Transactions of the Illinois State Academy of Science
(2000), Volume 93, #4, pp. 261-270

received 1/4/00
accepted 10/2/00

Seed Bank Ecology of Butterfield Creek Watershed Along Old Plank Road Trail

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ABSTRACT

Butterfield Creek watershed in Matteson, Illinois includes a wetland whose seed banks are of particular interest because of the presence of Old Plank Road Trail (OPRT). The trail runs from east to west bisecting the surrounding area into north and south wetland habitats. The resulting fragmentation of this landscape provides an interesting opportunity to investigate the effect of landscape fragmentation on seed bank ecology. The objective of this research was to determine any differential in seed bank composition related to landscape fragmentation resulting from OPRT. We removed a total of 60 core samples (30 from each side of the study area) representing three sequential depths, 0-15cm, 15-30cm, and 30-45cm respectively. Core samples were transported to the laboratory for comparative determinations of seed bank germination. Results indicate that there is a discontinuity in the composition of the north and south seed banks as a function of soil depth. Landscape fragmentation brought about by the construction of the railroad (ca.1855, Molony and Ogorek, 1998) and back-flooding of the south side of Butterfield Creek caused a cessation of seed bank formation on the south side, which appears to be a remnant of pre-railroad vegetation seed deposition. Landscape fragmentation related to wetlands can result in the formation of seed bank remnants, which may provide valuable information about the dynamics of seed bank ecology in general as well as local vegetative history in particular.

INTRODUCTION

Butterfield Creek watershed in Matteson, Illinois includes a wetland whose seed banks are of particular interest because of the presence of Old Plank Road Trail (OPRT). The trail runs from east to west bisecting the surrounding area into north and south wetland habitats. The resulting fragmentation of this landscape provides an interesting opportunity to investigate the effect of landscape fragmentation on seed bank ecology.

A seed bank is a reservoir of viable seeds capable of replacing adult plants that may be annuals or perennials, susceptible to death by disease, disturbance, or consumption by animals, including humans (Baker, 1989). Seeds incorporated into seed banks have been recorded to have viabilities ranging from a single season to well over a thousand years

(Roberts, 1972 and Gunther et al., 1984). Generalizations to be drawn from the literature on seed banks suggest that extended seed viability is characteristic of disturbed habitats and also of aquatic plants where conditions may inhibit seed decay (Harper 1977). The ecological significance of seeds incorporated in a seed bank is related directly to their viability (Harrington, 1972 and Gunther et al., 1984). Recovery of these viable seeds can be beneficial in determining community composition and may indicate the relative sequence of seed deposition. Differences between seed banks in terms of species composition can reflect ecological changes during seed bank formation. We suspect that landscape fragmentation caused this kind of change to occur in the two wetland areas adjacent to Butterfield Creek, and that it is reflected in their respective seed banks.

The Butterfield Creek watershed has received considerable attention in recent years due in large part to the activities of the Butterfield Creek Steering Committee and the formation of The Old Plank Road Trail (OPRT) recreational path. Partial funding for the purchase of the OPRT wetland was secured through an Illinois Department of Natural Resources 2500 grant channeled through the Thorn Creek Ecosystem Partnership, a watershed-based consortium of which the Butterfield Creek Steering Committee is a member. The OPRT recreational path is built on an old railroad embankment, which fragmented the area into two ecologically distinct north and south habitats.

This research focused on the potential effects of this landscape fragmentation on seed bank development in the area. The specific objective of the research was to determine any differential in seed bank composition related to landscape fragmentation resulting from OPRT. The null hypothesis is that landscape fragmentation does not cause differences in adjacent seed banks.

DESCRIPTION OF STUDY AREA

The seed banks included in our study are part of a wetland located along The Old Plank Road Trail (OPRT) in Matteson, Illinois (Figure 1). Specifically, the wetland is located 283 meters west of Central Avenue in Rich Township and is bisected by OPRT. The Trail was an abandoned railroad prior to recent conversion into a paved recreational walkway and nature preserve, which runs west from Chicago Heights and, at its completion, will end at the city of Joliet. It is the result of collaborative efforts from many townships and organizations to restore, preserve and utilize this tract of land stretching more than 12km. The Trail itself is approximately 2.5m wide and elevated 3-4m above the wetland surface. The introduction of the railroad resulted in a fragmentation of the landscape, which is maintained by the presence of OPRT (Kalisz et al., 1997). The soil surface on the south side slopes away from the Trail so that, the water depth (July 1997) is approximately 0.75m near the railroad embankment, and increases to about 1.2m at the southern edge of the study area (Figure 2). The water depth on the north side, however, is relatively even at approximately 0.75m from the railroad embankment to the northern edge of the study area.

