Sapling Survival Assessment: Prioritizing Native Tree Species to use in Riparian Zone Restoration in the City of Austin, Texas

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Abstract

Through the City of Austin Parks and Recreation Department's Urban Forestry Program a total of 4,200 bare root saplings were planted in the Fall/Winter 2011-2012. In order to quantify success of the program and survivability of the planted saplings the City of Austin Watershed Protection Department designed and implemented a Sapling Survival Assessment at all planting locations in Summer 2012. Species identity, relative light level, location, cage type, and whether the plant was alive or dead were recorded. Of the 2,022 saplings recaptured 1,266 were identified as alive (62.61%) and 756 were identified as dead (37.39%). Survivability was highest when planted saplings were protected with plastic mesh cages (67%) when compared to blue opaque tubes (57%) or no cage (54%). Survivability of individual species was found to be significantly impacted by light level and location. Understanding the optimal conditions for survival of each plant species can help to increase the chances of restoration success. It is recommended that future planting efforts use species with above average survivability identified in this study.

Introduction

The success of habitat restoration projects relies heavily on the success of the vegetation. Active planting of tree seedlings is becoming an increasingly common technique, especially in Texas and the arid southwest, as water restrictions and drought make planting large containerized trees less feasible due to the initial transplanting shock. Bare root seedlings have a greater potential to adapt to the current conditions of a site and do not experience as great a shock. Bare root seedlings are also less costly than containerized plants of similar size because they do not need to be kept in soil. Thus bare root seedlings are the best option to plant and should have long-term survival once established. However, the seedlings have to survive the initial establishment period. Desiccation, or lack of soil moisture, is the primary cause of seedling mortality within the first year and desiccation may result in more than 86% mortality of seedlings (Barbour *et al.* 1987). The relative light levels and distance from a water body can greatly affect the available soil moisture at a location, and thus could affect the seedling survival. Different plant species also respond differently to various levels of light and moisture (Bazzaz and Carlson 1982, Beckage and Clark 2003). Without detailed information on seedling survivability of each plant species related to these abiotic factors, selecting appropriate tree species for planting becomes a difficult task. In order to help guide riparian zone restoration projects in Austin, this study attempts to discover the optimal abiotic conditions for survivability of differing tree species planted during restoration projects. Maximizing the survivability by selecting appropriately adapted plant species will increase the success of any planting effort. Without being able to prove success it becomes increasingly difficult to maintain public support and resources for restoration projects (Woolsey *et al.* 2007).

Methods

A total of 4,200 bare root saplings were planted at seven park locations (Table 1) during Winter 2011/2012. Sites with minimal management and relatively healthy riparian zones were selected to each receive 600 bare root saplings planted adjacent to the stream. Planting was divided into zones (upland or riparian) and all saplings received a protective cage (plastic mesh or blue opaque plastic) to help safeguard against herbivory. Saplings lacking a protective cage during sampling were designated as having no cage for analysis. All planting was performed by volunteers and for the purposes of this study assumed to be uniform between locations. Planting efforts were coordinated to follow winter rain events in order to increase available water for the newly planted saplings as well as loosen the soil surface making planting easier for the volunteers.

Light, moisture, and cage type were selected as the independent (manipulated) variable while survivability was chosen as the dependent (observed result) for this study. Light was divided into low (0-33%), medium (33-66 %) and high (>66%) categories and was visually estimated (naked eye) for every sapling sampled. Moisture was divided into two categories and was based on planting location; upland environments (low moisture) versus riparian environments (high moisture). Planting location was predetermined using GIS aerial imagery and topographic contours and was field verified for every sapling sampled. For the purposes of this study the riparian zone was determined to extend from the bank of the active channel through the next major slope break greater than 25 percent. All sampled environments not in the riparian zone were considered upland. Cage type varied between plant species and sampling location and was recorded for every sampled sapling. Saplings that were obviously planted and did not contain a cage were recorded as no cage on the data sheet. All saplings were identified to species in the field by City of Austin botanists. Any species that was unidentifiable and still alive was marked as unknown on the data sheet. A sapling was considered to be alive if they contained any living parts (leaves and buds) or if the trunk felt firm (squeeze main trunk between fingers). Trunks that gave slightly and felt hollow when squeezed were classified as dead. Height was recorded for all living saplings in order to quantify growth for future sampling events. Sapling diameter was assumed to be too time consuming to sample in the field and was not recorded during this study. All sites were sampled for two hours by two biologists (4 survey hours). A copy of the data sheet is located in the Appendix 1.

Chi-square tests were performed in SAS 9.2 to determine if the survival of saplings was significant under various environmental conditions. Site, light level, cage type, location, and plant species were used as domains within the model. An alpha level of 0.05 was chosen for all chi-square testing.

