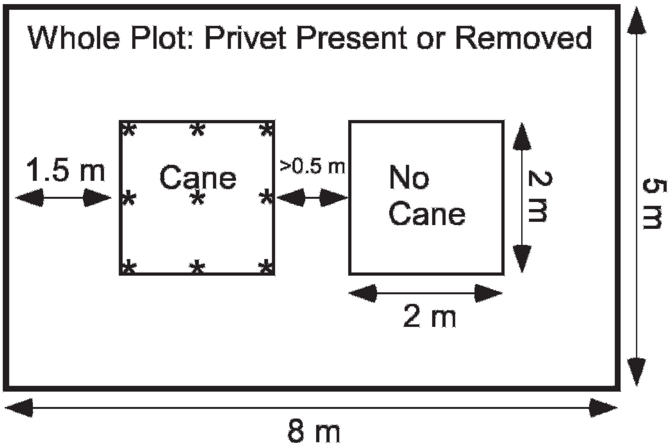

Figure 1. An illustration of the experimental design. The Privet treatment (Privet-Present or Privet-Removed) was applied to 40-m^2 whole plots. The Cane transplantation treatment (Cane or No Cane) was applied to 4-m^2 subplots. In the Cane subplot treatment, nine *Arundinaria gigantea* clump divisions were transplanted as depicted by the asterisks in the illustration.

painted with undiluted 50.2% glyphosate (Roundup® Weed and Grass Killer Super Concentrate, Monsanto Company, St. Louis, Missouri). We refer to this removal method as "cut and paint" (as discussed in Miller and Albritton 2004). Since this stand was close to monotypically privet, very few species remained in the plots after privet removal. This privet removal method resulted in 100% mortality; none of the privet treated in this manner resprouted. In the Privet-Present treatment, the privet stands were left intact.

Cane Planting via Clump Division

The cane treatments were applied at the subplot level in late April 2006. Whereas the No Cane treatments received no cane transplants, nine clump divisions were transplanted within each Cane Planted treatment plot (planting arrangement resulted in a density of 2.25 clump divisions/m^2 with clumps planted in three rows, 1 m apart). The 162 clump divisions were obtained from a donor cane stand along the floodplains of New Hope Creek within the Jordan Game Lands, Durham, North Carolina. This donor cane stand is about 7 km downstream of the study area and is one of few remnant cane stands within Durham city limits. The topography, hydrologic regime, and forest composition of the donor stand are similar to the conditions at the research site. Clump divisions were approximately 30 cm in diam, 15 cm deep, and contained 1–5 ramets (mean # of ramets $\pm$ SE $= 1.8 \pm 0.1$). In order to prevent desiccation and maximize transplantation survival, the clump divisions were buried in a bed of saturated peat moss during transport and planted the same day. To reduce transpiration, the number of leaves on each transplant was reduced by pruning each ramet at the lowest branching node, typically the third or fourth node. During transplanting, we dug a hole, inserted the clump division, and used the soil from the hole to cover the transplanted clump. We lightly compacted this soil with our hands to minimize evaporation and desiccation. Transplants were watered via precipitation or manually almost every day for the first two weeks after transplantation. The number of ramets and the diameter of these ramets were recorded for each clump division. Transplantation survival was determined by the number of genets alive at the end of the first and second growing seasons. Once a clump division survived transplantation, we refer to the group of rhizomes and culms as a genet. Each individual culm or shoot is referred to as a ramet.

Light Measurements

In order to compare canopy transmittance between treatments, we measured Photosynthetically Active Radiation (PAR) within each subplot using a linear PAR ceptometer (AccuPAR, Decagon Devices, Pullman, Washington). AccuPAR instantaneously averages PAR measurements at 80 independent photodiode sensors spaced at 1-cm intervals. In order to account for daily fluctuations in PAR due to changes in the angle of the sun, we measured PAR within each subplot once each hour for seven consecutive hours on two different days. For each time period and within each subplot, we took twelve measurements during cloudless periods (three in each of the four cardinal directions for a total of 960 photodiode measurements per time period). Each subplot estimate represents the mean of 14 time-period estimates where each is the mean of 960 photodiode measurements. During analysis of the whole plot treatment effect, we used the mean of the two subplot estimates from each whole plot.