A dense and extensive stand of *Typha latifolia* occurs on the north side of this elevated trail but is virtually non-existent on the south side. Seeds from the north population may be deposited in the seed bank on the south but are prevented from germination by current conditions. Also, fragmentation of the wetland may have changed the surface vegetation resulting in two different seed banks. Development of the seed bank on the north side may have been influenced by the presence of more recent seed deposits of *T. latifolia*. On the other hand, the seed bank on the south side may contain remnant plant communities extant prior to the introduction of the railroad. In order to investigate these alternatives, we conducted a comparative study of the north and south seed banks of the wetland.

MATERIALS AND METHODS

Each core was separated into three vertical segments referred to as core samples (0-15cm, 15-30cm and 30-45cm). These segments were selected based on previous studies (Kalisz, et al., 1997 and Gunther, et al., 1984), which showed an exponential decrease in viability of seeds with respect to depth. This decrease would mean that seed banks are by no means vertically homogeneous and actually should be treated as different populations as a function of depth.

Core Sample Collection

Core samples were collected using a posthole digger (14cm diameter) during July 1997. Ten coring sites were selected from each side (north and south) of the wetland. Designated coordinates for the coring locations were determined using a table of random numbers. The resulting coordinates identified coring locations within a $9m^2$ grid constructed of electrical conduit and string. Thus the total of twenty coring sites (ten from each side) yielded a total of 60 core samples for seed bank analysis. The volume of each sample was approximately $2300cm^3$. Each core sample was placed directly into a clear plastic bag. Air was removed from each bag prior to labeling and sealing. In order to prevent additional light exposure, samples were further sealed in opaque white plastic bags from which residual air was removed. This process helped to ensure preservation of seed dormancy until exposure under laboratory conditions. The sealed samples were stored in darkness at 20 C^o for 5 days and then transported to the laboratory experimental area.

Experimental Design

The experimental area consisted of a light canopy (1.6m x 2.3m) suspended 0.92m over a table of equal dimensions. Light intensity readings underneath the canopy ranged from 7800- 8800lux. Due to the pattern of light intensity variation, a randomized complete block design was used. Of the 60 core samples collected, 54 (27 from each side) were randomly selected for experimentation. Six core samples, 3 from each side, were retained in storage conditions for contingency purposes. The remaining core samples were placed into transparent plastic containers (17x28cm) and randomly assigned into three blocks in the experimental area (18 core-samples per block). Each container was covered with clear cellophane having openings at each end to prevent contamination from air borne spores while allowing for gas exchange. To maximize treatment exposure to light and air, core samples were repeatedly scored along their length and width (Gunther, et al., 1984). Treatment consisted of exposure to light and air for 70 days from July 21 to September 28, 1997.

Relative humidity and ambient temperature were monitored within the experimental area using recording hygrothermographs (NovaLynx Corporation, model#225-5020A) calibrated to mercury max/min thermometers (Taylor and forced-air psychrometers, model#H331, Weather Measure Corporation). The temperature regime under the canopy was maintained at 30- 32C° as a minimum and 32- 36C° as a maximum. Daily maximum and minimum humidity ranged from 98-67% and 86-50%, respectively. Average diurnal maximum and minimum humidity was 82% and 63%, respectively.

Numbers and identities of germinating seeds within each sample were recorded daily. These data provided a basis for characterizing any differences in the seed banks between the north and south sides of the trail. *T. latifolia* was the only plant enumerated by species while the identification of other species was noted as they matured. All samples were watered to maintain 3cm at the bottom of each tray.

RESULTS

Seed Bank Profiles

ANOVA and multiple range tests ($\underline{P} = 0.05$) applied to the seed bank profile on the south side showed that 0-15cm sample cores were significantly different from 15-30cm and 30-45cm, but sample cores from 15-30cm and 30-45cm were not significantly different from each other. The seed bank profile on the north side showed the same pattern of differences and similarities based on total emergence.

Seed Bank Comparisons

Figure 3 shows both seed banks have the typical profile as described earlier. Regarding 0-15cm core sample the seed bank on the south side had almost half the total number of germinating seeds compared to the seed bank on the north side. The seed banks are quantitatively similar in 15-30cm and 30-46cm depths. Therefore, major differences in terms of total germinating seeds between north and south seed banks occurred in the 0-15cm depth.

