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Field Evaluation of Three Cottonwood Restoration Methods

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ABSTRACT

Damming of rivers, urban expansion, clearing for agriculture and the encroachment of dense invasive grasses have contributed to a demise of cottonwood (*Populus deltoides*) galleries along streams in the Great Plains. In this study, three stock types (deep pot, unrooted cuttings, and conservation seedlings) were evaluated as a way to reestablish native cottonwoods in this altered landscape. Establishment success was limited due to water available at the site for cottonwood establishment and growth. On a small scale any of the stock types might have been successful if effective weed control and regular, deep irrigation were available and better protection from deer browse.

INTRODUCTION

For the Missouri River reach below Garrison dam near Washburn, ND, water levels during the summer can be 8 feet below the land surface adjacent to the river making the site no longer a riparian soil with attendant hydrology, but rather a dry upland site. Johnson (2012) states that without changes to the current river hydrology management, cottonwood forests in the Garrison reach of the river will essentially be lost as a significant community on remnant floodplains.

Invasion of perennial grasses such as smooth brome grass (*Bromus inermus*) and reed canarygrass (*Phalaris arundinacea*) have created dense sods covering much of the previously bare and periodically flooded, flood plain. This prevents natural recruitment of cottonwood from seed and greatly decreases the survival of rooted stock (Johnson et al., 2012).

Numerous groups and individuals have attempted cottonwood restoration within the floodplains of highly regulated rivers with mixed success. Methods have included irrigating bare soils at the time of seed dispersal (Interagency Riparian Report, 1996), planting bare root seedlings via traditional methods (numerous Great Plains conservation districts), planting unrooted cuttings of 8-30” lengths (North Dakota Forest Service, 1999), and planting stock grown in 36” tall pots (Los Lunas Plant Materials Center, 2007; Bridger Plant Materials Center, 2015). These methods showed promise, on a small scale, on the sites where tested.

Currently, there are no practical methods for establishment of cottonwood galleries where regulated river water flow has lowered the growing season watertable. Therefore, the objective of this study was to evaluate different planting stock and establishment methods, to determine the potential for successful reestablishment of cottonwood galleries in dewatered floodplains.

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MATERIALS AND METHODS

The study was conducted near Hensler, ND at multiple locations along the Missouri River on Nature Conservancy property (Fig. 1.). Three cottonwood stock types (deep pot, unrooted cuttings, conservation stock) with and without fabric, were evaluated from 2013-2017. Sites 1-4 were planted on 8 May 2013 and sites 5-7 on 23 May 2014. The water table was approximately 8’ deep at sites 1-4 at planting with the water table for sites 5-7 at 3-9’ depths. The following is a description of the stock types and planting methods:

- Deep pot - Unrooted cottonwood cuttings (6” long) were planted in 4” x 4” x 14” pots, started in a greenhouse for four months and moved outside for one season. By planting time the material had grown 3-4’ above the pot. Potted stock was planted in 4’ deep holes, placing the root mass closer to water while 1-2’ of the tree top was above the soil surface. Soil was lightly packed around the root ball and lower tree stem and several gallons of water added to the augured hole before backfilling 3’ of soil to the surface.
- Unrooted cuttings - Six-foot long cottonwood whips, with side limbs removed, were harvested in the fall and stored in a plant freezer. The day before planting, material was removed from the freezer and a fresh cut was made on the base end. Whips were placed butt end down in a barrel of water over night to rehydrate. Using a waterjet stinger (Hoag et al., 2001), this material was planted vertically in a hole created by the waterjet stinger. About 6” of the unrooted cutting remained above the soil. It was assumed that water from the hole boring action would provide sufficient water, initially, for the cutting. This method has been used successfully on many stream bioengineering projects where cuttings were water-jetted into the stream watertable (Hoag et al., 2001).
- Conservation stock – One-year old, traditional conservation stock, started from cuttings, was planted as a control. Several gallons of water were added after planting to stay consistent with the extra water added to the other stock types.