Vegetation Measurements: Growth, Expansion, and Recruitment

The height and diameter of each new giant cane ramet was measured at the end of each of the first two growing seasons. Since destructive sampling for belowground biomass was not possible, total genet area was used as a substitute and determined as the product of the greatest distance between two ramets and the distance between two ramets that were perpendicular to that axis (*sensu* Datillo and Rhoades 2005). Understory species presence and percent cover were measured in each plot at the end of both growing seasons. Percent cover was quantified as the estimated percent cover and not via the use of cover classes. In order to gauge species dominance, we used the percent cover values to calculate frequency and importance values (I.V.), calculated as: I.V. = (Mean Cover * Frequency) / 100.

Statistical Analyses

To assess the impact of privet removal and time on cane growth and expansion, we conducted a univariate repeated measures analysis of variance (ANOVA) for cane genet area, number of ramets per genet, ramet diameter, and ramet height data using SAS Version 9.1.3 (SAS Institute, Cary, North Carolina). To avoid pseudoreplication, we used the mean of all nine cane genets present in a subplot for all analyses and figures. Our model was structured with Block, Privet (Privet-Presence treatment), Year, and the Privet*Year interaction. To improve normality and better meet the assumptions of ANOVA, genet area and the number of ramets per genet were log-transformed prior to analyses. Block was treated as a random effect and there was no significant block effect for any of the cane growth and expansion models. Comparisons of means between treatments within years and between years within treatments were conducted using Student's t-tests and repeated measures t-tests, respectively. Survival analyses were conducted using Pearson chi-square tests to compare clump division survival between Privet-Presence treatments.

To assess the impact of privet removal, time, and cane transplanting on the abundance of native and non-native plants, we conducted a univariate repeated measures split-plot analysis of percent cover of bare ground, non-native plant species, and native plants species. The model was structured with Privet, Cane (presence or absence), Year, and the two and three-way interactions. In order to avoid the confounding impact of pre-existing and extensive *H. helix* coverage in Block 2 on recruitment after privet removal, this model was developed with Block 1 data. Comparisons of means between treatments within years and between years within treatments were conducted using Student's t-tests and repeated measures t-tests, respectively. Statistical significance was assigned at $\alpha < 0.05$.

RESULTS

Chinese Privet Removal, Chinese Privet Recruitment, and Light Availability

The use of the cut and paint method to remove mature privet individuals resulted in 100% mortality. However, privet recruitment following removal of mature individuals was high but spatially patchy; for Year 1, the mean ± 1SE was 26.0 ± 9.7 seedlings/m^2 and the range was 0–157 seedlings/m^2. As expected, privet removal resulted in greater light availability; the mean PAR ± 1SE for the Privet-Present and Privet-Removed plots was 52.1 ± 2.9 and 211.2 ± 29.6 μmol/m^2/s, respectively ($t = 5.4$, $p < 0.001$).

Cane Survival

After two years, cane survival for all clump divisions was 91%. Of the 162 total clump divisions transplanted, 11 died during the first growing season (Table 1). During the second growing season, only three additional clump divisions died. There were no significant differences in cane survival between the Privet-Present and Privet-Removed treatments in either Years 1 or 2 (Table 1).

Table 1. *Arundinaria gigantea* clump survival after transplantation via clump division. Data shown are the total number of individuals in each category. Data in parentheses represent either survival or mortality percentages at the end of the growing season relative to the number that were alive at the start of the growing season. There were no significant differences in cane survival between the Privet—Present and Privet—Removed treatments in either Years 1 or 2 (Year 1: $\chi^2 = 2.4$, $p = 0.12$; Year 2: $\chi^2 = 2.8$, $p = 0.09$)

	Privet Present	Privet Removed
Year 1		
Live—start of growing season	81	81
Live—end of growing season	73 (90%)	78 (96%)
Dead—end of growing season	8 (10%)	3 (4%)
Year 2		
Live—start of growing season	73	78
Live—end of growing season	71 (97%)	77 (99%)
Dead—end of growing season	2 (3%)	1 (1%)

Cane Growth and Expansion

At the end of Year 1, there were no significant differences in cane genet area, total number of ramets per genet, ramet height, or ramet diameter between the Privet-Present and Privet-Removed treatments (compare Year 1 black and gray bars in Figures 2 and 3). However, by the end of Year 2, all measurements of cane growth (ramet height and diameter) and expansion (genet area and number of ramets per genet) were greater in the Privet-Removed plots (compare Year 2 black and gray bars in Figures 2 and 3; t = 6.0, 6.0, 5.0, and 4.1, respectively; $p \leq 0.0001$, 0.0001, 0.001, and 0.002, respectively). Although there were no significant differences in either cane growth or expansion for the Privet-Present plots during the two-year time frame of the experiment (compare black bars for both years in Figures 2 and 3), there was significant growth (ramet height and diameter) and expansion (genet area and number of ramets per genet) in the Privet-Removed plots (compare gray bars for both years in Figures 2 and 3; t = 12.4, 4.9, 5.0, and 5.8, respectively; $p \leq 0.0001$, 0.002, 0.001, and 0.001, respectively).