Results

A total of 2,022 saplings were surveyed out of the 4,200 planted (48.14% recapture percentage). 1,266 of the recaptured plants were identified as alive (62.61%) and 756 were identified as dead (37.39%). Survivability varied between sites but was generally at or above 50% (Table 1). Average recapture percentage at all sites was 48.14 % (Table 1). The low recapture percentage observed at the Colorado River Wildlife Sanctuary was likely due to spring flooding, which could have washed away sapling cages and made it difficult to locate extant saplings. Dozens of downed mesh cages were observed during the sampling event. The higher recapture percentage obtained from Commons Ford park was likely due to the close proximity of planted saplings to one another making detection more efficient.

Cage type impacted overall survival with no relation to plant species or site. Plastic mesh cages (67%) had higher survivability than the blue opaque tubes (57%), while no cage (54%) had the lowest survival percentage. Several species demonstrated above average survivability under various light and location combinations (Table 2). For example, American Beautyberry showed significant survival trends at medium light in both riparian and upland locations (100%, 88% survival respectively) and in low light conditions for both riparian and upland locations (66%, 86% survival respectively). Mexican Plum and American Elm showed significant survival trends under all abiotic conditions (Table 2) suggesting that these species are ideal candidates for any sapling planting project. Conversely, both cypress species had below average survivability in upland environments under high light (Bald Cypress, 0% survival) and medium light (Montezuma Cypress, 0% survival) growing conditions (Table 2). For a list of survival percentages see Appendix 2. Some of the percentages in Appendix 2 were close to 100% or 0% survivability, but these percentages were calculated using limited data sets and no significant trends in survival were observed. Thus they were not listed in Table 2. While the survivability varied at each site, the differences should be contributed to the variability in plant species composition found at each site. There was no significant trend in survivability at a site level once plant species was compensated for in the chi-square test. Understanding which plant species are best adapted to a site will increase the success of planting efforts.

Table 1: Number of saplings sampled per site and associated survivability.

Site	Acres	# Recaptured	Recapture %	Alive	Dead	Survival %	Death %
Colorado River Wildlife Sanctuary	13.3	146	24.33%	87	59	59.59%	40.41%
Blunn	8.6	368	61.33%	223	145	60.60%	39.40%
South Barton Springs	3.5	292	48.67%	164	128	56.16%	43.84%
Mayfield Preserve	22	240	40.00%	164	76	68.33%	31.67%
Red Bud Isle	8.7	262	43.67%	135	127	51.53%	48.47%
Zilker Preserve	24.6	281	46.83%	138	143	49.11%	50.89%
Commons Ford	14.2	427	71.17%	347	80	81.26%	18.74%

Table 2: Sapling Survivability based on planting location (Riparian or Upland) and light level (low 0-33%, Med 33%-66%, and High >66%). R- = significantly lower survivability in riparian zone, R+ = significantly higher survivability in riparian zone, U- = significantly lower survivability in upland zone, U+ = significantly higher survivability in upland zone, ++ = significantly higher survivability in both upland and riparian zones, and O = no significant trends in survivability (50/50 chance of surviving).

Common Name	Scientific Name	High Light	Medium Light	Low Light
American Beautyberry	*Callicarpa americana*	O	++	++
Pecan	*Carya illinoinensis*	O	O	R+
Common Hackberry	*Celtis occidentalis*	O	O	O
Mexican Redbud	*Cercis canadensis var mexicana*	R-	O	R+
Roughleaf dogwood	*Cornus drummondii*	O	R+	R+
Texas Persimmon	*Diospyros texana*	O	O	O
Common Persimmon	*Diospyros virginiana*	O	O	O
Carolina Buckthorn	*Frangula caroliniana*	R+, U-	R+, U-	R+
Green Ash	*Fraxinus pennsylvanica*	U+	U+	O
Texas Ash	*Fraxinus texensis*	O	O	O
Possumhaw	*Ilex decidua*	O	U+	U+
Black Walnut	*Juglans nigra*	O	O	++
Red Mulberry	*Morus rubra*	R+	++	++
American Sycamore	*Platanus occidentalis*	O	O	O
Eastern Cottonwood	*Populus deltoides*	O	O	O
Mexican Plum	*Prunus mexicana*	++	++	++
Black Cherry	*Prunus serotina*	U-	O	O
Shumard's Oak	*Quercus shumardii*	O	++	O
Live Oak	*Quercus virginiana*	++	++	O
Prairie Sumac	*Rhus lanceolata*	U+	R+	++
Texas Mountain Laurel	*Sophora secundiflora*	++	++	++
Eve's Necklace	*Styphnolobium affine*	U+	U+	U+

Bald Cypress	*Taxodium distichum*	R+, U-	O	U-
Montezuma Bald Cypress	*Taxodium mucronatum*	O	U-	U-
American Elm	*Ulmus americana*	++	++	++
Cedar Elm	*Ulmus crassifolia*	U+	U+	U+
Mexican Buckeye	*Ungnadia speciosa*	R-	++	R+

Conclusions

Overall, the survivability of all saplings planted was extremely high (62.61%) suggesting that focusing planting efforts adjacent to stream channels can increase the chances of restoration success and tree establishment. Seedling mortality of more than 86% within the first year has been reported in other studies (Barbour *et al.* 1987). Plastic mesh cages increased survivability by 10% over the blue opaque plastic tubes and 13% over using no cages at all. Although the mechanism for this increase in survivorship is unknown, utilizing plastic mesh cages during seedling planting events can increase restoration success. Survivability of individual species was significantly impacted by light and moisture level suggesting that plant establishment success can be maximized when relative site conditions are taken into consideration. For example, when planting in riparian locations that receive high light, selecting Carolina Buckthorn, Green ash, Mexican Plum, Live oak, Bald cypress, and American Elm (Table 2) will likely increase overall survivability of planted saplings. Performing site visits in order to understand relative light and moisture levels prior to implementing a planting strategy can maximize the success of future City of Austin sapling planting efforts.