Plots/blocks were sprayed with glyphosate several days before planting. After planting, 6’ x 6’ weed control fabric squares were installed on one-half of each planted stock type. Four-foot tree shelters were installed on all trees to protect them from deer damage. There were 6 replications of each treatment per site consisiting of three stock types (planting methods) with weed control fabric on half of each stock type. Trees were planted on 8’ x 8’ spacing. Ground water measurement wells were installed to 12’ deep in the middle of each block/site by the North Dakota Health Department to monitor ground water depth.

Annual evaluations were conducted in the fall (September or October) of each year. Survival was determined by counting the number of surviving seedlings in each treatment. Vigor (plant health) was determined by ocular estimate using a scale of 1 to 9 where 1 = best and 9 = worst. Plant heights were measured with a graduated rod to the absolute plant height.

RESULTS AND DISCUSSION

Percent survival varied among planting stock with and without weed control fabric, and year of evaluation (fig 2. and 3). At sites 1-4, percent survival between planting stock and weed control treatments was similar among treatments in 2013 and 2014 except for the unrooted cutting

treatments (fig. 2) which exhibited considerably less survival. At sites 5-7, deep pots and unrooted cuttings planted with and without weed control fabric exhibited the highest survival from from 2014-2016. There was a considerable decline in survival of all treatments after 2016. Conservation stock maintained the highest survival through 2016, but dropped to less than 30% by 2017. Conservation planting stock may have survived longer because the small, young seedlings did not require as much moisture as the other treatments. All the stock types might have survived below normal precipitation if any of the following factors were not also impacting tree health: competition with mature cottonwoods, dense sods of invasive perennial grasses such as bromegrass and scouring rush, and continuous deer browse. Generally, the application of fabric for weed control did not appear to provide an advantage for increasing survival at these sites. The conservation stock and the deep pot stock of the first 4 sites, all showed better survival without fabric, than with fabric. We have no rational explanation for that occurrence.
Plant height was not analyzed due to significant browse damage by deer.

Natural recruitment of cottonwood from seed requires moist, bare mineral soil at the time of seed dispersal, which usually coincides with spring flooding. For larger stock (seedlings, cuttings or potted stock) soil water must be adequate to ensure that at least part of the root mass or cutting is in the capillary fringe of the water table. For any stock type, the water table fringe cannot recede faster than the tender roots can grow.

CONCLUSION

Reestablishment of native cottonwoods on dewatered floodplains below dams on major rivers with coarse textured alluvium such as the Missouri River below Garrison dam, is difficult, if not impossible on a large scale. Deep pots, unrooted cuttings and conservation planting stock with and without weed control fabric were evaluated on a portion of the Missouri River near Hensler, ND, to determine an effective establishment method for cottonwoods in this environment. None of the establishment methods evaluated at these 7 sites showed promise for reestablishment of native cottonwoods. Perhaps the biggest reason for failure was 4 years of below average precipitation at the time trees were struggling to become established. In 2017, the last year of the study, precipitation was 46% below normal.

On a small scale any of the stock types might have been successful if effective weed control and regular, deep irrigation were available and if the plantings had not been affected by deer browse.

What was learned from this study:

- Average precipitation for the area is 16-18” per year. Rainfall fluctuates considerably from one spot to another in North Dakota. To determine approximate rainfall at the test site, readings from the three closest North Dakota Ag Weather Network (NDAWN) recording stations were averaged. The NDAWN sites were located 21-to 30 miles from the site.
- In 2017, the average precipitation between the three closest recording stations near the study was only 9.6”, which was 46% below average. This was the fourth year of below average precipitation (Table 1).
- Cottonwoods require lots of soil moisture for growth and survival, but apparently can drown from saturated soils as a young seedling, which might have happened in block 7.