Plant Percent Cover, Frequency, and Importance Values after Privet Removal

Privet-Present plots had very little vegetation beneath the dense privet canopy in either year. Hence, we focus on the change in cover in the Privet-Removed plots in these analyses. As expected, the percent cover of bare ground after privet removal decreased from Year 1 to Year 2 in both the Cane and No Cane plots (compare black bars for both years and gray bars for both years in Figure 4a; t = 4.0 and 3.9, respectively; p = 0.01 and 0.01, respectively). At the end of the second growing season, Privet-Removed plots were dominated primarily by non-native species (Table 2) and there was no significant difference in non-native cover in the plots with or without Cane (compare Year 2 black and gray bars in Figure 4b). In Privet-Removed plots with No Cane transplants, there was a large increase in non-native cover (compare black bars for both years in Figure 4b; t = 3.1, p = 0.03) and an insignificant increase in native cover during the second year (compare black bars for both years in Figure 4c). In Privet-Removed plots with Cane transplants, there was an insignificant increase in non-native cover during the second year (compare gray bars for both years in Figure 4b), and a large increase in native cover (compare gray bars for both years in Figure 4c; t = 4.4, $p < 0.01$). The majority of the native cover in these Privet-Removed plots with Cane consists of one species, the transplanted cane (Table 2). The only other native species in these plots with an importance value that ranked in the top five was *Phytolacca americana* L. which was frequently present but with a relatively small mean cover (Table 2).

DISCUSSION

Moisture availability during transplantation appears to play an important role in determining the survival of giant cane clump divisions (Platt and Brantley 1993, Dattilo and Rhoades 2005); transplantation is more likely to be successful when implemented early in the growing season and in conditions that will minimize desiccation. In this study, cane transplantation via clump division was very successful. However, we must note that we were very careful to insure high moisture availability during clump transport and also during the first two weeks post-transplantation. Successful use of this species by the restoration community will likely require a similar level of initial transplant care to ensure comparable transplant survivability. Once established, cane transplants appear to be very drought-resilient; despite an extraordinary drought in the second growing season of this study (2007), cane survival was very high. In an experi-

