

LOWER GREY CLOUD ISLAND FOREST PATCH: A 15 YEAR RECLAMATION MONITORING STUDY¹

J. B. Burley,² C.A. Churchward, C.J. Burley, and W. D. Sanders

Abstract. Reclamation specialists are constantly searching for efficient and effective revegetation methods upon xeric sites. In our investigation, we created a small forest patch, densely packed with woody plants and observed the development (expansion and mortality) of individual plants and groups of plants in the patch for 15 years. The patch has expanded from about 0.046 hectares (0.11 acres) to 0.24 hectares (0.58 acres) in area; while the inner core of trees has only slightly expanded from 0.0333 hectares (0.08 acres) to 0.0475 hectares (0.09 acres) in size. The collective basal area of most tree species has increased but is concentrated in fewer individuals. The basal area growth of some of the inner individuals has nearly halted (less than 2.5 mm (0.1 inches) in dbh over 5 years). In contrast, many surviving edge trees have increased their basal area with some individuals growing more than 1.27 cm (0.5 inches) dbh per year. Box elder (*Acer negundo* L.) is the only species that has increased in the number of individual trees (dbh \geq 10 cm). Siouland Eastern cottonwood (*Populus deltoides* Bart. Ex Marsh. "Siouland") has gone extinct due to mortality caused by white-tailed deer rubbing against the trees. Woody plant seedling recruitment has occurred for northern red oak (*Quercus rubra* L.), woodbine (*Parthenocissus quniquefolia* (L.) Planch.), riverbank grape (*Vitis riparia* Michx.), Eastern red cedar (*Juniperus virginiana* L.), and common hackberry (*Celtis occidentalis* L.). A small stand of Kentucky Bluegrass (*Poa pratensis* L.) has formed in the understory of the inner core of the stand. Even though changes in the inner core have been slow, we have observed signs that the core may be beginning to expand and expect to observe tree recruitment and increased diversity over the next 10 years.

Additional Key Words: plant ecology, landscape ecology, landscape architecture, planting design, landscape horticulture, urban forestry, landscape planning

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Introduction

In 1998, we described a circular forest patch that we had established in 1983 on the Lower Grey Cloud Island, southeast of the Twin Cities (Minneapolis and St. Paul, Minnesota) (Burley et al. 1998). The forest patch has been installed on a large xeric mound of excess sand, one of many mounds created to provide suitable post-mining building sites above the 100 year floodplain of the Mississippi, River (Fig. 1). The surface mine is still in operation and supplies sand and gravel for road mixtures and concrete. The mine has been extensively studied (Sanders and Associates 1981) and is expected to complete mining operations in about 20 years (Sanders, Burley, and Churchward 1982). As mining operations continue, our study reports upon the developments within this forest patch since that initial 10 year report and publication.



Figure 1. Lower Grey Cloud Island, Minnesota along the Mississippi River, looking southwest in the spring of 2003.

Study Area and Methodology

Study Area

Over the first ten years, the green ash (*Fraxinus pennsylvanica* Marsh.) trees and smooth sumac (*Rhus glabra* L.) shrubs outside the patch had a higher rate of mortality ($p \leq 0.01$) (Burley et al. 1998). We had interpreted this response to mean that the forest patch configuration (see Forman and Godron 1986 for a definition of a patch and related landscape ecology features) provided an environment more suitable for the establishment of vegetation upon xeric landscapes (see Curtis 1959 for a definition of xeric landscapes). In addition, the patch had grown from 0.115 acres in size to 0.259 acres by 1993. We had predicted that the area of the patch and rate of change for the patch could be expressed in equations 1 and 2, explaining 98 percent of the variance, with significant regressors (intercept and age of the stand in years squared) at $p \leq 0.001$ (Burley et al. 1998). We thought that the expansion of the forest patch was important to consider, as we were looking for a strategy to decrease plant mortality and also to expand the extent of vegetation across the landscape.

$$\text{Area of Patch in Acres} = 0.121 + 0.001 * (\text{age of stand in years})^2 \quad (1)$$

$$\text{Rate of Change in Area of Patch} = 0.002 * (\text{age of stand in years}) \quad (2)$$

By 1993 green ash, amur chokecherry (*Prunus maackii* Rupr.), black cherry (*Prunus serotina* Ehrh.), and boxelder (*Acer negundo* L.) had increased in basal area while cottonwood (*Populus deltoides* Bart. Ex Marsh.), and northern red oak (*Quercus rubra* L.) had decreased (Burley et al. 1998). Soil temperature was recorded in August of 1983 and light intensity was recorded in 1993. It was reported that August 1983 surface soil temperature within 20 feet of the forest patch center ranged from 70 to 71 degrees Fahrenheit; while soils at the edge of the patch ranged from 79 to 86 degrees Fahrenheit and soils beyond the patch ranged from 84 to 94 degrees Fahrenheit. During August, near the noon hour on a bright sunny day, light intensity was about

125 foot candles in the darkest areas of the patch. Beneath the woody deciduous saplings, the light intensity was about 800 foot candles. Beneath the sumac bushes, the light intensity ranged from 800 to 1200 foot candles; while areas open to full sun, beyond the edge of the forest patch were exposed to 3000 foot candles.

