Effect of changes in deposition and erosion, due to climate change, on the shallow seed bank and future vegetative community

TREE

Anna K. Boeck, Jared Haney, Janis K. Bush, and J.K. Haschenburger

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Abstract

Riparian zones are some of the most diverse, complex, and dynamic habitats on the terrestrial Earth and are particularly sensitive to environmental change. One factor that contributes to high plant species diversity in riparian zones is periodic disturbance caused by floods. However, this disturbance is thought to facilitate invasive plant species establishment in these habitats, which can threaten biodiversity and impact the ecosystem as a whole. Climate change is predicted to alter dominant patterns of precipitation and runoff, which can change the vegetative structure and function of riparian zones. However, studies examining how changes in the hydrologic regime, due to climate change, may impact the seed bank within the riparian zone, and consequently the vegetative biodiversity, have not been identified. The overall goal of this research was to project potential impacts that climate change may have on the native and invasive vegetation along meander bends. One aspect, presented here, is quantifying the viable seed bank in relatively shallow soils and exploring potential relationships between species composition in the seed bank and distance from channel. Along the Little Tennessee River, NC, the floodplain was sampled at three inner and outer positions of meander bends. Three inner and outer bends of the river were sampled. At each position, eleven, 20 cm deep cores were extracted at each depositional environment moving perpendicular to the channel. Cores were placed in trays in a greenhouse and species were identified as germination occurred. Preliminary results comparing species composition and distance from channel will be presented.

Introduction

Riparian zones, as interfaces between terrestrial and aquatic ecosystems, are some of the most diverse, complex, and dynamic habitats on the terrestrial Earth and are particularly sensitive to environmental change (Gregory et al. 1991, Malanson 1993, Naiman and Decamps 1997, Naiman et al. 1993). One factor that contributes to high plant species diversity in riparian zones is periodic disturbance caused by floods (Gregory et al. 1991, Naiman and Decamps 1997, Pollock et al. 1998, Wissmar and Swanson 1990). However, this same disturbance is thought to facilitate invasive plant species establishment in these habitats (Hood and Naiman 2000, Stohlgren et al. 1998). Invasive plant species can threaten biodiversity (Chapin et al. 2000, Dukes and Mooney 1999), potentially impacting the productivity and stability of the ecosystem (Tilman 2000). Climate change is predicted to alter dominant patterns of precipitation and flooding, which also presents a threat to the structure and function of riparian zones (Meyer et al. 1999, Poff et al. 2002).

Riparian seed bank composition often does not correspond to the aboveground vegetation (Beismann et al. 1996). Furthermore, species richness and abundance of seeds in riparian seed banks has been shown to vary widely after disturbance (Abernethy and Willby 1999, Skoglund 1990). This disconnect could be partly attributed to the life history and reproductive strategies of the plant species present (Berge and Hestmark 1997, Thompson and Grime 1979) but also because the seed bank composition may be influenced by physical processes, such as the hydrologic regime, erosion/deposition of sediment, and a variety of seed dispersal mechanisms (Abernethy and Willby 1999, Bornette et al. 1998, Goodson et al. 2002). In general, it is believed that most deeply buried seeds will not germinate due to lack of viability, regardless of habitat (Harper 1977). On average, most studies sample depths ranging from 10 to 20 cm, with a few ranging from 30 to 50 cm, but very few any deeper (Chippindale and Milton 1934, Harper 1977, Thompson et al. 1997). However, preliminary germination results of my research suggest that perhaps researchers are not sampling deep enough to fully characterize the seed bank.

Study Location

Fieldwork was conducted along the Little Tennessee River, NC within Needmore Game Lands (19.4 km^2), which includes a 39 km reach between Lake Emory Dam and Fontana Dam (Figure 1). This particular reach of the Little Tennessee River is described as the most intact portion of the river and supports the richest biodiversity in the Little Tennessee River basin (LTLT, 2012).