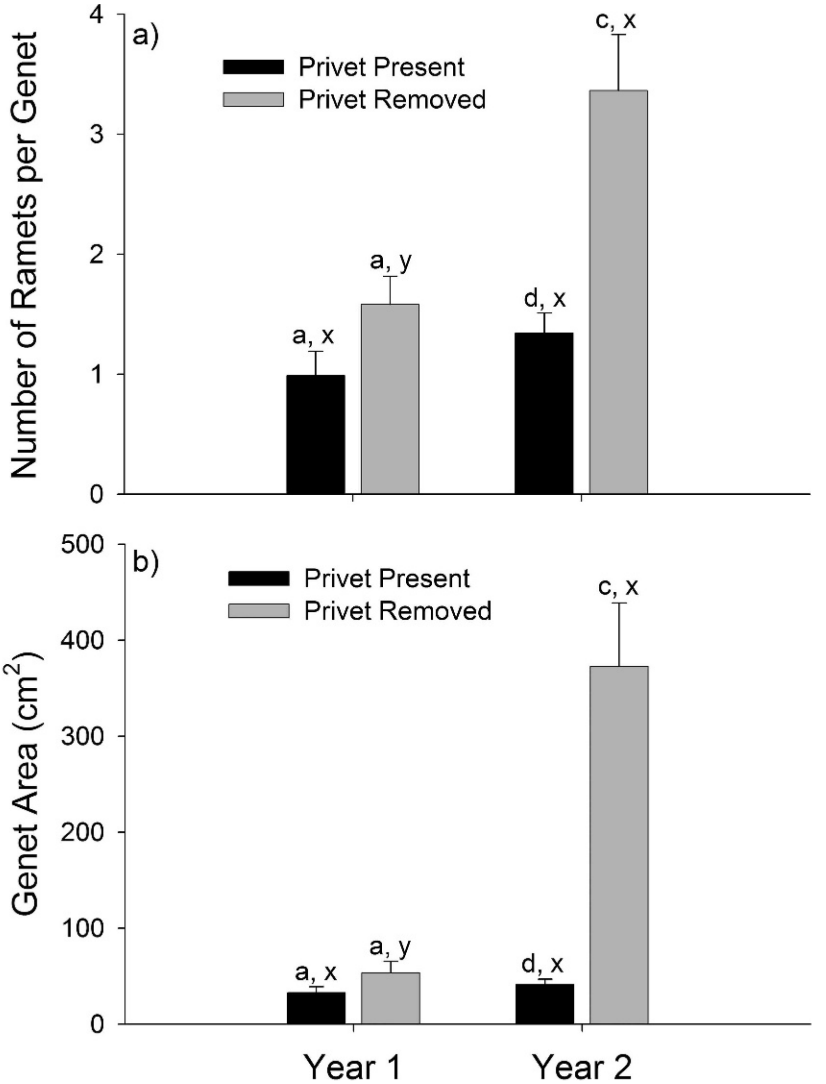

Figure 2. Effect of Privet-Presence and Year on: a) mean # of ramets per *Arundinaria gigantea* genet; and b) mean *A. gigantea* genet area. Error bars depict +1SE. Columns not connected by the same letter are significantly different ($\alpha < 0.05$). Whereas the first letter (a or b for year 1; c or d for year 2) refers to comparisons between treatments within each year, the second letter (x or y) refers to comparisons between years within each treatment.

ment with cane seedlings, Cirtain et al. (2004) found similar results; cane seedling survival was high despite periodic drought conditions. However, they also found the cane seedling growth was reduced during drought conditions (Cirtain et al. 2004).

With regards to light availability, cane survival was high in both the low and high-light conditions provided by the privet treatments indicating that cane transplants can tolerate diverse light conditions in at least the first several years. This finding is supported by Gagnon et al. (2007) who found that cane is able to persist sparsely in low-light environments. Despite high survival, cane growth and expansion during the first year of this study was minimal and not different in the contrasting light conditions provided by the privet treatments. Datillo and Rhoades (2005) also observed minimal growth and expansion during the first year post-transplantation. In the second year of our investigation, the genets not beneath a privet canopy (i.e., higher light availability and potentially greater availability of other resources such as moisture and nutrients) produced more ramets, expanded in