- The flood plain adjacent to the The Nature Conservancy site has degraded from a Conservation Tree and Shrub Group (CTSG) Site 1 or 2 to a CTSG site 5 or 7 due to the dewatering that resulted from stream downcutting and the course textures of the soils. The site is currently more suitable to conifers than cottonwoods.
- Waterjet stingers are an easy way to plant deep cuttings, but the base ends must be in the free water of the water table throughout the growing season, so that roots can develop in the capillary fringe until well-established.
- Existing mature cottonwood roots reach 1-3 times the height of the tree away from the tree. All but one of the sites fell within the range of these roots. Perhaps the new trees were out-competed for moisture at critical times of the year by the mature cottonwoods.
- Tree shelters may have had a serious impact on the trees. Many of the trees had top dieback with resprouting. Perhaps the shelters impacted hardening off resulting in winter dieback.
- Deer can devastate a cottonwood planting. 4’ tree shelters were not tall enough in most cases. Deer continuously browsed trees at the top of the shelter. At a minimum, 5’ tree shelters or a sound exclusionary fence is needed to protect from deer browse. It is likely that the continuous browsing stress contributed to mortality.
- It was initially thought the soil mottling at 30” indicated the presence of a seasonally high water table for most years. In actuality, the mottling was a relic from before Garrison dam was built. On most of the test blocks, ground water was never closer than 8’ to the surface.
- Coarse textured soils without a near-surface water table provide too little water to establish cottonwood trees.
- The conservation stock and the deep pot stock of the first 4 sites showed better survival without fabric, than with fabric. We have no explanation for that.

Acknowledgement

The Nature Conservancy in Washburn, ND assisted with plot establishment on their property. They graciously helped with site preparation, mowing; cut 6’ fabric squares; provided a fire truck to operate the waterjet stinger, helped with weed control after planting, and mowed access lanes to each planting site.

