The Plant and Animal Diversity of Columbia County, NY Floodplain Forests: Composition and Patterns

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Columbia County NY Floodplain Forests:

An Initial Description of their Flora and Fauna and of Certain Factors Influencing that Diversity.

Claudia Knab-Vispo & Conrad Vispo, Farmscape Ecology Program, Hawthorne Valley Farm. 2009.

Introduction

Floodplains lurk. They are inconspicuous and not necessarily welcome. Located in hard-to-reach valleys of our landscape, sometimes muddy and sometimes brushy, few people seek them out as special natural places. Not surprisingly, roads generally skirt them rather than cross them. While we don't advocate building roads through them, this lack of familiarity is a pity, because floodplains deserve more appreciation. Part of our goal with this report is to explain why this is so by introducing some of the plants and animals that live in our county's floodplain forests and some of the unique dynamics that influence that diversity.

In this document, we describe our biological studies of relatively pristine floodplains in Columbia County. There are four main sections: first, we briefly review the definition, history and distribution of this forest type in the County; second, we outline our methods for describing the floodplain forests; third, we report the plant and animal biodiversity that we found, pointing out which organisms are largely confined to floodplains and which are especially rare; lastly, we look for patterns in that diversity. Floodplains, scoured as they are by seasonal floods, have many dips, levees, back channels, beaches and other features creating on-the-ground physical diversity; furthermore, existing vegetation is regularly setback by such floods while the waters bring in upstream seeds to settle on newly-deposited soils from higher in the watershed. How do these conditions influence the biological diversity of these forests?

Part 1: Definition, History, Distribution & Site Selection

Definitions

A "floodplain" is the relatively low land adjacent to a waterway which is regularly flooded. "Regularly", in our case, meant more or less seasonally during the spring floods and other times of high water. We estimate, based on field observations, that most of the floodplains we studied flood 1 -3 times per year. Scientists also talk about 100-year floodplains or 500-year floodplains, meaning the areas that get inundated once in 100 years or once in 500 years. This study focused on the more frequently flooded lands. "Floodplain forest", therefore, is the forest that occurs on the floodplain. In our part of the Northeast, almost all floodplains were historically forested unless they had been cleared by humans or catastrophic floods.

Floodplain forests can be challenging habitats for plants and animals. The seasonal floods can be dramatic and can carry off or bury numerous organisms. Hydrologically, the surface soils can go from flood to drought because the sometimes rocky/sandy soils may have little water-holding capacity. Finally, floods leave behind an intricate tapestry of soil textures and of micro-topography, from sand banks and gravel bars to secondary channels bottomed with fine silt to coarse-soiled levees; some of these represent habitats not found elsewhere in our area.

A theme of our report is the fact that the biota one finds in the floodplain forest is composed of species with varying affinities for the ecological conditions of the floodplain. One structure for categorizing the niches of these organisms is the following:

1) **Primary Floodplain Forest Obligates** - Those species which are adapted to the specific physical conditions created by the floodplain (e.g., radical wet/dry cycle, flood-derived soils topped by leaf-litter).

2) **Secondary Floodplain Forest Obligates** - Those species which rely upon the above species; an example might be a butterfly whose caterpillars feed on an obligate floodplain plant.

3) Those species whose niches include some of the conditions created by floodplain forests, but who don't require floodplain forests per se. These can be broken into three groups:

    a. **Disturbance-adapted, Facultative Floodplain Forest Species -** Disturbance-adapted species who flourish in the disturbed areas created by flooding but which also do well in areas disturbed by other factors (e.g., humans).

    b. **Forest-adapted, Facultative Floodplain Forest Species** - Forest-dwelling species for whom floodplain forests provide one example of suitable habitat but for whom other forest types are also adequate.

    c. **Waterbody-adapted, Facultative Floodplain Forest Species** – Species whose ecology is tied to aquatic systems and who will occur in or near floodplain forests, but may not require them.

In our description of the plants and animals we found in these floodplain forests, we will allude to this general outline as a way of helping you to make sense of the rich biological diversity of these sites. In terms of conservation, it is species in the first two categories that are of primary concern, because these are the species which would be likely to disappear from our landscape were floodplain forests to disappear.

Aside from their role as habitat for native species, floodplain forests have also been widely recognized as buffers which filter out sediments and chemicals entering waterways from adjacent uplands. This is an important 'ecological service', however the present work focuses on floodplain forests as habitat rather than as safeguards of water quality. (For a good overview of the structure and function of riparian corridors, see, for example, Naiman et al. 2005)

History

Over the past 400 years, if not longer, humans have had strong motivation to clear floodplains. In 1721, John Mortimer, writing about English agriculture in a book that helped inform progressive American farmers, wrote "As to lands lying near Rivers, the great Improvement of them is their over-flowing, which brings the Soil of the Up-lands upon them, so that they need no other mending, tho' constantly mow'd". John Mortimer was hardly the first to recognize the importance of regular floods to soil quality, such realizations surely date back to the time of the Egyptians along the Nile and earlier, but his succinct statement is evidence that colonial farmers certainly continued to make the connection. As Brian Donahue pointed out in his book on colonial agriculture in Concord, Massachusetts, the importance of stream-side meadows was so widely recognized that efforts were made to ensure that each farm had their own wet meadow allotment (Donahue 2004).

John Bartram, writing about agriculture in the Mid-Atlantic State during the middle of the 18th century, commented on both the riches of such floodplain land and the consequences of its clearing,

> One cause [of erosion] is very obvious in rich low lands by ye banks of rivers that are fresh which are Anualy enriched by ye floods that brings down mud & trash deposited there where ye stream doth not run very strong or in eddy or back water or where there grows bushes weed or brambles to retain ye leaves or trash that is brought down: I have observed that … rich low lands before they was cleared: produced abundance of hasels, weeds & vines which entangled ye trash which ye floods brought there: & in time rotting kept it very rich, but when cleared & plowed they had A contrary effect upon it & instead of bringing a rich supply & leaving it they often bore away some of ye best of ye soil… (Bartram in Eliot 1748, quoted in McDonald 1941).

Closer to home, a newspaper article filed from Kinderhook, Columbia County in 1811 and commenting on the Creek of the same name reported,

> There are few houses on the banks of the creek, and its beauties can only be seen by those who are willing to endure the fatigue of scrambling through thick woods. The land is yet uncleared, and there are but a few corn or grass inclosures, altho' the soil is more fruitful, and the situation more inviting than that of any place yet cultivated. In many places, in spring, the water overflows the banks, and leaves behind it a prolific slime which increases the fertility . . .
>
> The creek is often diverted from its channel by large trees, driven into it by the wind, which fasten to some bank, and intercept the earth, stone etc. carried along by the current. Owing to this, some beautiful islands have gradually increased in size, and some of them are now covered with trees as tall as any of those of the adjoining wood.
>
> Some of the oldest people of the place say that the creek has suffered a considerable dimunition. The cause of this appears very obvious. From the place where the creek takes its rise to the North [Hudson?] river, of late years, the woods have been destroyed, and the lands cultivated. (Crassus 1802)

In other words, agriculture quickly sought out floodplains and began taking advantage of their rich soils. Today, many farm fields are still located on floodplains and produce valuable crops. The result of this activity on soils, forest, and stream water was also quickly noted by contemporary observers, and those consequences continue to this day.

Floodplain Forest Distribution & Study Site Selection

The initial step of the present study was to find 'relatively pristine floodplain forests' for our study sites. At first, we used topography, soil maps, and current aerial photographs to find tracts of floodplain forest. However, we soon realized that we were overlooking one key factor: history. We visited a number of sites and during preliminary visits we noted the relative abundance of invasive woody plant species (e.g., multiflora rose, barberry, honeysuckle). We were puzzled to find that some sites were densely overgrown with such plants, while others had few. It soon became apparent that some of our 'weedier' sites were in fact new forests that had regrown during the past 60 years. Columbia County farm land has decreased dramatically over the last century, and some of the abandoned land has been on floodplains. Figure1 shows a gross quantification of the relationship between the extent of older forest (as judged by historical aerial photographs) and the abundance of invasive species (based on a semi-subjective estimates made during initial site visits).