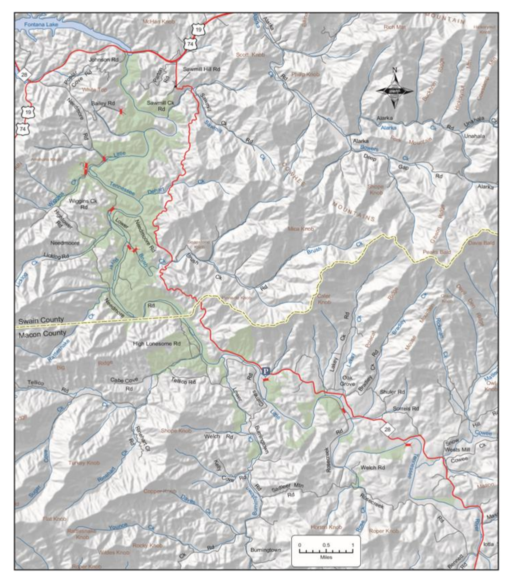

Figure 1: Topographic map in 3-D showing the Needmore Game Land area (in green) and the Little Tennessee River in Swain and Macon County, NC. Map courtesy of NC Wildlife Resources Commission 2013.

Fieldwork

Three inner and outer positions of meandering bends along the Little Tennessee River were sampled (Figure 2).

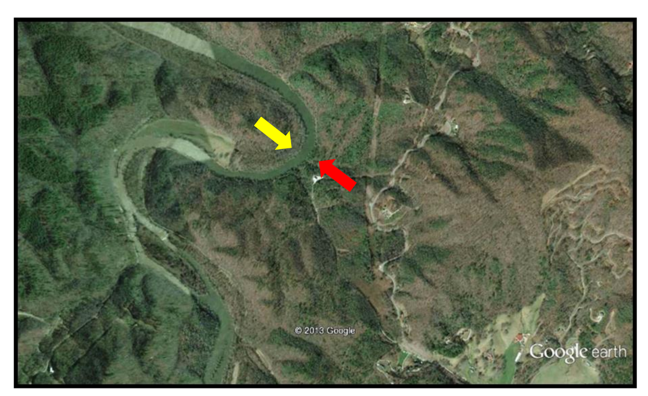

Figure 2: Arial view of an inner (indicated by the yellow arrow) and outer (indicated by the red arrow) position of meandering bends along the Little Tennessee River. Image courtesy of Google Earth 2013.

At each position, starting from the apex of the bend, a surveyor's tape was extended perpendicular to the channel into the floodplain until the hillslope was met. Depositional environments were identified by changes in slope and the width of each environment was measured. A 20 cm x 7.6 cm PVC pipe was hammered into the soil and extracted at 1 m increments, for a total of 5 m, moving parallel to the channel, both left and right from the tape at the middle of each depositional environment (Figure 3). The soil from each pipe was placed into a plastic bag and brought to UTSA for a greenhouse study.

Figure 3: (A) Field crew measuring one meter increments to the right of the surveyors tape and (B) member of crew using a sledge hammer and 2 x 4 to drive PVC pipe into ground. Photos by Anna K. Boeck 2013.

Greenhouse Work

A total of 310 shallow core samples were collected across all 6 sites. Each sample was evenly spread in a tray with drainage holes that contained a mixture of potting soil and sand. The trays were placed in the greenhouse at UTSA and monitored daily to maintain even moisture, by watering with tap water, and identify species as they germinated (Figure 4).