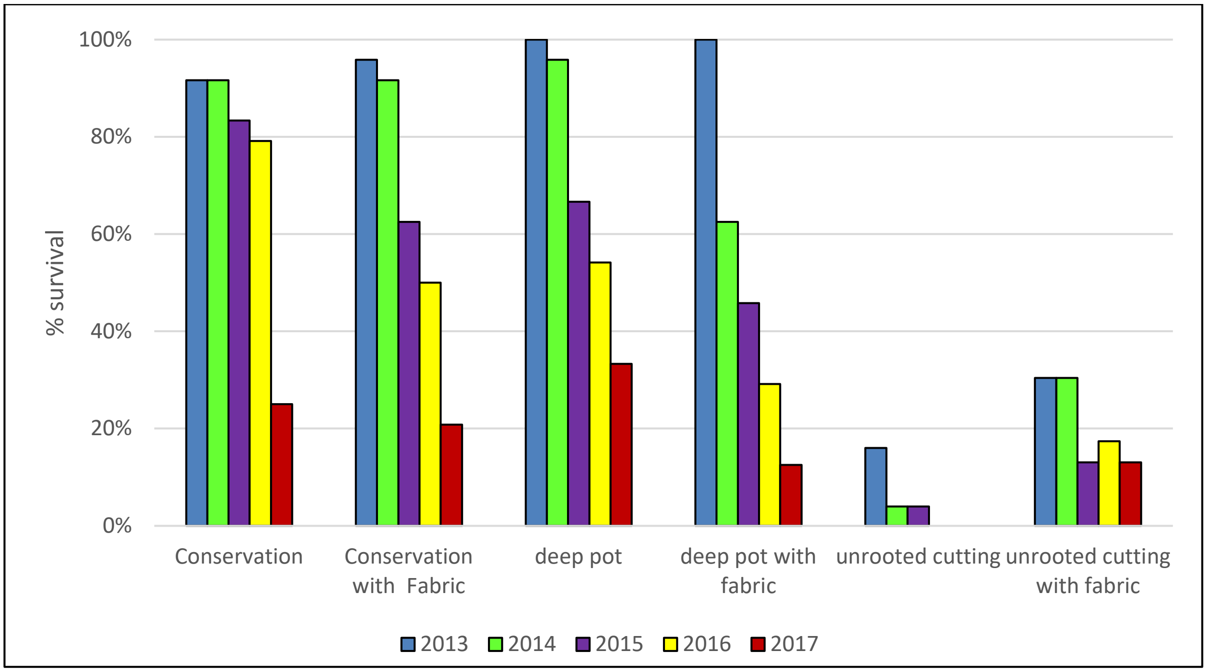

Fig. 2. Survival by stock types with and without weed control fabric at sites 1-4 near Hensler, ND, 2013-2017.

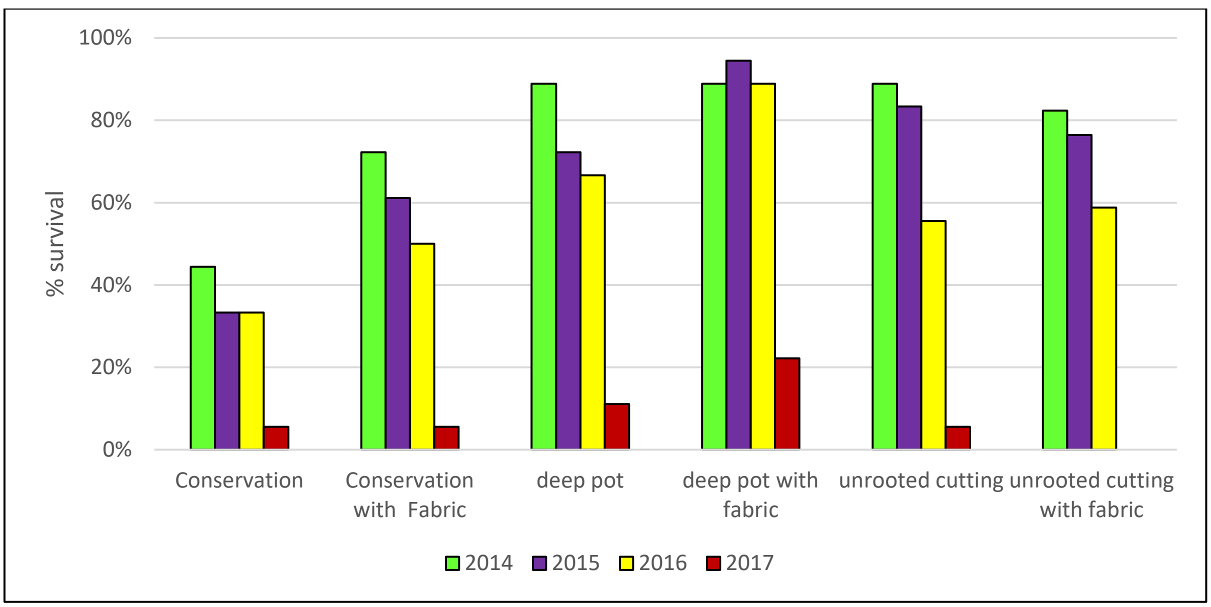

Fig. 3. Survival by stock types with and without weed control fabric at sites 5-7 near Hensler, ND, 2013-2017.