T. latifolia seed bank profile shows most germinating seeds were located in the 0-15cm samples (Figure 4). However, there are more than eight times as many germinated *T. latifolia* seeds in the north versus south side in 0-15cm core samples. *T. latifolia* is not represented in 15-30cm and 30-45cm samples from the south side. The seed bank on the north side shows a significant decrease in *T. latifolia* from 0-15cm to 16-30cm (80%) and from the 15-30cm to 30-45cm level (50%) in germination.

DISCUSSION

Our view is that the absence of *T. latifolia* at lower levels on the south side is related to fundamental differences in the seed bank forming processes between the north and south sides. It is our contention that the discontinuity in the seed bank profiles (as measured by total germination) between the two sides is related to a differential in the relative age of the two seed banks as a function of depth.

The total number of germinating seeds as a function of depth was less in all core samples taken from the south side as compared to the corresponding core samples on the north side (Figure 3). Seeds of *T. latifolia* germinated in core samples at all depths on the north side (Figure 4), even at the lowest levels (15-30cm, 30-45cm). However, *T. latifolia* germinated only in the 0-15cm core samples recovered from the south side. These observations suggest that the seed bank on the south side is older than the seed bank on the north side.

A likely scenario is that this discontinuity in age between the seed banks of the north and south sides was a direct result of the original railroad development. The railroad embankment restricted the normal northward flow of Butterfield Creek resulting in back flooding and inundation south of the railroad embankment (Figures 1 and 2). This area was previously a flood plane colonized by species typically associated with upland dry habitats and lower emergent vegetation. The species composition found in all depths of the south core samples (Table 1) support this interpretation. The south side seed bank, therefore, represents a vestige of the pervious upland and emergent vegetation, which was extinguished by inundation due to the back flooding of Butterfield Creek. Since then, the area has been colonized by sparse vegetation, and as a result the contribution of seeds to the seed bank has nearly ceased. Given that Butterfield Creek flows north through this area, the restriction in water flow caused by the introduction of the railroad in turn allowed emergent conditions to prevail or perhaps even expand in the landscape on the north side of the embankment. This difference in landscape conditions, that is inundation on the south and emergence on the north hindered seed bank formation in the former while accelerating it in the latter. The acceleration of seed bank formation is due largely to the extensive colonization of the north landscape by *T. latifolia*. This is supported by the observation that 68% of the germinated seeds from north side 0-15cm core samples were produced by seeds of *T. latifolia* while only 14% of *T. latifolia* seeds germinated from 0-15cm core samples from the south side (Figures 3 and 4). Seed germination of *T. latifolia* has been demonstrated to be greatly favored by emergent conditions while being retarded under conditions of inundation (McNaughton, 1968; Linde, et al. 1976).

These facts are consistent with the scenario outlined above. Namely, that landscape fragmentation resulting from the introduction of the railroad caused a discontinuity in the seed banks on the north and south sides of the Old Plank Road Trail (OPRT). And, the discontinuity is one of age in that the south side seed bank is older than the north side bank, and it is a vestige of the pre-railroad vegetation community.

Landscape fragmentation related to wetlands can result in the formation of seed bank remnants, which may provide valuable information about the dynamics of seed bank ecology in general as well as local vegetative history in particular.

ACKNOWLEDGEMENTS

We would like to thank the Governors State University Division of Science for its financial support and use of laboratory space and equipment. We would also like to thank the town of Matteson for granting us access to the study site and to the Matteson Historical Society for background information on the development of The Old Plank Road Trail. Addional background information was provided by Will County Forest Preserve District (ELC) and the Newberry Library Geneology Department. Appreciation is expressed to Dr. William Zales (Joliet Junior College) for verification of plant species identification and to Christopher Burke Engineering for access to hydrology and soil maps.

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Figure 1. Redrawn from the hydrologic atlas, Tinley Park quadrangle (1965), and Frankfort quadrangle (1967).