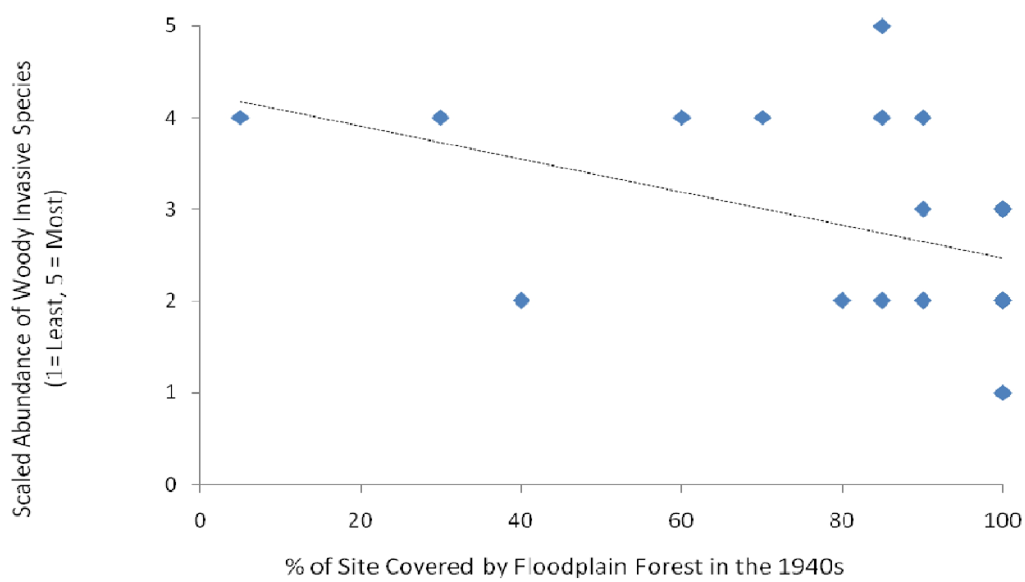

Figure 1: The relationship between the historical extent of floodplain forest on individual sites and the corresponding abundance of woody invasive plants on the same sites. *Please note that some sites had identical coordinates and so single symbols may represent more than one site. The regression line is statistically significant at p<.05.*

With this pattern in mind, we went back to aerial photographs from the 1940s (kindly provided by Columbia County Soil and Water Conservation District), and used those images to refine our study site selection and to estimate the current extent of ancient floodplain forest in the County. We use "ancient" in the sense of the British who define an "ancient" forest as being one that "has existed – although usually felled many times – for several centuries" (Rackham 2006). This can be distinguished from *old growth* or *primary forest* which has presumably been largely untouched for equally long periods. The emphasis with "ancient" forest is that the given tract of land has long been covered by forest, albeit a forest that may have been extensively cut or even grazed. All old growth forests are also ancient, but the reverse is not necessarily true. Other researchers have shown that continuous forestation can help maintain certain forest plants and animals, even if those forests were heavily used as woodlots or grazing grounds.

We do not have aerial photographs from before the second third of the 20th century, but, given our local land use history (where agricultural extent peaked around 1870), we are assuming that a site which appeared to be in mature forest in the mid-20th century had not been completely cleared during the preceding century or two and so qualifies as ancient.

Using our new designation of "ancient" forests, we returned to our county maps and mapped the extent of current floodplain forests, including in our designation "ancient" forests. The map below indicates the presumed, pre-colonial extent of floodplain forests in the County (based on the distribution of floodplain soils), and the current extent of ancient floodplain forests. We estimated that roughly 6800 acres (or 27%) of pre-settlement floodplain forests are currently forested, although, of that, only some 3610 acres (or about 14% of the total floodplain soil area) were forested in the 1940s (Figure 2) and so can be considered 'ancient' floodplain forests today. Please note that we do not have detailed information regarding indigenous use of floodplain forests. As witnessed by archeological relicts, Native Americans often did camp along streams in the County, and they may have periodically cleared some of these lands for agriculture, although they may not have cultivated directly on the highly dynamic, sometimes coarse, surface of active floodplains.

Based on our mapping of ancient floodplains and on site accessibility, we selected 15 study sites – five each in the Kinderhook, the Claverack and the Roeliff-Jansen Kill watersheds (Figure 3). The study of these sites forms the basis for all the data presented in the subsequent sections of this report. Appendix 1 summarizes select characteristics of our sites. We will elaborate on aspects of this appendix later in the report.

In sum, due to their biophysical characteristics, floodplain forests harbor some unique, native plants and animals. Because of their rich soils however, they have been extensively cleared for agriculture. More recently, while their rates of clearing have probably diminished, their existence has been somewhat overlooked by the public. We hope that our report helps highlight the unique features of these forests and might even stimulate their exploration.

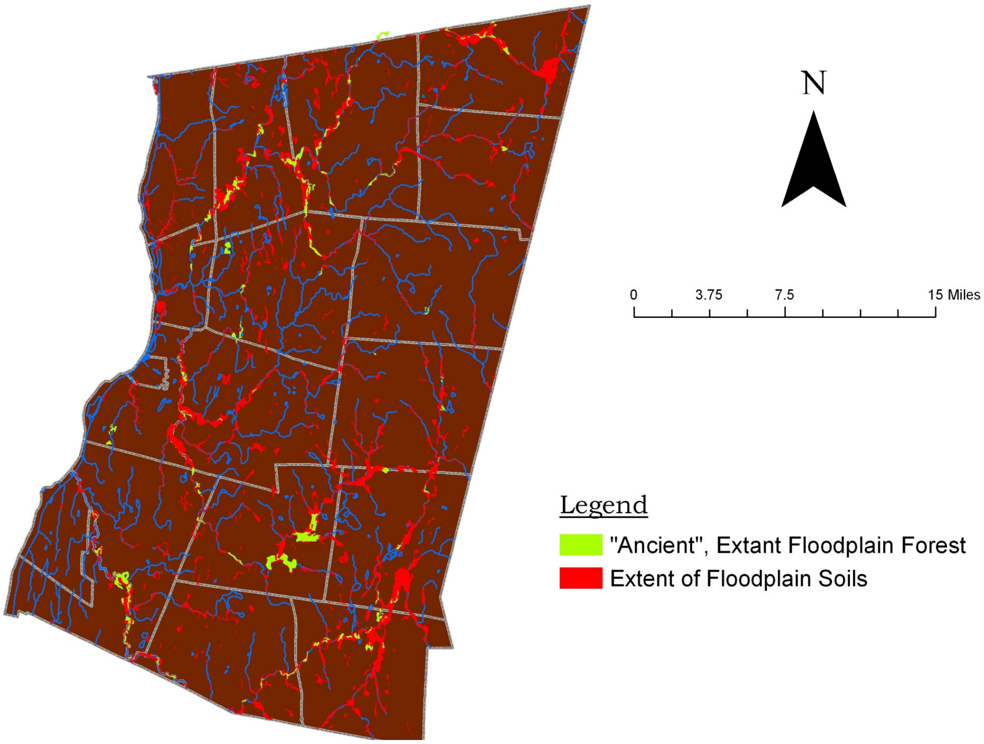

Figure 2: A map indicating the presumed original location of floodplain forests in Columbia County prior to European settlement, and the location of existing ancient floodplain forest as determined from historical aerial photographs.

