Comparison of current vegetative community and the seed bank to understand potential changes in the vegetative community due to climate change

Anna K. Boeck, Joseph Montoya, Janis K. Bush, and J.K. Haschenburger
The University of Texas at San Antonio, San Antonio TX, 78249

TREE

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 disturbances, particularly flood events. However, this same 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 run-off which presents a threat to the structure and function of riparian zones. 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 comparing the current vegetative community to the viable seed community in the seed bank. Along the Little Tennessee River, NC, the floodplain was sampled at three inner and outer positions of meander bends. A survey was conducted to examine the present woody and herbaceous species. This data was compared to seed bank data collected in each of the sample sites. Phytosociological tables from each sample site will be presented, as well as, preliminary comparisons of current vegetation to the seed bank as each site.

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 J.S. 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 run off 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).

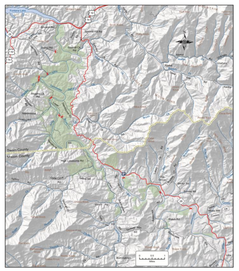

Figure 1: Topographic map in 3-D showing the Needmore Game Land area (in green) and the Little Tennessee River in Swain and Macon County, NC. Map courtesy of NC Wildlife Resources Commission 2013.

Fieldwork

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

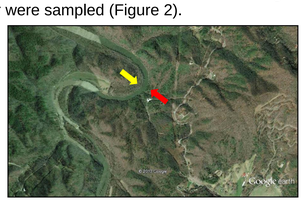

Figure 2: Arial view of an inner (indicated by the yellow arrow) and outer (indicated by the red arrow) position of meandering bends along the Little Tennessee River. Image courtesy of Google Earth 2013.

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. Belt transects were extended parallel to the channel for 45 m to the right. At 5 m increments, a 10 m long rope was extended perpendicular to the transect with 5 m above the transect and 5 m below the transect to form 25 m^2 quadrats Figure 3). This procedure was continued into the floodplain until the hillslope was met and it was repeated on the left side of the tape.

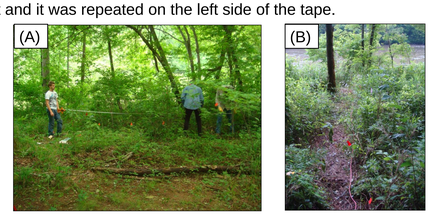

Figure 3: (A) Field crew extending surveyor's tape parallel to the channel and (B) ropes placed perpendicular to the channel. Photos by Anna K. Boeck 2013.

Within each 25 m^2 quadrat, the basal diameter of all woody species (> 3 cm in circumference and > 0.5 m in height) was recorded with a caliper.

Results

New species and density stabilization curves were generated to ensure adequate sampling. The new species curve leveled off indicating adequate sampling, while the density stabilization curve appeared to continue increasing (Figure 4).

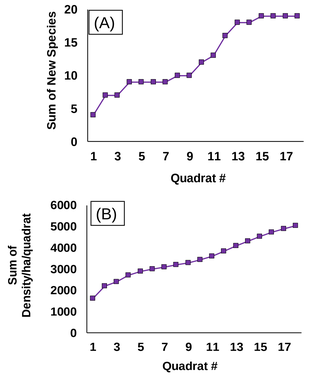

Figure 4: (A) New species curve of the transect 0-5 m into the floodplain from Site 2B; (B) Density stabilization curve of the same transect.

The total density of the transect running parallel to the channels edge and 0 – 5 m into the floodplain, at Site 2B (inner position of bend) was 3844 plants/ha. *Pyrularia pubera* had the greatest individual density (1956 plants/ha), but one of the smallest basal areas (0.1955 m^2/ha). *Leucothoe editorum* and *Carpinus caroliniana* had the highest basal areas of all species (26.5829 and 26.3717 m^2/ha, respectively (Table 1).

Table 1: Phytosociological table of the closest transect to the channel from Site 2B. RIV means relative importance value. An asterisk (*) indicates an invasive species. Unknowns 2 and 5a are in the process of being identified.

Species	# of Individuals	Density (plants/ha)	Relative Density (%)	Average Basal Area (cm^2)	Basal Area (m^2/ha)	Relative Basal Area (%)	RIV (%)
Pyrularia pubera	88	1956	51	1.0	0.1955	0	26
Halesia carolina	20	444	12	102.7	4.5636	6	9
Leucothoe editorum	18	400	10	664.6	26.5829	33	22
Carpinus caroliniana	17	378	10	698.1	26.3717	33	21
Ilex opaca	5	111	3	3.3	0.0370	0	1
Robinia pseudoacacia	4	89	2	501.3	4.4558	6	4
Sambucus canadensis	3	67	2	1.5	0.0102	0	1
Lyonia ligustrina	3	67	2	0.5	0.0032	0	1
Carya tomentosa	3	67	2	1252.9	8.3529	10	6
Acer rubrum	3	67	2	272.6	1.8172	2	2
Cornus florida	1	22	1	0.2	0.0004	0	0
Catalpa bignonioides	1	22	1	11.3	0.0252	0	0
*Rosa multiflora**	1	22	1	0.8	0.0017	0	0
Tsuga canadensis	1	22	1	0.2	0.0004	0	0
Diospyros virginiana	1	22	1	0.2	0.0004	0	0
Kalmia latifolia	1	22	1	41.8	0.0930	0	0
Quercus falcata	1	22	1	3286.1	7.3023	9	5
Unknown 2	1	22	1	1.1	0.0024	0	0
Unknown 5a	1	22	1	0.8	0.0017	0	0
Total	173	3844	100		79.8177	100	100

Preliminary Results

Preliminary results from an ongoing shallow seed bank analysis from Site 2B, at a distance of 0 – 5 m from the channel, show no similarities to the aboveground woody species catalogued in this current study as all species are herbaceous (Table 2).