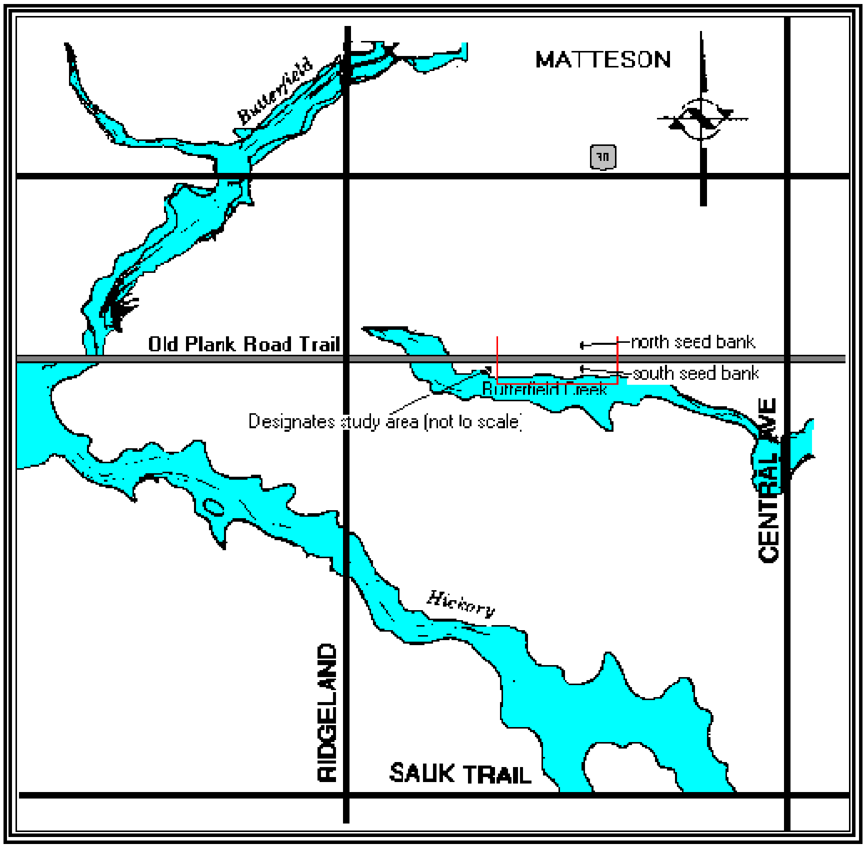

Figure 2. Pictoral display of the seed banks north and south of Old Plank Road Trail.

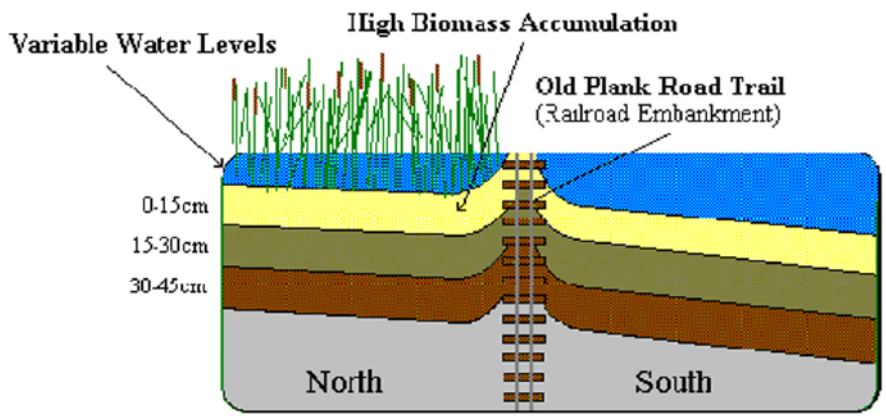

Figure 3. Comparisons of <u>all seeds</u> germinated from the north and south sides of Old Plank Road Trail at depth 0-15cm, 15-30cm, and 30-45cm.

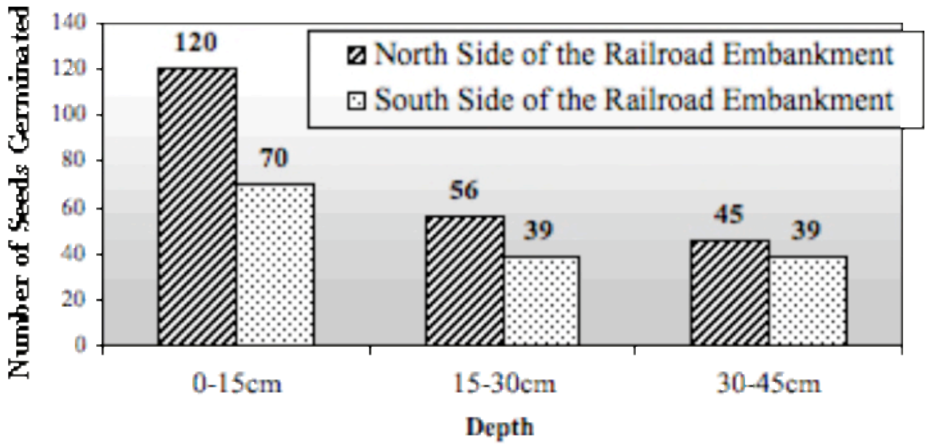

Figure 4. Comparisons of *T. latifolia* seeds germinated from the north and south sides of Old Plank Road Trail at depth 0-15cm, 15-30cm, and 30-45cm.