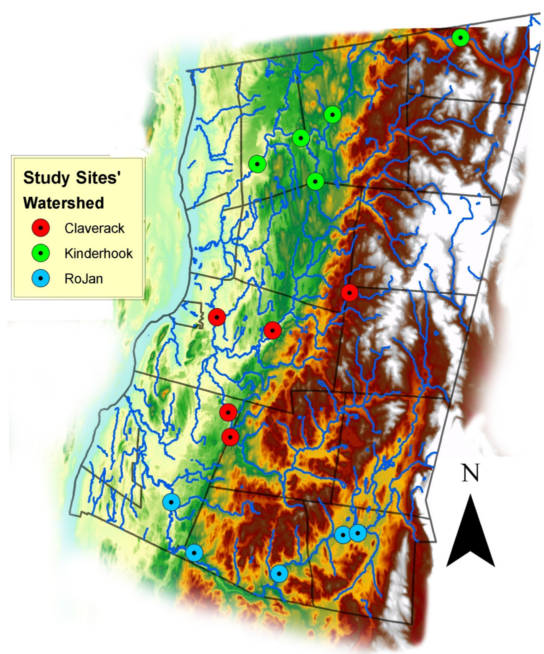

Figure 3. A map of Columbia County indicating the approximate locations of our study sites in relationship to topography and watershed. *Elevation varies from only slightly above sea level along the Hudson to peaks of over 2000' in the Taconic Hills along the eastern side of the County.*

Part 2: Methods of Describing the Floodplains

As part of our introduction to floodplain forests, we have explained our process of site selection and our sites. In this section, we describe the methods we applied at each site in order to quantify the physical conditions and the organisms found there.

Topographic Transects (= Toposequences)

A key goal of our work was to document the relationship between biological and physical diversity on our sites. In order to do this, we needed to somehow describe where, in a hydrogeomorphological sense ('hydrogeomorphology' refers to the topography of the floodplain as formed by the forces of water flow), our organisms were found. We established transects perpendicular to the river and documented the changes in topography as we moved in a straight line from the river's edge to the end of the floodplain. These topographic cross-sections or "toposequences" enabled us to pinpoint the location of our smaller study plots in terms of distance from the stream and their elevation within the floodplain.

Physical Description of the Ancient Floodplain Forest Study Sites

At each study site, we established three terrestrial transects located perpendicular to the creek from the water to the end of the floodplain forest. In a few cases of wide, but homogeneous floodplains, we limited the transect length to 300 feet. The middle transect started at the creek's shore approximately in the center of the study site, while the outer transects started at the creek's shore approximately 50 feet from the up- and down-river edge of the ancient floodplain forest. Because most of the study sites were located at a bend in the creek bed, transects were rarely parallel. In a few cases, transects even crossed each other at a certain distance from the creek bank. Along each of the 45 terrestrial transects, we mapped a topographic profile, taking laser level readings every 2 feet along the length of the transect. We determined the bankfull stage using a combination of indicators, such as the height of depositional features, changes in vegetation and/or particle size of bank material, slope or topographic breaks along the bank, etc. (Harrelson et al. 1994) and expressed all the height measurements relative to the bankfull stage.

Along each transect (or toposequence), we designated sections based on relatively uniform elevation, soil texture (see paragraph below for definition of soil texture classes used in this study) and moisture, and understory vegetation. We then described a number of physical and structural variables at the midpoint of each seemingly homogeneous section along the transect. Sampling points were located at the center of each section. If these sections were more than approximately 50 feet in length, we added additional sampling points spaced 20 to 50 feet apart depending on the total length of the given section.

At each of the resulting 594 sampling points, we determined

- distance from bankfull stage (read in the field from the measuring tape)
- elevation relative to bankfull stage (calculated from laser level readings)

- soil texture of top two inches and at 2-3 feet depth, if possible (field inspection of soil samples taken with an augur; classified into 1: silt/clay; 2: loam; 3: sandy loam; 4: sand; 5: fine pebbles <1cm; 6: coarse pebbles/gravel 1-7cm; 7: cobbles >7cm)
- % canopy cover (average of two estimates of the percentage of sky covered by leaves and branches when looking straight up through a 4 ft^2 frame held overhead at arm's length, second measurement taken after turning 180^o)
- height of tallest herbaceous plant by mid summer
- % cover[1] (in mid summer) of herbaceous plants, moss, leaf litter, fine woody debris, and bare ground within a 4 ft^2 plot randomly placed on either side of the measuring tape and at 3 feet distance (to avoid sampling of areas that had been impacted when the transect was originally established)

Landscape Context

We also gathered information on landscape context of each of our floodplain forest sites. For each of the 15 study sites, we measured the 'as-the-stream-flows' distance to the confluence of its waters with the Hudson (by tracing the stream on the aerial image with ArcView), determined its altitude above sea level from the digital topographic layer, determined the approximate area of ancient floodplain forest (combination of field observations and inspection of aerial photos from the 1940s and 2004). We also determined stream slope[2] and sinuosity[3] from aerial photographs. In the field, we documented the profile of the stream bed at one cross-section per study site. This facilitated the calculation of the width/depth ratio and the entrenchment ratio[4] at each site. The sites were then classified into stream types according to the Rosgen Classification (Rosgen 1994). The current landuse surrounding our study sites was determined from 2004 aerial photos. We estimated the percent cover of forest, agricultural fields/orchards, and residential areas within 2000 feet of the center of each study site. As an indicator of the degree of development surrounding each study site, we also determined the total length of black-top roads located within the 2000 feet radius.

Plants

Tree Inventories: Along the 45 transects, we recorded the species and size (diameter at breast height, dbh) of all trees and woody climbers (dbh at least 2") within 25 feet of either side of the transect and noted their distance from bankfull stage. For multiple-trunked trees, we recorded the dbh of each trunk, but counted only one individual. Standing dead trees (i.e, "snags") were also noted.

Small Woody Plant Inventories: At the center of each of the 594 sampling points along the transects, we recorded the woody plants (dbh<2") in a 60 ft^2 plot randomly assigned to one side of the transect. For each species present with less

[1] % cover was estimated in the following classes: 0, <1, 1-<10, 10-<25, 25-<50, 50-<75, 75-<100
[2] =elevation difference between consecutive topo lines (in feet)/length of streambed between consecutive topo lines (in feet)
[3] =length of streambed within each study site (following the meanders)/direct distance between points where stream enters and exits study site
[4] = width of bankfull stage/width of floodplain

than 21 individuals, we classified abundance in three groups: 1 individual, 2-5 individuals, 6-20 individuals; for species with more than 20 individuals, we estimated % cover in 4 classes: <26%, 26-50%, 51-75%, 76-100%. This resulted in seven abundance classes 1, 5, 20, 25, 50, 75, 100, which were treated as roughly equivalent to percent cover in the statistical analysis.

Herbaceous Plant Inventories: At each of the 594 sampling points along the transects, we recorded % cover[5] (in mid summer) of each herbaceous plant species (plus ground-covering woody species, such as Virginia Creeper and Poison Ivy) within a 4 ft^2 plot randomly placed on either side of the measuring tape and at 3 feet distance (to avoid sampling of areas that had been impacted when the transect was originally established).

Inventories of Spring Ephemerals: The presence of spring ephemerals was surveyed quickly at the site level (in Spring 2008, before the transects and sampling points had been established). We attempted a complete inventory of all spring ephemerals present at each site, and at most sites we ranked the species by abundance (1: rare, 2: occasional; 3: common; 4: dominant), but the effort for these surveys was not standardized.

Additional Plant Observations at the Study Sites: During the multiple visits to each study site, we kept notes on plant observations, especially of species that had not been recorded at the particular site in any of the systematic inventories described above.

Animals

Butterfly Surveys: We did one focused, mid-summer survey for butterflies at each of our study sites by scanning the shoreline for butterflies during a relatively sunny mid-day period. Butterfly activity was minimal away from the streamside. All butterflies seen were identified by sight and recorded. When necessary to confirm identifications, photographs were taken. The duration of our surveys varied due to forest conditions and the abundance of butterflies. Butterflies were also noted whenever seen during our extensive additional work at each site. While we did not attempt to standardize our surveys, we do believe they provide a useful summary of at least the common butterfly species of these forests.