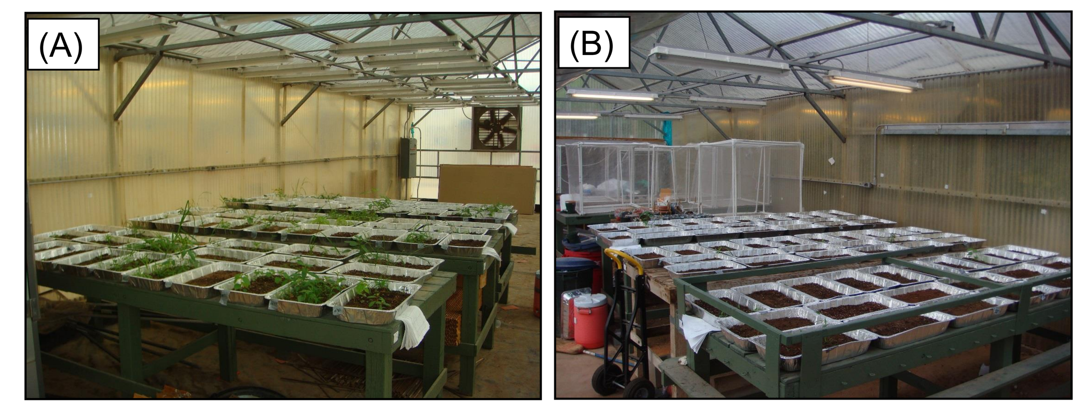

Figure 4 (A) and (B): Views of the trays in the greenhouse at UTSA. Photos by Anna K. Boeck 2013.

Preliminary Results

Seventeen different species have germinated from Site 2B (Table 1), with *Oxalis stricta* being the most common germinant, particularly further from the channel. Five different species have germinated from Site 2A (Table 2), with both *Galium aparine* and *Cyperus sp.* being the most common germinant (Figure 5).

Table 1: Number of species that germinated at a given distance from the channel at Site 2B (an inner position of a meandering bend). Species followed by parenthesis indicate the number of individuals that germinated. Species followed by an asterisk (*) indicates an invasive species.

SITE 2B			
Distance (m)	Species	Distance (m)	Species
0-5	*Cyperus* sp. (5)	10-15	*Cyperus* sp. (2)
	Verbesina alternifolia (3)		*Galium aparine* (2)
	Galium aparine (2)		*Solanaceae*
	Oxalis stricta		*Rhus glabra*
	Cardamine hirsuta		*Polygonum cespitosum*
	Scrophulariaceae	15-20	*Oxalis stricta* (3)
	Portulaca oleracea		*Galium aparine*
5-10	*Oxalis stricta* (2)		*Phytolacca americana*
	Scrophulariaceae (2)	20-30	*Oxalis stricta* (11)
	Galium aparine		*Cyperus* sp. (4)
	Hypericum mutilum		*Sedum ternatum** (3)
	Portulaca oleracea		*Polygonum cespitosum* (2)
	Ipomoea hederacea		*Verbesina alternifolia*
	Polygonum cespitosum	50-60	*Oxalis stricta* (18)
			Verbascum thapsus (4)
			Eleusine indica
			Hypericum mutilum
			Galium aparine

Table 2: Number of species that germinated at a given distance from the channel at Site 2A (an outer position of a meandering bend). Species followed by parenthesis indicate the number of individuals that germinated. Species followed by an asterisk (*) indicates an invasive species.

Site 2A	
Distance (m)	Species
0-5	*Galium aparine (5)*
	Cyperus sp. (3)
	*Sedum ternatum**
5-10	*Cyperus sp. (3)*
	Galium aparine (2)
	Dichanthelium commutatum
10-15	*Rhus glabra*

Preliminary Results - con't

Figure 5: The most common species that have germinated from Sites 2B and 2A;
(A) *Oxalis stricta* Photo courtesy of www.ppws.vt.edu
(B) *Galium aparine* Photo courtesy of southeasternflora.com,
(C) *Cyperus sp.* Photo courtesy of NC State University 2004.