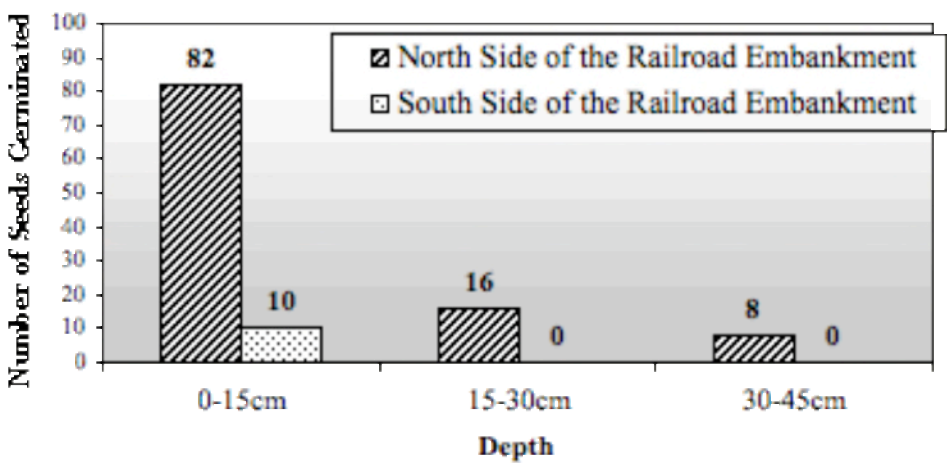

Table 1. Species composition of germinated seeds for North and South (0-15cm, 15-30cm, and 30-45cm). Note: The total # of seeds does not include spores of mosses and liverwort which were also abundant.

North Wetland	South Wetland
0-15cm Core Samples	0-15cm Core Samples
Algae (Chlorophyta)	*Brassica juncea*
Brassica juncea	*Carex spp.*
Carex spp.	*Fragaria virginiana Dutch.*
Fragaria virginiana Dutch.	*Leersia oryzoides*
Hypericum canadense L.	*Leptobryum pyriforme (Hedw.) Wils.* (moss)
Leersia oryzoides	*Ludwigia paulustris americana (L.) Ell.*
Leptobryum pyriforme (Hedw.) Wils. (moss)	*Ludwigia polycarpa* Short & Peter
Ludwigia paulustris americana (L.) Ell.	*Lycopus americanus Mulh.*
Mimulus ringens	*Mnium cuspidatum (moss)*
Mnium cuspidatum (moss)	*Penstemon digitalis Nutt.*
Penstemon digitalis Nutt.	*Ricciocarpos natans (L.) Corda.* (liverwort)
Ricciocarpos natans (L.) Corda. (liverwort)	Unknown Species
Unknown Grass	*Typha latifolia*
Unknown Species	
Typha latifolia	
15-30cm Core Samples	15-30cm Core Samples
Allium canadense L.	*Brassica juncea*
Brassica juncea	*Fragaria virginiana Dutch.*
Carex spp.	*Hypericum canadense L.*
Cyperus spp.	*Leersia oryzoides*
Leersia oryzoides	*Leptobryum pyriforme (Hedw.) Wils.* (moss)
Leptobryum pyriforme (Hedw.) Wils. (moss)	*Ludwigia paulustris americana (L.) Ell.*
Mnium cuspidatum Hedw. (moss)	*Lycopus americanus Mulh.*
Ricciocarpos natans (L.) Corda. (liverwort)	*Mimulus ringens*
Rorippa sessiliflora (Nutt.)	*Mnium cuspidatum* (moss)
Typha latifolia	*Penstemon digitalis Nutt.*
Unknown Grass	*Ricciocarpos natans (L.) Corda.* (liverwort)
	Rorippa sessiliflora (Nutt.) Hitchc.
	Unknown Grass
30-45cm Core Samples	30-45cm Core Samples
Brassica juncea	*Carex spp.*
Carex spp.	*Fragaria virginiana Dutch.*
Fragaria virginiana Dutch.	*Leersia oryzoides*
Hypericum canadense L.	*Leptobryum pyriforme (Hedw.) Wils.* (moss)
Leptobryum pyriforme (Hedw.) Wils. (moss)	*Ludwigia paulustris americana (L.) Ell.*
Ludwigia polycarpa Short & Peter	*Ludwigia polycarpa* Short & Peter
Lycopus americanus Mulh.	*Mnium cuspidatum* (moss)
Mnium cuspidatum Hedw. (moss)	*Ricciocarpos natans (L.) Corda.* (liverwort)
Ricciocarpos natans (L.) Corda. (liverwort)	Unknown Grass

Typha latifolia
Unknown Grass