Surveys of Ground Beetles and other Ground Invertebrates: A single pit trap made from an 8 oz plastic cup was buried up to its brim near the center of our 594 sampling points along the 15 transects. About 1” of soapy water was put in the bottom of each cup. Cups and contents were collected after three days and three nights of continuous sampling. Sites were sampled in succession (with some overlap) between 28 July and 22 August. The contents of each trap were preserved in alcohol and subsequently sorted. Each ground beetle was mounted and the presence/absence of other insect groups in the sample was noted. Mounted beetle specimens were identified by Robert Davidson of the Carnegie Museum of Natural History.

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[5] % cover was estimated in the following classes: 0, <1, 1-<10, 10-<25, 25-<50, 50-<75, 75-<100

Dragonfly & Damselfly Surveys: In June and July, we surveyed each site once for adult dragonflies/damselflies and exuvia. Adults were recorded by observing and netting along the stream margin. During that same period, we also surveyed an approximately 6' strip along the banks of each site for exuvia (the empty skins that dragonflies leave behind when they transform from aquatic larvae to air-borne adults). All exuvia were collected and subsequently identified. Adults and exuvia were also tallied if they were found during our other extensive work at each site. Like our butterfly surveys, these odonate surveys were not strictly standardized, however, taken as a whole, we do believe that they provide a useful summary of the dragonfly and damselfly fauna of these sites. Results of these tallies were filed with and reviewed by the New York State Dragonfly Survey.

Native Bee Preliminary Surveys: At five of our sites, Martin Holdrege surveyed for native bees in late April and early May of 2008. Because the spring flowers of the floodplain forests provide some of the season's first pollen and nectar resources, they can be important for early-flying bees. At each site, bees were collected using fluorescently-painted, soap-water-filled bee bowls set along three transects parallel to the stream edge and usually running through or near wildflower beds. All bees were mounted and identified by Martin Holdrege and by Sam Droege of the US Geological Survey.

Bird Surveys: Intern Erin Philp was the primary person responsible for bird surveys. Bird surveys were conducted using 10-min point counts within a 100-foot radius circle. Surveys were conducted between 05:00-09:00 hours EST from June 12th to July 19th in 2008. Points were located 200 ft apart and 50 ft from the river's edge. Point counts were conducted further into the forest, beyond the points within 50 ft of the water's edge, if the floodplain extended >250 ft from the river's edge. Each point was surveyed once. Birds observed or heard during each count were noted; whether or not birds were within 50 feet of the water's edge was also recorded. Cris Winters assisted Erin in becoming familiar with the floodplain fauna.

Amphibians & Reptiles Preliminary Tallies: Most amphibians and reptiles were recorded incidentally during our fieldwork. We did attempt to use cover boards to survey for snakes and salamanders, but either these creatures were scarce on the floodplain or the material we used for our coverboards (semi-translucent plastic barrel tops) was inappropriate. During our first visits late in the Spring, we did visit backwaters in order to check for Wood Frog or Mole Salamander eggs. We also did standardized surveys for stream salamanders by turning rocks six feet on either side of the water's edge along three 45-foot transects. Adult and larval salamanders caught during these surveys were identified, and released. Although our methods were largely informal, we did spend ample time at each site and so present our results as an initial description of the herps likely to be found in floodplain forests in the County.

Mammal Surveys: Intern Victoria Shelley was primarily responsible for mammal surveys. Two types of surveys were conducted. First, muddy or sandy shorelines and backwaters were surveyed for tracks, and the entire site was scanned for mammal sign (e.g., scat, chews, rubs). All tracks and sign observed at each site were summarized and a list of mammals observed at each site was obtained.

Aside from the tracking efforts at each site, we also carried out live-trapping with small Sherman live traps at three sites. This sporadic work was only intended to give us some basic data about which other mammals might be present. We also used an Anabat system to record bat calls at four sites. Again, this incomplete sampling was only meant to give us an idea of the presence/absence of some additional organisms at these sites. Finally, a couple of species of small mammals were observed incidentally during our other work.

Deer Browsing

Systematic observations on the intensity of deer browsing were made by Victoria Shelley along three transects in each of the fifteen study sites. Each transect was walked beginning at the water's edge and moving toward the slope at the edge of the floodplain. Observations were taken at every 10 feet along the transect; at each point, the first being at the water's edge, a radius of 3.5 feet around was observed. If vegetation within the observable area was visibly browsed by deer, then the plant species were recorded and assigned a "browse intensity" number (1:1-25%; 2:26-50%; 3:51-75%; 4:76-100%). Browse intensity is an estimate of the percent of available individual plants browsed upon within the point radius[6]. The browse data were summarized to provide an average browse intensity for each transect and a percentage of points at which browse was observed on each of the individual plant species. The latter statistic, when compared to the plant survey data indicating the percentage occurrence of each species at sampling sites along the transect, was used to compute a browse preference score for each species.

Statistical Analysis

Basic summary statistics were computed with Microsoft Excel. Detailed community analysis was performed using Indicator Species Analysis, Hierarchical Cluster Analysis, and Canonical Correspondence Analysis (CCA) available in PC-ORD (McCune and Mefford 2006). Aaron Ellison of Harvard forest provided important input on the use of these techniques. An explanation of the specific community analysis methods is presented as part of the description of the results in the appropriate section. Sample-based rarefaction was done using the PAST data analysis program (Hammer et al. 2001).

[6] For example, Jewelweed may have received a browse intensity of 2 at a given point. This would mean that 26%-50% of the available Jewelweed within the observed radius was browsed upon.

Part 3: Plant and Animal Diversity of Columbia County Ancient Floodplain Forests

Plants

Overview: We documented 362 species of plants at our 15 study sites. Appendix 2 is an annotated list of all these plants, providing information about their origin (native vs. introduced), invasiveness, rarity, and affinity for floodplain forest habitat. The list also indicates how frequently each species was observed across the 15 study sites.

The following is a summary description of information that can be gleaned from Appendix 2. Please refer to the appendix for scientific nomenclature (Gleason & Cronquist 1991) corresponding to the common names mentioned in the text.

Three quarters of the species documented in the 15 ancient floodplain forest sites were plants considered native to our county, 92 species were introduced. Most of the introduced species were herbs, but we also found six tree, six shrub and four vine species introduced to our region. We found one NYS-threatened species (*Carex davisii*) and one uncommon species (*Mimulus alatus*) that is on the Watch List of rare plants for the State of New York (Young 2008). We classified another 40 species found in the study sites as rare or scarce in the Hudson Valley (based upon Kiviat and Stevens 2001, Stevens, pers. com.) or in Columbia County (Knab-Vispo pers. obs.). Twenty-one of the plant species found in the 15 study sites are protected by NYS as "exploitably vulnerable". These are plants that, though not yet rare, could become rare in the future due to frequent collecting. We also found 30 species considered invasive in New England[7], including 12 of the 18 species listed by the Invasive Plant Council of New York State (IPC) as the most invasive plants in NewYork[8]. ("Invasive" plants are non-native species which appear to be expanding into natural or semi-natural habitats and may well be influencing the ecology of native species.)

The flora of the ancient floodplain forest sites was composed of native species that occur ***almost exclusively*** along streams (18 species; returning to our initial framework, these species are almost 'primary floodplain forest obligates'), species that occur ***mostly*** along streams, but are also found elsewhere in wetlands and along roadsides (39 species, including 4 invasives), and species that are generally ***associated with rich mesic forests***, be they in a floodplain or in upland forest (30 species; i.e., 'forest-adapted, facultative floodplain forest species'). Furthermore, the floodplain forests also have a large number of widespread and less common upland forest and wetland plants, as well as a variety of native and introduced colonizers (think "weeds"), that thrive on the exposed soil (e.g., beaches, occassionally flooded secondary channels) and under the canopy gaps created by the dynamics of the stream (i.e., 'disturbance-adapted, facultative floodplain forest species').