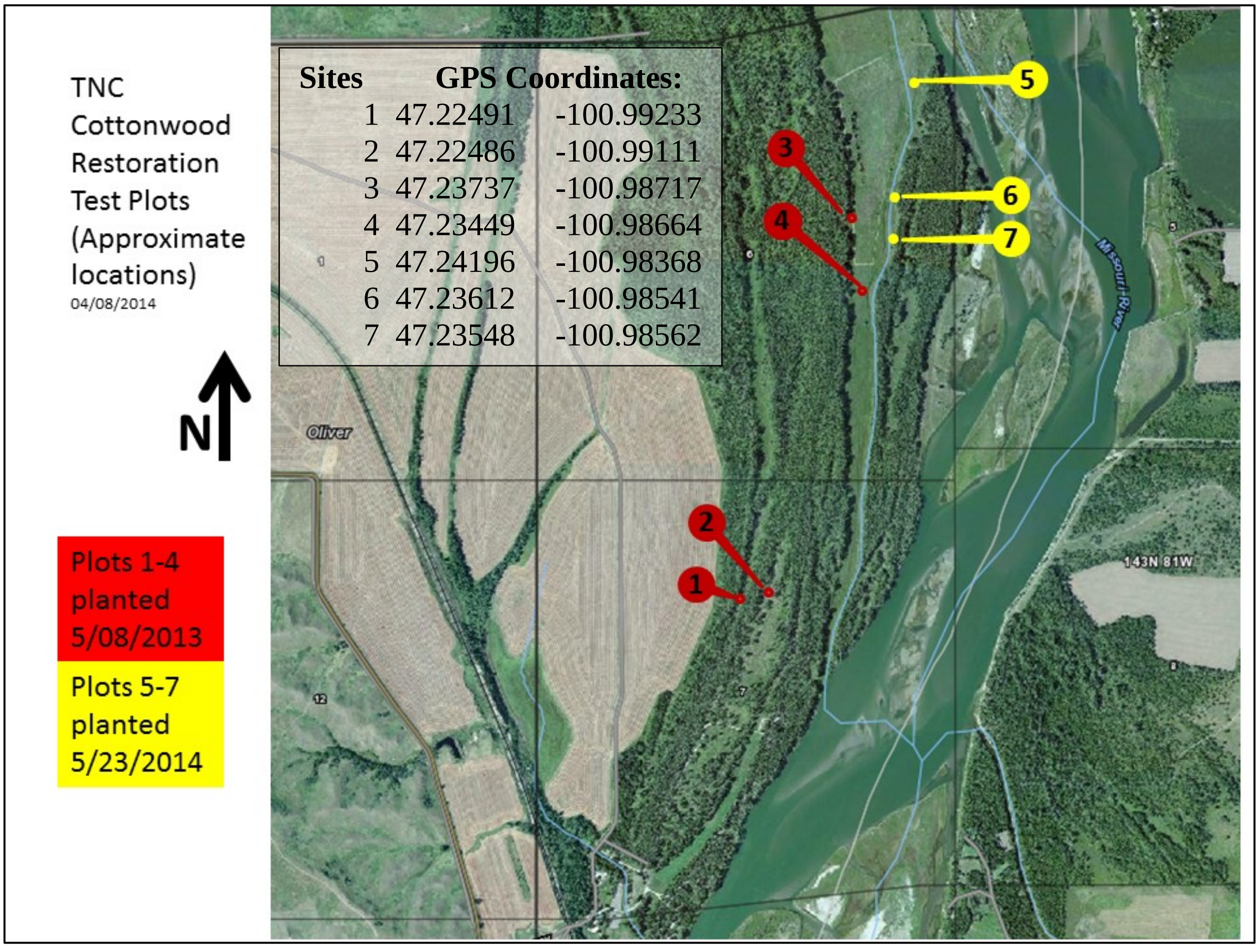

Fig. 1. Study sites along the Missouri River near Hensler, ND.

Table 1. Annual precipitation from North Dakota Ag Weather Network (NDAWN) The three closest recording stations near Washburn, ND, (Longterm yearly rainfall average is 17.75").

Year	Turtle Lake	Mandan	Hazen	Yearly Avg.	Difference between sites	Departure Washburn, ND
	---------------------------------inches---------------------------------					
2013	17	22.9	21.5	20.5	5.9	+2.75
2014	18.6	14.1	18.3	17	4.5	- 0.75
2015	12.4	15.4	13.2	13.7	3	- 4.05
2016	14.5	17.5	16.6	16.2	3	- 1.55
2017	7.5	11.4	9.8	9.6	3.9	- 8.15

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