Table 2: Number of different species that have germinated from Site 2B between 0 – 5 m from the channel. Soil was collected with a 20 cm x 7.6 cm PVC pipe and placed in separate plastic bags (n = 10). The samples were spread evenly in individual trays in the greenhouse at UTSA, kept moist and species were identified as they germinated.

Distance (m)	Species
0-5	*Cyperus sp. (5)* *Verbesina alternifolia (3)* *Galium aparine (2)* *Oxalis stricta* *Cardamine hirsuta* Scrophulariaceae *Portulaca oleracea*

Conclusions

- While *Pyrularia pubera* was present in the greatest number in this transect, *Leucothoe editorium* and *Carpinus caroliniana* also appear to be important components in the vegetative community at 0 – 5 m in the floodplain.
- Only one invasive species was found: *Rosa multiflora*.
- All species that germinated in the ongoing shallow seed bank study were herbaceous.
- The germination study will continue through the Spring/Fall to give species with germination requirements the time to germinate.

References

Abernethy VJ, Willby NJ. 1999. Plant Ecology 140: 177-190.
Bakker J, Poschlod P, Strykstra R, Bekker R, Thompson K. 1996. Acta Botanica Neerlandica 45: 461-490.
Beismann H, Kollmann J, Bogenreider A, Speck T. 1996.. Neues Jahrbuch Fur Geologie Und Palaontologie-Abhandlungen 202: 1095-1106.
Berge G, Hestmark G. 1997. Annales Botanici Fennici 34: 77-90.
Bornette G, Amoros C, Lamoroux N. 1998. Freshwater Biology 39: 267-283.
Brock J. 2003. Leiden, NL: Backhuys Publisher.
Chapin FSI, et al. 2000. Nature 405: 234-242.
Chippindale HG, Milton WEJ. 1934. Journal of Ecology 22: 508-531.
Cline D, Juricek C, Lym RG, Kirby DR. 2008. Invasive Plant Science and Management 1: 120-132.
Cox RD, Allen EB. 2008. Plant Ecology 198: 37-46.
Dukes JS. 2002. Plant Ecology 160: 225-234.
Dukes JS, Mooney HA. 1999. Trends in Ecology and Evolution 14: 135-139.
Fenner M, Thompson K. 2005. The ecology of seeds. Cambridge, UK: Cambridge University Press.
Goodson JM, Gurnell AM, Angold PG, Morrissey IP. 2002. Geomorphology 47: 45-60.
Gregory SV, Swanson FJ, McKee WA, Cummins KW. 1991. BioScience 41: 540-551.
Harper J. 1977. The population biology of plants. London, UK: Academic Press.
Hood WG, Naiman RJ. 2000. Plant Ecology 148: 105-114.
Housman DC, Naumburg E, Huxman TE, Charlet TN, Nowak RS, Smith SD. 2006. Ecosystems 9: 374-385.
Krinke L, Moravcova L, Pysek P, Jaroik V, Pergel J, Perglova I. 2005. Seed Science Research 15: 239-248.
Malanson GP. 1993. Riparian Lanscapes. Cambridge: Cambridge University Press.
Mason TJ, French K, Russell KG. 2007. Biological Conservation 134: 428-439.
Meyer JL, Sle MJ, Mulholland PJ, Poff NL. 1999. Journal of American Water Resources Association 35: 1373-1386.
Mooney HA, Hobbs RJ. 2000. Invasive species in a changing world. Washington, D.C.: Island Press.
Naiman RJ, Decamps H. 1997. Annual Review of Ecology and Systematics 28: 621-658.
Naiman RJ, Decamps H, Pollock M. 1993. Ecological Applications 3: 209-212.
Poff NL, Brinson MM, Jr. JD. 2002. Arlington: Pew Center on Global Climate Change.
Pollock MM, Naiman RJ, Hanley TA. 1998. Ecology 79: 94-105.
Shrestha RR, Dibike YB, Prowse TD. 2012.. Journal of the American Water Resources Association 48: 74-89.
Skoglund SJ. 1990. Canadian Journal of Botany 68: 754-760.
Stohlgren TJ, Bull KA, Otsuki Y, Villa CA, Lee M. 1998. Plant Ecology 138: 113-125.
Syvitski JPM, Andrews JT. 1994. Arctic and Alpine Research 26: 199-212.
Thompson K, Grime J. 1979. Journal of Ecology 67: 893-921.
Thompson K, Bakker JP, Bekker RM. 1997. Cambridge, UK: University Press.
Tilman DT. 2000. Nature 405: 208-211.
Wissmar RC, Swanson FJ. 1990. The Parthenon Publishing Group.

Acknowledgements

This work was supported by a grant from the US Forest Service Southern Research Station, a grant from the USDA HSI Program, and private donations from Vale/Waller/Alvarez.