Woody Plants: Tree species present in all of the study sites were American Elm, Basswood, and Bitternut. Almost ubiquitous were Sugar Maple and Wild Black Cherry (present at 90% of the study sites) and Green Ash, Sycamore and Cottonwood (present at 80% of the study sites). Of all the tree species documented, Boxelder and Silver Maple occur in our region ***almost exclusively*** in floodplain forests, while Bitternut, Green Ash, Sycamore, Cottonwood, Slippery Elm, Black Walnut, Black Willow, Crack Willow, as well as Black Ash, Butternut and Hackberry seem to be ***mostly*** *associated*

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[7] http://nbii-nin.ciesin.columbia.edu/ipane/icat/catalogOfSpecies.do
[8] www.nysgextension.org/glhabitat/epacd/pages/plants/invasives.htm

with floodplain forests in Columbia County (Table 1). The latter three are uncommon species in Columbia County and Hackberry is of uncertain occurrence throughout the Hudson Valley. Red Mulberry is a tree species that is rare or scarce in the Hudson Valley and was documented in our floodplain forest study sites, but it also seems to occur in other habitats. During her studies in other parts of the Hudson Valley, Stevens (pers. com.) observed Butternut to be generally associated with rich forests, and Slippery Elm and Green Ash to be also very common in wooded swamps. More intensive studies of these other habitats in Columbia County might show that, here too, floodplain forests are only one but not necessarily the main habitat for these species. On the other hand, Weatherbee (1996), describing Massachusetts plants, reports habitat affinities very similar to those that we observed in Columbia County. There seems to be a pattern for species with a temperate distribution to occur in a variety of habitats at the core of their range, but to extend towards the northern boundary of their range mostly along river valleys. McVaugh (1958) made similar observations about "southern" species coming into Columbia County along the Hudson, but not reaching into the higher eastern part of the county. Thus, it may be that some plants that are mainly riverine in Columbia County are more widely distributed farther south.

Norway Maple and Black Locust, which both occurred at almost half of the study sites, are considered amongst the worst invasive species in NYS by the Invasive Plant Council[9]. Tree-of-Heaven and Russian Olive are listed in the Invasive Plant Atlas of New England[10]. Chinese Tree Lilac (*S. pekinensis*) is locally very common and seems to act like an invasive plant in the floodplain forest of the Kinderhook Creek in New Lebanon, but was not recorded in any of our study sites. This plant is not currently considered an invasive species in the US, but the NYS `Invasive Species Council has received other reports of possible invasions of floodplain forests by Chinese Tree Lilac (Weldy, pers. com. 2008).

The introduced and invasive Multiflora Rose was the only shrub species present at every study site, but only at two sites did it cover close to 10% of the sampled area. Other invasive shrubs present in low densities at some of the study sites were Japanese Barberry, Honeysuckle, European Buckthorn, Common Privet, and Winged Burning Bush. The regionally-rare Leatherwood is a native shrub that is ***almost exclusively*** found in floodplain forests, including ravines of small tributaries. The NYS-protected Winterberry was found at one of our study sites, and Bladdernut, a shrub we consider uncommon in Columbia County, was found at three of the study sites.

Vines: The native vines Poison Ivy and Virginia Creeper were present at all study sites. The invasive Oriental Bittersweet was found at almost 50% of the sites, while the invasive Japanese Hops, which is ***mostly*** found in floodplain forests, occurred only once in our study sites. The native Marshpea, which is rare in the Hudson

Table 1: Trees, shrubs, and vines that almost exclusively or mostly occur in floodplain forests in our region *(listed in order of their frequency of occurrence in the sample sites) 1) Kiviat and Stevens 2001; 2) Knab-Vispo, pers. obs.; 3) Stevens (pers. com.) did not find these species particularly associated with floodplains in other parts of the Hudson Valley, but see discussion in text*

[9] www.nysgextension.org/glhabitat/epacd/pages/plants/invasives.htm
[10] http://nbii-nin.ciesin.columbia.edu/ipane/icat/catalogOfSpecies.do

Almost exclusively floodplain:			
67%	Boxelder	*Acer negundo*	
40%	Silver Maple	*Acer saccharinum*	
7%	Marsh Pea	*Lathyrus palustris*	rare in Hudson Valley[1)]
7%	Leatherwood	*Dirca palustris*	rare in Hudson Valley[1)]
Mostly floodplain:			
100%	Bitternut	*Carya cordiformis*	
80%	Sycamore	*Platanus occidentalis*	
80%	Green Ash[3)]	*Fraxinus pennsylvanica*	
80%	Cottonwood	*Populus deltoides*	
40%	Slippery Elm[3)]	*Ulmus rubra*	
40%	Virgin's Bower	*Clematis virginiana*	
20%	Butternut[3)]	*Juglans cinerea*	uncommon in Columbia County[2)], NYS exploitably vulnerable
20%	Hackberry	*Celtis occidentalis*	uncommon in Columbia County[2)], occurrence in Hudson Valley uncertain[1)]
13%	Black Ash	*Fraxinus nigra*	uncommon in Columbia County[2)]
13%	Black Walnut	*Juglans nigra*	
13%	Wild Cucumber	*Echinocystis lobata*	
7%	Black Willow	*Salix nigra*	
7%	Bur-cucumber	*Sicyos angulatus*	
7%	Crack Willow	*Salix fragilis*	
7%	Japanese Hop	*Humulus japonicus*	INVASIVE!

Valley is found ***exclusively*** in floodplain forests, the more common Wild cucumber, Bur-cucumber, and Virgin's Bower were ***mostly*** found in this habitat (Table 1). Moonseed, which is scarce in the Hudson Valley and Groundnut, which is uncommon in Columbia County, were also found at some of the study sites.

Herbaceous Plants: Herbaceous plants present at all study sites were the natives Jack-in-the-Pulpit, Trout Lily, Spotted Jewelweed, Clearweed, Common Wood-sorrel, Common Enchanter's Nightshade, Honewort, Reed Canary-grass, Common Blue and/or Marsh Violets, and Beggar-ticks (*Bidens* sp.). Also present at all study sites were the non-native, invasive Garlic Mustard and Dame's Rocket.

The following herbaceous species (Table 2) recorded at our study sites seem to occur in Columbia County and neighboring areas ***almost exclusively*** in floodplain forests (McVaugh 1958, Weatherbee 1996, Knab-Vispo pers. obs.). The values in front of each species indicate the percentage of the 15 study sites in which this species was recorded.

These are all native species and a good proportion of these floodplain forest specialists are rare in our region or even within the state of New York.

Table 2: Herbaceous plant species that <u>almost exclusively</u> occur in floodplain forests in our region *(listed in order of their frequency of occurrence in the sample sites) [1) Kiviat and Stevens 2001; [2) Knab-Vispo, pers. obs.; [3) Stevens, pers.com.; [4) Young 2008*

87%	False Mermaid Weed	*Floerkea proserpinacoides*	
87%	Ostrich Fern	*Matteuccia struthiopteris*	occurrence in Hudson Valley insufficiently known[3)]
47%	Green Dragon	*Arisaema dracontium*	rare in Hudson Valley[1)]
47%	Giant Ragweed	*Ambrosia trifida*	scarce in Hudson Valley[1)]
40%	Wild Rye	*Elymus virginicus*	
27%	Canada Brome	*Bromus altissimus*	
27%	Davis's Sedge	*Carex davisii*	NYS-threatened[4)]
27%	Hairy Wild-rye	*Elymus villosus*	
27%	American Germander	*Teucrium canadense*	rare in Columbia County[2)]
13%	Sprengel's Sedge	*Carex sprengelii*	potentially rare in Hudson Valley[1)]
13%	Winged Monkeyflower	*Mimulus alata*	NYNHP Watch List[4)]
13%	Anise Root	*Osmorhiza longistylis*	uncommon in Columbia County[2)]
13%	Hedge-nettle	*Stachys tenuifolia var. hispida*	uncommon in Columbia County[2)]
7%	Common Sneezeweed	*Helenium autumnale*	

Table 3 lists herbaceous species documented at the 15 study sites that occur in our region ***mostly*** in floodplain forests, but can also occasionally be found in swamp forests, wet meadows, roadside ditches or other wetlands (McVaugh 1958, Weatherbee 1996, Knab-Vispo pers. obs.).