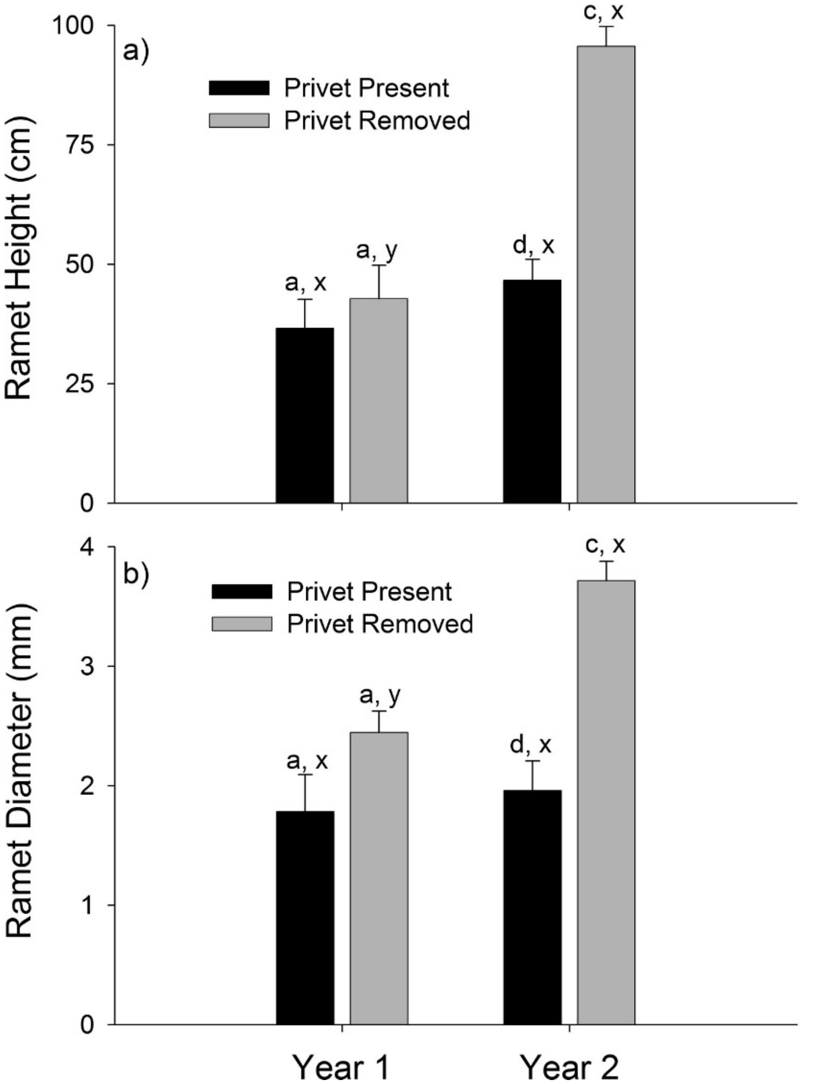

Figure 3. Effect of Privet-Presence and Year on: a) mean *Arundinaria gigantea* ramet height; and b) mean *A. gigantea* ramet diameter. Error bars depict +1SE. Columns not connected by the same letter are significantly different ($\alpha < 0.05$). Whereas the first letter (a or b for year 1; c or d for year 2) refers to comparisons between treatments within each year, the second letter (x or y) refers to comparisons between years within each treatment.

genet area, and grew taller and thicker. Fire and gap opening disturbances have been shown to stimulate cane growth and canebrake formation (Gagnon 2006, Gagnon et al. 2007, Gagnon and Platt 2008a), and we expect that in future years the difference in cane growth and expansion between privet treatments will be even more dramatic as the cane genets in the Privet-Removed treatment continue to grow and expand more rapidly.

Cane restoration via clump division is an effective but somewhat labor intensive process. However, cane is not readily available commercially and other techniques for propagation are not yet widespread. In the next decade, it is likely that more efficient and commercially viable techniques for cane propagation and canebrake restoration will be available (Sexton et al. 2003, Brendecke and Zaczek 2008). In the meantime, clump division appears to be a relatively simple and effective way to transplant cane into a site. Even if cane propagules become more available commercially in the future, restoration via clump division may continue to be a valuable technique for cane transplantation,

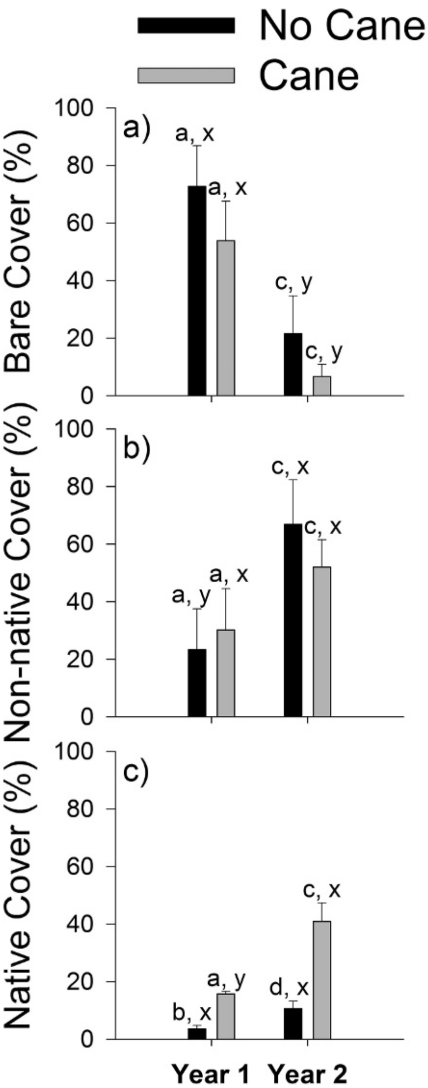

Figure 4. The effect of *Arundinaria gigantea* transplantation via clump division and time on (a) mean bare, (b) mean native plant, and (c) mean non-native plant percent cover in plots where privet was removed. Error bars depict +1SE. Columns not connected by the same letter are significantly different ($\alpha < 0.05$). Whereas the first letter (a or b for year 1; c or d for year 2) refers to comparisons between treatments within each year, the second letter (x or y) refers to comparisons between years within each treatment. Bare refers to the area not covered by vegetation. This figure only depicts the change in cover after privet removal. Plots with privet had very little vegetation beneath the dense privet canopy throughout the study and are not included in this figure.

particularly in sites where restoration objectives stipulate the use of local genotypes.