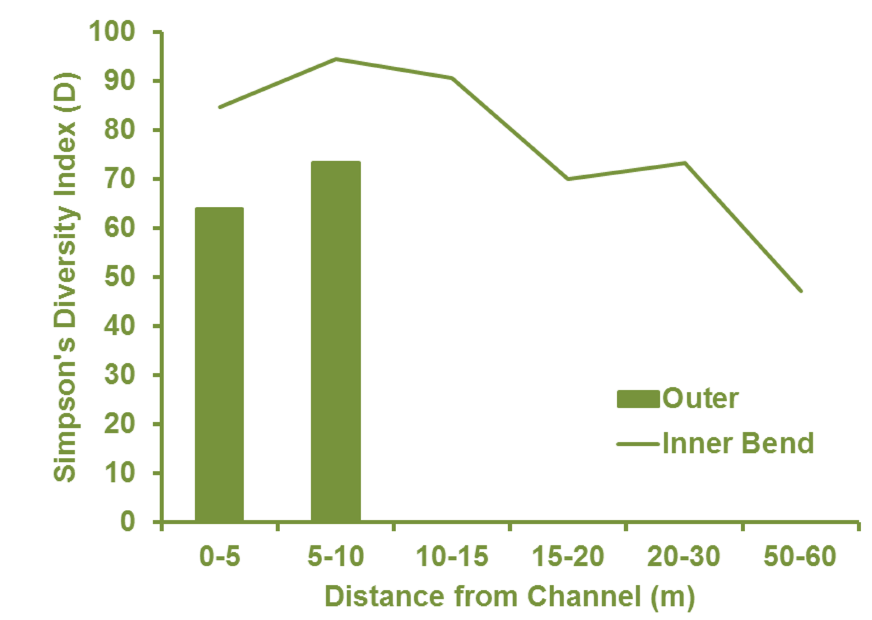

Figure 6: Changes in Simpson's Diversity Index as a function of distance from the channel for the inner bend (line) and outer bend (bars).

Conclusions

- The outer bend had fewer depositional environments than the inner bend.
- Species richness and species diversity were higher in the outer bend compared to the inner bend.
- Only one invasive species was found in each inner and outer bend, and it was the same species: *Sedum ternatum.*

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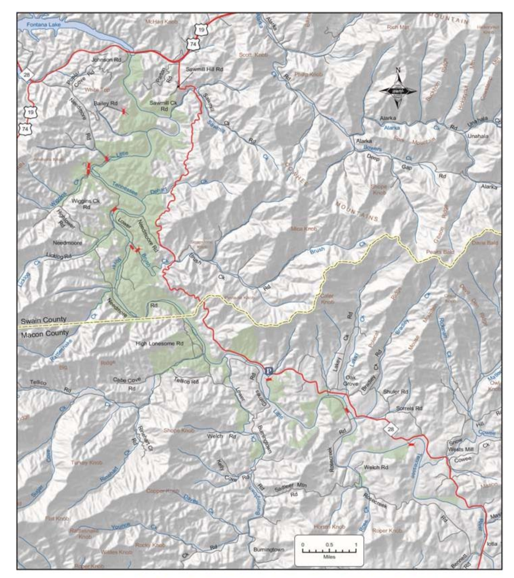

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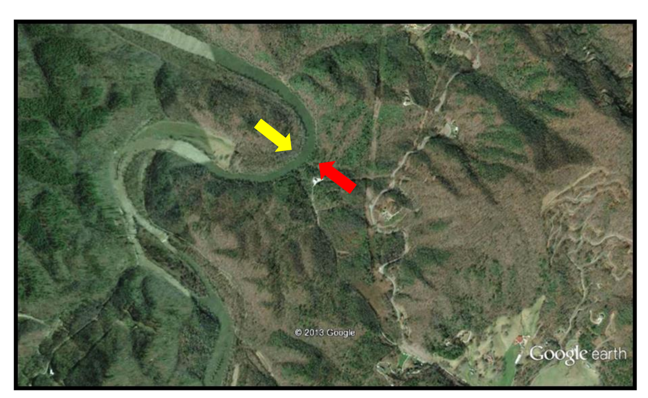