All but three of these species are native to our region and this group of plants also includes a high percentage of NYS-protected and regionally rare plants. The invasive Dame’s Rocket and Japanese Knotweed seem about equally common along riparian corridors and along road corridors. Japanese Stiltgrass is generally considered an aggressive invader of areas with disturbed soil. We have only recently begun to monitor Japanese Stiltgrass in Columbia County and have not noted it often outside of floodplains, but it seems to readily invade disturbed upland areas and seepy places in other places and has to be expected to do the same in our county.

Finally, Table 4 lists those native herbaceous plants documented from the 15 study sites that are generally ***associated with rich mesic forests*** and also frequently occur in rich mesic sites within riparian corridors (McVaugh 1958, Weatherbee 1996, Knab-Vispo pers. obs.).

Table 3: Herbaceous plant species that <u>mostly</u> occur in floodplain forests in our region *(listed in order of their frequency of occurrence in the sample sites) 1) Kiviat and Stevens 2001; 2) Knab-Vispo, pers. obs.*

100%	Dame's Rocket	*Hesperis matronalis*	INVASIVE!
100%	Trout Lilly	*Erythronium americanum*	
93%	Whitegrass	*Leersia virginica*	
88%	Wood-nettle	*Laportea canadensis*	
80%	Japanese Stiltgrass	*Microstegium vimineum*	INVASIVE!
67%	Wild Onion	*Allium canadense*	
53%	Zig-zag Aster	*Aster prenanthoides*	uncommon in Columbia County[2)]
53%	Forest Sunflower	*Helianthus decapetalus*	
47%	Meadow Lily	*Lilium canadense*	scarce in Hudson Valley[1)], NYS exploitably vulnerable
40%	Streambank Wild Rye	*Elymus riparius*	
40%	Japanese Knotweed	*Polygonum cuspidatum*	INVASIVE!
40%	Forest-muhly	*Muhlenbergia sylvatica*	
40%	Narrow-leaved Spring Beauty	*Claytonia virginica*	uncommon in Columbia County[2)], potentially scarce in Hudson Valley[1)]
33%	Wild Rye	*Elymus canadensis*	
33%	Lopseed	*Phryma leptostachya*	rare in Hudson Valley[1)]
27%	Gray's Sedge	*Carex grayi*	potentially scarce in Hudson Valley[1)]
27%	Figwort	*Scrophularia marilandica*	rare in Columbia County[2)]
20%	Hairy-fruited Sedge	*Carex trichocarpa*	occurrence in Hudson Valley uncertain[1)]
13%	Cardinal Flower	*Lobelia cardinalis*	rare in Columbia County[2)], NYS exploitably vulnerable
13%	Green-headed Coneflower	*Rudbeckia laciniata*	scarce in Hudson Valley[1)]
13%	Yellow Water-cress	*Rorippa palustris var. fernaldiana*	
7%	Twisted Sedge	*Carex torta*	
7%	Eastern Bluebell	*Mertensia virginica*	rare in Columbia County[2)], NYS exploitably vulnerable
7%	False Pimpernel	*Lindernia dubia var. dubia*	
7%	Nodding Trillium	*Trillium cernuum*	rare in Columbia County[2)], NYS exploitably vulnerable

Table 4: Herbaceous plant species associated with <u>rich mesic forests</u> in our region *(listed in order of their frequency of occurrence in the floodplain forest sample sites)* [1] *Kiviat and Stevens 2001;* [2] *Knab-Vispo, pers. obs.*

100%	Jack-in-the-pulpit	*Arisaema triphyllum*	
100%	Honewort	*Cryptotaenia canadensis*	
93%	Wild Leek	*Allium tricoccum*	
87%	Bloodroot	*Sanguinaria canadensis*	NYS exploitably vulnerable
80%	Zig-zag Goldenrod	*Solidago flexicaulis*	
73%	Blue Cohosh	*Caulophyllum thalictroides*	scarce in Hudson Valley[1)]
73%	Wild Geranium	*Geranium maculatum*	
67%	Bottlebrush Grass	*Elymus hystix*	
60%	Dutchman's Breeches	*Dicentra cucullaria*	scarce in Hudson Valley[1)]
53%	Cut-leaved Toothwort	*Dentaria laciniata*	
53%	Virginia Waterleaf	*Hydrophyllum virginianum*	
53%	Early Meadow Rue	*Thalictrum dioicum*	
47%	Toothwort	*Dentaria diphylla*	
33%	Wild Ginger	*Asarum canadense*	uncommon in Columbia County[2)]
27%	Pubescent Sedge	*Carex hirtifolia*	
27%	Herb-Robert	*Geranium robertianum*	
27%	Small-flowered Crowfoot	*Ranunculus abortivus*	
20%	Mayapple	*Podophyllum peltatum*	scarce in Hudson Valley[1)]
20%	Sweet Cicely	*Osmorhiza claytonii*	uncommon in Columbia County[2)]
13%	White Baneberry	*Actaea alba*	NYS exploitably vulnerable
13%	Horse-balm	*Collinsonia canadensis*	
7%	Black Cohosh	*Cimifuga racemosa*	rare in Columbia County[2)]
7%	Red Baneberry	*Actaea rubra*	scarce in Hudson Valley[1)], NYS exploitably vulnerable
7%	Maidenhair Fern	*Adiantum pedatum*	uncommon in Columbia County[2)], NYS exploitably vulnerable
7%	Rue Anemone	*Anemonella thalictroides*	
7%	Maple-leaved Waterleaf	*Hydrophyllum canadense*	rare in Columbia County[2)]
7%	Clustered Snakeroot	*Sanicula canadensis*	
7%	Foam Flower	*Tiarella cordifolia*	
7%	Large-flowered Bellwort	*Uvularia grandiflora*	potentially scarce in Hudson Valley[1)]
7%	Barren Strawberry	*Waldsteinia fragarioides*	

For a number of rare plants associated with rich mesic forest, floodplain forests also provide suitable habitat.

A regionally-rare hybrid between White and Blue Vervain (*Verbena* x *engelmannii*) was observed on a gravel bar at a single study site, but we don’t know enough about its distribution to fit it into any of the above categories.

Animals

Butterflies: Butterflies are generally uncommon in the understory of forests, probably because there are so few nectar sources. In floodplain forests, butterflies are most commonly found along the stream edge, and, even then, there is relatively low diversity. We recorded 24 butterfly species along the stream reaches we studied (see Table 5).