Besides reducing mortality and being able to expand across the landscape, we also thought that the forest patch had another advantage over traditional planting approaches. We thought that the patch was highly visible as a clump of vegetation right from initial establishment, whereas in many cases traditional planting approaches, installed vegetation is almost invisible across an expansive herbaceous post-mining landscape (Fig. 2).



Figure 2. Location of the forest patch on a mound of sand above the 100 year floodplain. The lakes typically are at the elevation of the Mississippi River.

Methodology

Our methodology to study the site has been quite simple. For the first 10 years we measured the site every fall, and then again five years later. We measured the diameter at breast height (dbh) of every tree on a measured map, locating each individual. We have also counted live stems, dead stems, and fruiting stems of every shrub on the site. We have mapped the location of new seedlings (recruitment) and note the mortality of individual trees. In addition, we have mapped the extent of groundcover and dimension of the xeric clump. We intend to continue measuring the stand every five years.

Results

We have recorded that the patch has expanded from about 0.046 hectares (0.11 acres) to 0.24 hectares (0.58 acres) in area; while the inner core of trees (Fig. 3) has only slightly expanded from 0.0333 hectares (0.08 acres) to 0.0475 hectares (0.09 acres) in size. The collective basal area of most tree species has increased but is concentrated in fewer individuals. The basal area growth of some of the inner individuals has nearly halted (less than 2.54 mm (0.1 inches) in dbh over 5 years). In contrast, many surviving edge trees have increased their basal area with some individuals growing more than 0.5 dbh inches per year. Box elder (*Acer negundo* L.) is the only

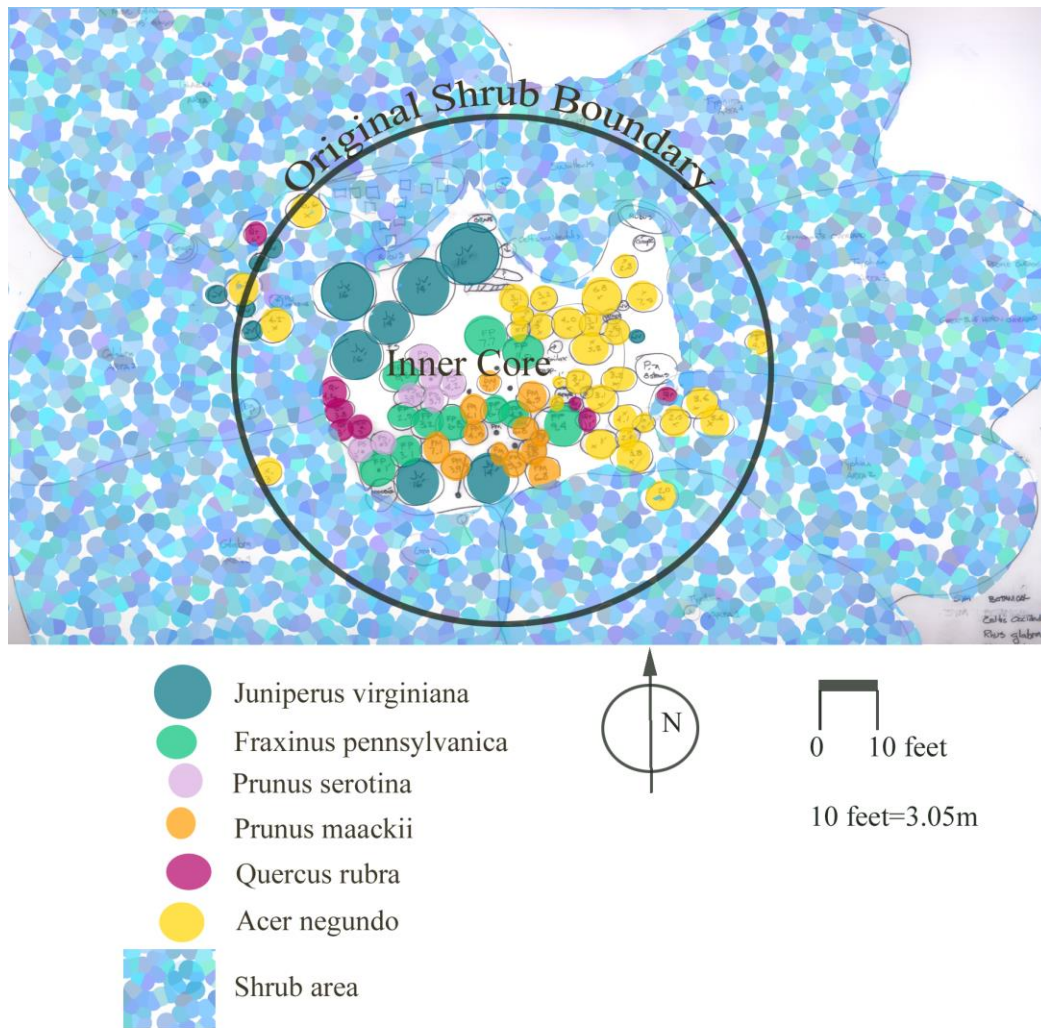


Figure 3. This map illustrates the configuration of the forest patch in 1998.