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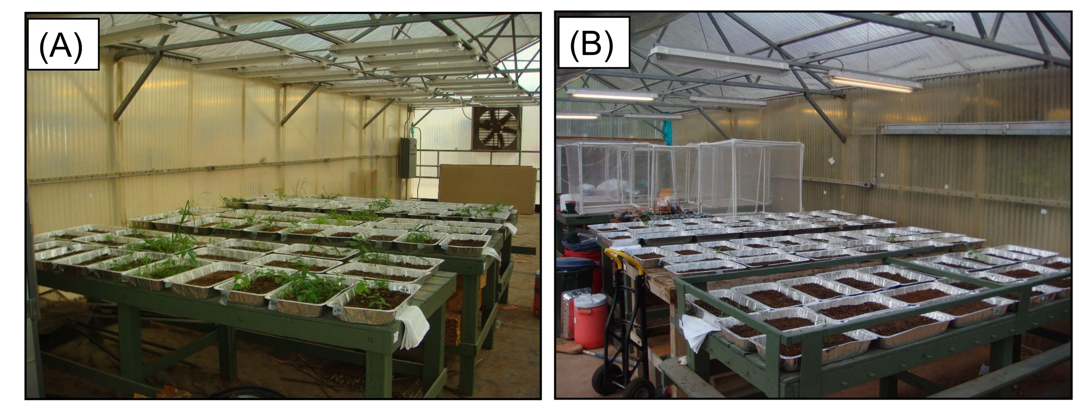

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5-10	*Oxalis stricta* (2)		*Phytolacca americana*
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	Polygonum cespitosum	50-60	*Oxalis stricta* (18)
			Verbascum thapsus (4)
			Eleusine indica
			Hypericum mutilum
			Galium aparine

Table 2: Number of species that germinated at a given distance from the channel at Site 2A (an outer position of a meandering bend). Species followed by parenthesis indicate the number of individuals that germinated. Species followed by an asterisk (*) indicates an invasive species.

Site 2A	
Distance (m)	**Species**
0-5	*Galium aparine (5)*
	Cyperus sp. (3)
	*Sedum ternatum**
5-10	*Cyperus sp. (3)*
	Galium aparine (2)
	Dichanthelium commutatum
10-15	*Rhus glabra*

Preliminary Results - con't

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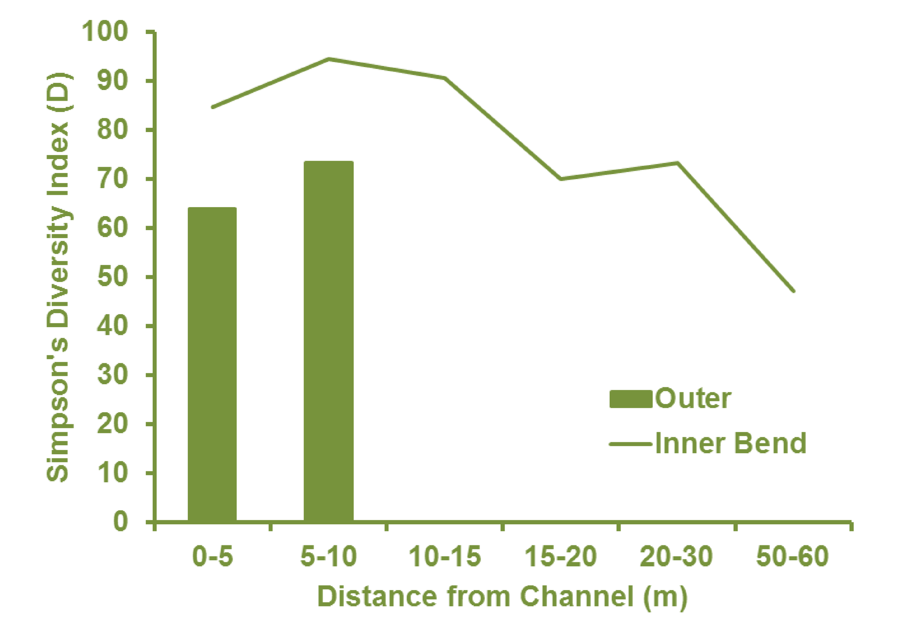

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