Table 5: Occurrence of butterflies at 15 Columbia County stream corridors *(14 of our 15 floodplain forest sites plus an additional Roeliff Jansen Kill site surveyed in 2007). The butterflies whose larvae feed on plants that occur exclusively or mostly in floodplain forests (i.e., 'secondary obligate floodplain forest species') are highlighted.*

Species	Number of Sites Where Found	% occurrence
Eastern Comma	12	80
Cabbage White	7	47
Red Admiral	6	40
Azure	5	33
Pearl Crescent	5	33
Silver-spotted Skipper	3	20
Tiger Swallowtail	3	20
Appalachian Brown	2	13
Great Spangled Fritillary	2	13
Hackberry Emperor	2	13
Least Skipper	2	13
Monarch	2	13
Red-spotted Purple/White Admiral	2	13
Unidentified Skipper	2	13
American Lady	1	7
American Copper	1	7
American Snout	1	7
Common Ringlet	1	7
Little Wood Satyr	1	7
Northern Pearly Eye	1	7
Question Mark	1	7
Spicebush Swallowtail	1	7
Tawny-edged Skipper	1	7
Viceroy	1	7

For the sake of description, the butterflies we observed can be broken up into five categories: common 'secondary floodplain forest obligates' which depend upon floodplain plants (i.e., the Eastern Comma and Red Admiral whose caterpillars feed largely on nettles), regionally rare 'secondary floodplain forest obligates' which depend upon floodplain forest plants (i.e., the American Snout and Hackberry Emperor who depend on Hackberry; the Spicebush Swallowtail which feeds on Spicebush), Wetland Butterflies (i.e., the Appalachian Brown and Least Skipper whose caterpillars feed at least partially on wetland sedges or grasses; i.e., 'waterbody-adapted facultative floodplain species'); Forest or Forest Edge Butterflies (i.e., the Azure, Tiger Swallowtail, Great Spangled Fritillary, Red-spotted Purple, Little Wood Satyr, Viceroy; i.e., ‘forest-dependent facultative floodplain forest species’); and Widespread or Openland Species (i.e., Cabbage White, Pearl Crescent, American Lady, Northern Pearly Eye, Silver Spotted Skipper, Monarch, American Copper, Common Ringlet, Tawny-edged Skipper; i.e., disturbance-adapted facultative floodplain species). It is only the first two categories (highlighted in green in the table below) that really interest us here.

Eastern Comma was nearly ubiquitous at our sites; we would be surprised if repeated surveys did not reveal it to be present at all of our sites. Its caterpillars reportedly feed on Elm and Nettles, two plants found at most sites. The Red Admiral was also common and feeds mainly on nettles. The abundance of this migratory species varies radically from year to year; they were common in 2007, less so in 2008. The Cabbage White, who comes between them in terms of occurrence, is an introduced species which is found widely. Among other plants, its caterpillars feed on the invasive Garlic Mustard, a plant which occurred at all of our sites.

The Appalachian Brown and Least Skipper are butterflies of wet areas. The caterpillars of the former feed on sedges, while those of the latter have more diverse tastes but seem to be most common around grassy, wet areas.

Finally, comes a quartet of butterflies whose young feed upon woody plants: the Hackberry Emperor and American Snout (both of which specialize on Hackberry), the Question Mark (whose caterpillars feed on Elm), and the Spicebush Swallowtail (who is named after its favored food). The first two butterflies are reportedly patchy or even rare in parts of the East Coast where Hackberry is common and here, at the northern end of Hackberry’s range, they are even more unusual. The Hackberry Emperor, while not a New York State listed species, is on the State’s rare animal watch list. Neither the Question Mark nor the Spicebush Swallowtail is as rare, however, in our experience both are only sighted occasionally in the County.

A pair of additional species, not highlighted in the above table, might be described as forest-edge species. The Great Spangled Fritillary is often found coursing along field/forest margins. Its larvae favor violets, most common in or near the forest, but its adults frequently come out into the open to nectar and search for mates. Likewise, the caterpillars of Tiger Swallowtail are tree eaters (Black Cherry), and yet the adults are frequently seen nectaring on field flowers. Prior to the creation of extensive fields and forest openings, stream sides may have been one of the most frequently used edges for these species. They are hardly restricted to such sites now, but our observations may be hints of a former life.

In sum, in the floodplain forests which we studied, butterflies were not especially abundant nor unusually diverse. However, they were a distinct subset of our county’s butterflies, and included two of our rarer species. Given the feeding specificity of most of the woodland species we observed, we doubt they could occur in areas where the forest had been highly altered.

Ground Beetles: Ground beetles are a family of beetles (the Carabidae). They are the medium-sized, often black, beetles that one sees scurrying away upon lifting up a rock. They include the better-known and more conspicuous tiger beetles. There are an estimated 500-550 species of ground beetles in New York State. Because of this diversity and because their life cycles are often tied to soil conditions (soil provides the physical structure that they live within and habitat for their food species), they have been used in Europe and, to a lesser extent, elsewhere as indicator species of soil or habitat health. It is recognized that a set of North American ground beetle species are largely restricted to floodplain forests, and thus we chose to include them in our work as one additional way of describing the biota of our floodplains.

Based on 990 captures or observations, we recorded 62 species of ground beetles from our sites (Table 6). Tiger beetles were noted during visual surveys of beaches, and these data were not extensive enough to permit anything more than a list. The remaining species were captured in pit traps, and so those data allow for more precise description of habitat use. We will describe apparent ground beetle distributions in our detailed section on microhabitats. Here, we summarize our data and consider the set of species captured in a broad sense.

It is important to note the limits of our data: sites were only sampled for 3 days/ 3 nights during one, mid-summer trapping period. As such, our data are lacking in species which are primarily spring-active, and our data were probably highly influenced by chance occurrences that affected beetle activity (e.g., weather, passing predators, and moonlight). Furthermore, the traps of some sites were heavily disturbed by flooding and/or scavengers (primarily skunks?). Thus, the only value of our data is in their positive evidence – i.e., they do document that a species occurred at a given site, but the absence of a species from our samples does not mean it was actually absent from the site.

It is recognized that riparian areas harbor a distinct set of ground beetles. Indeed, ground beetles have been used in Europe as a bio-indicators of riparian habitat quality. Genera such as *Bembidion, Brachinus, Nebria, Elaphrus*, and *Dyschirius* are riparian groups largely confined to water edges (although not necessarily to forested edges; i.e., 'waterbody-adapted, facultative floodplain forest species'). As holds true for butterflies, plants and birds, there are some species which may have originally evolved to live along shorelines frequently disturbed by flooding, but whose evolution has pre-adapted them to take advantage of human-caused disturbance, thus freeing them from a reliance on the flood zone (i.e., disturbance-adapted facultative floodplain species). Certain species of *Amara, Bembidion, Chlaenius*, and *Pterostychus* fall into this group of disturbance-adapted species. Finally, a few of the species which we captured appear to be primarily mesic-forest species and capable of finding suitable conditions both near and far from a floodplain (i.e., 'forest-adapted, facultative floodplain forest species'). Such species include *Amphasia interstitialis, Anisodactylus verticalis, Chlaenius emarginatus, Pterostychus adoxus, Pterostychus coracinus*, and *Sphaeroderus stenosomus*. In the case of *Platynus hypolithos*, the focal habitat is not forest but rocky patches that might or might not be river-associated.