Recommendations

1. Focusing planting/restoration efforts adjacent to streams can increase overall sapling survival.
2. Using plastic mesh cages around newly planted saplings can increase overall sapling survival.
3. Understanding the relative moisture and light levels of a site prior to designing planting plans, and selecting appropriate plant species form the above list (Table 2) can help restoration practitioners maximize sapling survival and overall success of riparian restoration projects within the city of Austin.
4. Continued investigation and monitoring of future City of Austin sapling planting efforts is necessary to validate the above results and help better define ideal plant species for use in urban restoration projects.

References

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Appendix 1

City of Austin - Sapling Survival Assessment

Site name: **Date:** **Time:** **Staff:**

All sites will be sampled for a total of 4 survey hours by teams consisting of two participants. Teams will record species name, if the plant is alive, relative light level, height, diameter at 2 inches, and cage type used. Only sample saplings that have an intact cage surrounding it. Saplings are considered alive if they contain any living parts (leaves and buds) or if the trunk feels firm (squeeze main trunk between fingers). Trunks that give slightly and feel hollow when squeezed are likely dead. Light levels are divided in to Low (<33% canopy cover), Medium (33%-66% canopy cover), and High (>66% canopy cover) and should be visually estimated. Measure sapling height to the nearest inch; starting from the soil surface to the top of the apical bud on the main stem, ignoring any limbs or leaves that may protrude above. Diameter should be measured to the nearest 1/2 millimeter using calipers. Diameter measurements should be taken 2.5 centimeters above the soil surface. For multi stem species choose the largest available stem. In addition, record cage type, planting zone (R1, R2, U1, etc... from planting map), and any useful notes such as site disturbances, herbivory, management activates or invasive regrowth that may have impacted survival.

Species	Alive (Y/N)	Light (L, M, H)	Height (ft)	Diameter (mm)	Cage Type	Planting Zone	Notes

Appendix 2

Percent survival of each plant species under differing light conditions and location.

Common Name	Scientific Name	High Light	Medium Light	Low Light	High Light	Medium Light	Low Light
		Riparian Location			Upland Location		
American Beautyberry	*Callicarpa americana*	70	100	66	59	88	86
Pecan	*Carya illinoinensis*	50*	50*	91	--	25*	33*
Common Hackberry	*Celtis occidentalis*	100*	--	--	--	100*	100*
Mexican Redbud	*Cercis canadensis var mexicana*	10	40	71	100*	67	100*
Roughleaf dogwood	*Cornus drummondii*	60	91	86	68	59	59
Texas Persimmon	*Diospyros texana*	--	100*	--	100*	--	--
Common Persimmon	*Diospyros virginiana*	--	--	--	67*	100*	100*
Carolina Buckthorn	*Frangula caroliniana*	73	83	88	31	40	49
Green Ash	*Fraxinus pennsylvanica*	100*	50*	100*	100	100	60
Texas Ash	*Fraxinus texensis*	100*	100*	100*	--	100*	100*
Possumhaw	*Ilex decidua*	100*	50*	80*	71	79	92
Black Walnut	*Juglans nigra*	--	50*	100	71	100	100
Red Mulberry	*Morus rubra*	100	100	94	71	100	100
American Sycamore	*Platanus occidentalis*	100*	75*	25*	25*	50	70
Eastern Cottonwood	*Populus deltoides*	100*	100*	50*	--	57	0*
Mexican Plum	*Prunus mexicana*	100	84	95	100	91	83
Black Cherry	*Prunus serotina*	--	0*	--	0	63	66
Shumard's Oak	*Quercus shumardii*	100*	100	50	54	90	83*
Live Oak	*Quercus virginiana*	100	100	--	100	100	100*
Prairie Sumac	*Rhus lanceolata*	63	85	86	100	70	82
Texas Mountain Laurel	*Sophora secundiflora*	85	92	88	82	100	89
Eve's Necklace	*Styphnolobium affine*	0*	--	--	88	100	90
Bald Cypress	*Taxodium distichum*	100	56	61	0	--	17
Montezuma Bald Cypress	*Taxodium mucronatum*	50	60	25*	0*	0	17
American Elm	*Ulmus americana*	75	100	81	70	83	89
Cedar Elm	*Ulmus crassifolia*	100*	100*	100*	86	75	100
Mexican Buckeye	*Ungnadia speciosa*	14	81	79	61	68	57

*Indicates a percent that is calculated from a small dataset (usually 1 to 3 samples).