species that has substantially increased in the number of individual trees and saplings (dbh \geq 2.54 cm) (Table 1). Siouxland Eastern cottonwood (*Populus deltoides* Bart. Ex Marsh. "Siouxland") has gone extinct due to mortality caused by white-tailed deer rubbing against the trees. Woody plant seedling recruitment has occurred for northern red oak (*Quercus rubra* L.), woodbine (*Parthenocissus quiquefolia* (L.) Planch.), riverbank grape (*Vitis riparia* Michx.), Eastern red cedar (*Juniperus virginiana* L.), and common hackberry (*Celtis occidentalis* L.). A small stand of Kentucky Bluegrass (*Poa pratensis* L.) has formed in the understory of the inner core of the stand.

Table 1. Total number of trees and saplings (\geq 2.54 cm dbh) by species within the patch.

Tree Name	1983	1988	1993	1998
<i>Acer negundo</i>	0	1	21	30
<i>Fraxinus pennsylvanica</i>	11	11	11	11
<i>Populus deltoides</i>	15	8	1	0
<i>Prunus maackii</i>	15	13	13	12
<i>Prunus serotina</i>	0	0	8	7
<i>Quercus rubra</i>	10	5	2	7

Discussion

Forest Patch Expansion

Based upon predictions made from the first 10 years of forest patch development, it was estimated that the forest patch would grow to 0.144 hectares (0.346) acres in size. However, the patch has now grown to 0.24 hectares (0.58 acres) in size. Nevertheless, the expansion has been primarily in the spread of shrubs and not the spread of trees. We still believe that the forest portion of the patch will begin expanding, but we find it interesting that the expansion has not yet begun. Thus we interpret the results of our study to mean that the stand withstood the ravages of establishing vegetation and that the stand was highly visible (noticeable) from the first day of planting; however, the woody

core portion of the stand has not begun to highly influence landscape beyond the borders of the initial planting.

Tree Recruitment and Mortality

We also find the dynamics of the tree recruitment and mortality interesting. *Acer negundo* continues to increase in abundance. Besides the installed seedlings that have grown to sapling and tree size plants, recruitment has occurred from outside the patch. These new trees were established within the shrubland environment of the patch, close to the existing forest patch (within 20 feet). No seedlings have survived beyond the edge of the patch and colonized the herbaceous groundplain.

We believed that the *Quercus rubra* individuals would go extinct similar to the extinction of the *Populus deltoides* individuals. However these trees as a group have begun to gain biomass and reach current stability. We attribute the near loss of these individuals to difficulties in establishment upon the xeric landscape. Many of these *Quercus rubra* individuals suffered die-back and resprouted and are now larger in biomass than when they were initially planted.

The *Fraxinus pennsylvanica* group has remained stable and accumulated biomass. However, these trees have yet to have an impact upon expanding the patch.

The *Prunus maackii* group has slowly reduced in numbers and the biomass accumulation has been slow. In contrast the *Prunus serotina* group is gaining biomass. We attribute the difference in responses between the two *Prunus* groups due to the competitive nature of the plants. *Prunus serotina* is a near mesic forest species capable of enduring some competition; while *Prunus maackii* is not as strong of a competitor.

We were pleased to see the recruitment of the *Celtis occidentalis* individual within the patch. This species can be spread by birds and their droppings. If *Celtis occidentalis* individuals are arriving, we would expect to see the recruitment of *Amelanchier* sp. (Medic.) and *Prunus virginiana* (L.) within the stand soon.

We are less hopeful of seeing individuals of *Tilia* sp. (L.), *Acer saccharum* (Marsh.), *Acer rubrum* (L.), *Populus tremuloides* (Michx.), *Betula* sp. (L.), and *Ulmus* sp. (L.) as their dispersal into the patch is less dependent upon birds. Nevertheless, the recruitment

of *Acer negundo* to the site indicates that these other species may arrive. We do not expect to see new individuals from *Quercus* sp. (L.), *Carya* sp. (Nutt.), and *Juglans* sp. (L.), their dispersal is limited because the seed is large and is rarely deposited far from the source.

We have recorded data to assess plant diversity, importance values, and vegetation dominance in anticipation of studying the dynamics of the stand and the composition of the stand in relationship to related stands described by Curtis (1959). However, since so little change has take plant in the stand, we believe reporting such information is currently of only limited value.

Conclusion

We are waiting for the core to expand and influence its borders. We were initially impressed with the establishment and visual impact of the clump. However, we are disappointed and maybe somewhat impatient for the clump to expand. Since there are so few long-term studies observing the growth and development of individual plants, we are hopeful that we may observe future phenomena about the individual plants as they interact with the environment. Even though changes in the inner core have been slow, we have observed signs that the core may be beginning to expand and expect to observe tree recruitment and increased diversity over the next 10 years.

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