One of our tangential objectives was to assess the cut and paint method for removal of mature privet individuals. This method resulted in 100% mortality in this study and appears to be an effective means for removing mature stands of privet (Miller and Albritton 2004). As expected, privet removal resulted in rapid recruitment and growth of other plant species. To our knowledge, this is the first study to assess cane growth in the presence of other plant species in a restoration context, particularly common invasive non-native species. Invasive non-native plants are common in Southeastern United States floodplain ecosystems/restoration sites and we were especially interested in monitoring cane growth in the presence of the following invasive non-native species: *Microstegium vimineum*, *Ligustrum sinense*, and *Lonicera japonica*. In these initial years, *M. vimineum* has clearly become the most dominant species at the site. However, giant cane genets continue to grow and expand despite the presence of this non-native grass. We will monitor whether cane will be able to compete with *M. vimineum* in the future and prevent it from continuing as the dominant understory species. In addition to the interaction with *M. vimineum*, we will also closely monitor the competitive interaction between cane and the very dense privet seedlings which have recruited in parts of the site. Although these privet seedlings have grown very slowly in these first two years, we plan to monitor growth in the subsequent years and determine whether these individuals will negatively impact future cane growth.

The cane transplantation process we utilized presents several potentially confounding factors to plant community composition comparisons that are not directly controlled in the experimental design and should be addressed. These factors include possible additions or withdrawals from the seed bank and the physical soil disturbance associated with transplanting clump divisions. Within each cane plot, the area potentially impacted by the transplantation process is fairly large, roughly 20% of the overall plot area. Hence, the disturbance associated with transplantation could potentially have a considerable impact on the plant community. When designing the experiment, we expected that the cane in the Privet-Removed plots would quickly fill in this disturbed area and continue to expand into the undisturbed portions of the plot.

In these first two years, the mean cane genet area has increased sevenfold after

Table 2. Mean Cover, Frequency (Freq.), and Importance Value (I.V.) of the most common plant species in the Privet-Removed plots with and without Cane transplants (Cane and No Cane, respectively) at the end of the second growing season. Only the five most common species in the Cane and No Cane treatment are presented. I.V. was calculated as: I.V. = (Mean Cover * Freq.)/100. The letters in parentheses following species names denote whether the species is non-native (nn) or native (N)

	No Cane				Cane		
Species	Mean Cover (%)	Freq.	I.V.	Species	Mean Cover (%)	Freq.	I.V.
Microstegium vimineum (nn)	55.4	77.8	43.1	*Microstegium vimineum* (nn)	41.1	100.0	41.1
Phytolacca americana (N)	9.1	55.6	5.1	*Arundinaria gigantea* (N)	26.7	100.0	26.7
Hedera helix (nn)	6.7	44.4	3.0	*Phytolacca americana* (N)	8.0	88.9	7.1
Lonicera japonica (nn)	3.2	77.8	2.5	*Lonicera japonica* (nn)	2.7	77.8	2.1
Ligustrum sinense (nn)	2.4	100.0	2.4	*Ligustrum sinense* (nn)	2.1	88.9	1.8

privet removal and much of this rhizome expansion has occurred in areas well beyond the immediate area impacted by the transplantation process. The maximum and mean $\pm$ 1SE genet length (an indicator or rhizome expansion) in Privet-Removed plots after the second year was 100 cm and 25.8 $\pm$ 2.6 cm, respectively. Although these expansion values are not extremely large by leptomorphic bamboo standards, they do help demonstrate that much of the cane expansion is occurring beyond the area potentially impacted by the transplantation process.

After these first two years, plots with cane had greater native cover relative to plots without cane. However, we must be clear that the increase in native cover is not due to a facilitative process; most of native cover in these plots consists of one species, cane, and the increase in native cover is due to the fact that we planted cane in these plots and this cane has begun to expand. Another critical point is that in addition to increasing the overall native cover, the transplantation process simultaneously decreased the non-native cover since *M. vimineum* or one of the other common non-native species would likely have recruited into and dominated these areas if cane was not planted there. The results from these first two years indicate that the cane in Privet-Removed plots will likely be able to compete with the other species present in this study. However, we only have two years of data and are hesitant to make strong conclusions regarding long-term future trajectories. Our future research will continue to measure the rate of cane growth and expansion and monitor changes in plant community composition. In the process, we will continue to investigate whether giant cane is a suitable native competitive-dominant species that can be targeted during floodplain restoration efforts for its ability to reduce non-native community invasibility and also restore important ecosystem functions and services.

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