Table 6: The abundance and occurrence of ground beetle species found during this study. *Shading indicates different habitat affinities as noted at the bottom of the table.*

Ground Beetle Species	Total Number of Individuals	Number of Sites Where Found (% of 15)
Agonum melanarium	56	9 (60%)
Nebria pallipes	46	9 (60%)
Pterostychus mutus	76	9 (60%)
Chlaenius impunctifrons	34	8 (53%)
Bembidion quadrimaculatum oppositum	25	8 (53%)
Omophron americanum	28	8 (53%)
Poecilus lucublandus	30	8 (53%)
Bembidion tetracolum	41	7 (47%)
Brachinus janthinipennis	30	7 (47%)
Amphasia interstitialis	23	7 (47%)
Chlaenius sericeus sericeus	21	6 (40%)
Pterostychus melanurius	18	6 (40%)
Agonum palustre	7	6 (40%)
Platynus hypolithos	46	5 (33%)
Patrobus longicornis	13	5 (33%)
Brachinus cyanipennis	44	4 (27%)
Harpalus pensylvanicus	5	4 (27%)
Cicindela sexguttata	x*	4 (27%)
Elaphropus incurvus	6	4 (27%)
Bembidion frontale	12	4 (27%)
Chlaenius brevilabris	29	4 (27%)
Oxypselaphus pusillus	9	4 (27%)
Pterostychus caudicalis	7	4 (27%)
Pterostychus luctuosus	6	4 (27%)
Cicindela repanda	x*	3 (27%)
Bradycellus rupestris	3	3 (20%)
Chlaenius cordicollis	15	3 (20%)
Agonum muelleri	3	3 (20%)
Asaphidion curtum	3	3 (20%)
Pterostychus corvinus	4	3 (20%)
Amara aenea	2	2 (13%)
Apristus subsulcatus	25	2 (13%)
Bembidion nigrum	3	2 (13%)
Brachinus cordicollis	2	2 (13%)
Dyschirius pilosus	9	2 (13%)
Elaphrus californicus	2	2 (13%)
Chlaenius emarginatus	2	2 (13%)
Nebria lacustris lacustris	3	2 (13%)
Pterostychus coracinus	2	2 (13%)
Pterostychus stygicus	118	14 (93%)
Agonum extensicolle	49	11 (73%)
Chlaenius tricolor	31	10 (67%)
Chlaenius aestivus	62	10 (67%)
Amara exarata	2	1 (7%)
Anisodactylus discoideus	1	1 (7%)
Anisodactylus sanctaecrucis	1	1 (7%)
Bembidion castor	3	1 (7%)
Bembidion chalceum	3	1 (7%)
Brachinus fumans	1	1 (7%)
Bradycellus atrimedeus	1	1 (7%)
Dyschirius sphaericollis	1	1 (7%)
Elaphropus tripunctatus	1	1 (7%)
Paratachys scitulus	1	1 (7%)
Schizogenius lineolatus	9	1 (7%)
Chlaenius lithophilus lithophilus	1	1 (7%)
Chlaenius pennsylvanicus pennsylvanicus	1	1 (7%)
Elaphropus anceps	1	1 (7%)
Sphaeroderus stenosomus	1	1 (7%)
Agonum ferreum	2	1 (7%)
Anisodactylus verticalis	4	1 (7%)
Loricera pilicornis	3	1 (7%)
Pterostychus adoxus	1	1 (7%)

* = visual surveys, no talley of individuals

[blue] = favors the borders of waterways/waterbodies
[yellow] = favors disturbed areas, inc. those disturbed by humans and (?) water
[green] = favors forest or other natural habitat, not necessarily associated with waterbodies/waterways

Given our own limited sampling and, in general, the limited regional sampling, it is difficult for us to highlight species which are indicative of well-developed floodplain forests. The most relevant data available to us comes from the work of Adams *et al.* (2001) in the Catskills. Based on the collection of 612 individuals, these workers identified 75 species, and further classified them based upon the magnitude of the creek beside which they were trapped. Three species qualified as widespread, occurring across first through third order streams. However, the remaining species could be associated with a particular creek magnitude. Interestingly, a large majority of our water-associated species fell into their ‘third-order streams’ category. This is not surprising given that it is only the relatively larger streams that have floodplains of any size.

The literature also includes a relatively detailed account of Connecticut ground beetles (Krinsky and Oliver 2001) and several New England states list select ground beetles in their conservation priorities. Several of the species we encountered are described as rare or are even listed in Connecticut (*Bemidion tetracolum*, *Brachinus cyanipennis, B. fumans,* and *Nebria lacustris lacustris* are listed by Connecticut). None of these species are rare in the Northeast (Bob Davidson, pers. communication), however it is likely that these species (except in the case of misidentifications or taxonomic nomenclature confusions) are among the less common species in our area.

For the purposes of this report, our goal is to highlight the floodplain forest-dependent species. Several of the beach or edge species seem relatively confined to such habitats and apparently infrequently show up in other disturbed habitats. However, it remains to be seen whether these species have any particular relationship with the floodplain forest – do they need healthy forests as well as appropriate stream banks, or is the latter the key environmental requirement? Based on our own results and a survey of the literature, eight of the species we captured appear to be largely restricted to floodplain forests *per se* (i.e., ‘primary obligate floodplain forest species’). These are *Agonum ferreum, A. palustre, Chlaenius aestivus, Loricera pilicornis, Oxypselaphus pusillus, Pterostychus caudicalis, P. corvinus* and *P. luctuosus.* These eight species are the key characters of a hypothesis to be tested during our 2009 work, i.e., we would predict that floodplains with brushy, less-developed forests might harbor a similar beach fauna to what we found, but might well lack the forest species we just listed.

We will explore our own evidence with regard to microhabitat selection in ground beetles later in this report.

Birds: There are few if any Northeastern birds which are restricted to floodplain forests (i.e., there are no ‘obligate floodplain forest species’). Of the 46 bird species we found, several are water-favoring birds which occur along wooded streams or small rivers, some are edge-dwellers who find edge along streams, others are forest-dwellers who include floodplain forests in their pervue, and finally, a few are widely distributed. Thus, the question researchers have usually considered is not whether Northeastern riparian forests harbor unique birds (they don’t) but whether or not they provide especially good habitat for certain forest birds.

Our results parallel those reported for the Merimack River in New Hampshire (Hunt *et al.* 2001), with birds such as Eastern Wood Peewee, Red-eyed Vireo, Veery, Song Sparrow, Warbling Vireo, and Downy Woodpecker being relatively common in the floodplain forests. Work from elsewhere in the Northeast, as reported by Staicer (2005), further confirmed these results, adding Least Flycatcher, Great-creasted Flycatcher, Blue-headed Vireo, and Rose-breasted Grosbeak.

Floodplain forests might be especially good habitat for certain bird species because of the increased abundance of food around streams and rivers. The emergence of winged adult insects from aquatic larvae can provide a concentrated food source for forest birds (and other predators). One way to detect birds which are benefitting from this food source is to ask, which of the forest birds found in floodplains tend to occur relatively close to the water?

We looked at this by dividing our sightings into those that occurred within 50' of the stream and those that occurred within the floodplain forest but at a greater distance (Table 7). Our sample size is tiny (miniscule for some species), however in our sample, aside from the aquatic birds and edge species, Pileated Woodpecker, Warbling Vireo, Blue-headed Vireo, and Downy Woodpecker tended to be more common near the streams (with 70% or more of the observations occurring within 50' of the streams), while Red-bellied Woodpecker, Wood Thrush, and Ovenbird seemed to favor areas farther from water (with 30% or less of their sightings occurring within 50 ft of the water).

Inman (2002) did much more extensive and detailed work in Minnesota. He likewise observed Warbling Vireo to be most common nearer to water, Downy Woodpecker was seen more often inside than outside of the floodplain forest, but, within the forest, showed no pattern. He did not observe Pileated Woodpecker nor Blue-headed Vireo at all. Inman reported Ovenbird and Wood Thrush to be more common at a distance from the water. Red-bellied Woodpecker showed no pattern within the floodplain, although it might have been more common inside than outside of the floodplain. In his data, Hairy Woodpecker, Blue-grey Gnatcatcher and American Robin were observed significantly more often near the streams, while Eastern Wood Peewee and Blue Jay were more common at a distance. White-breasted Nuthatch was significantly more common within the floodplain forest than outside of it, but showed no pattern within the floodplain. Aside from noting that the food of some species might be more common near the waters, Inman also suggested that snags for cavity nesting birds were also more common closer to the water.

Our own data suggested that some potential invertebrate prey were more abundant closer to the water while others were more abundant at a distance; gaps, at any distance from the water, might be particularly rich in potential prey (see Figures 5-7 in the section below on "Other Invertebrates"). Our own information on snag distribution showed no evidence that standing dead timber was most common nearer the water (Figure 4).

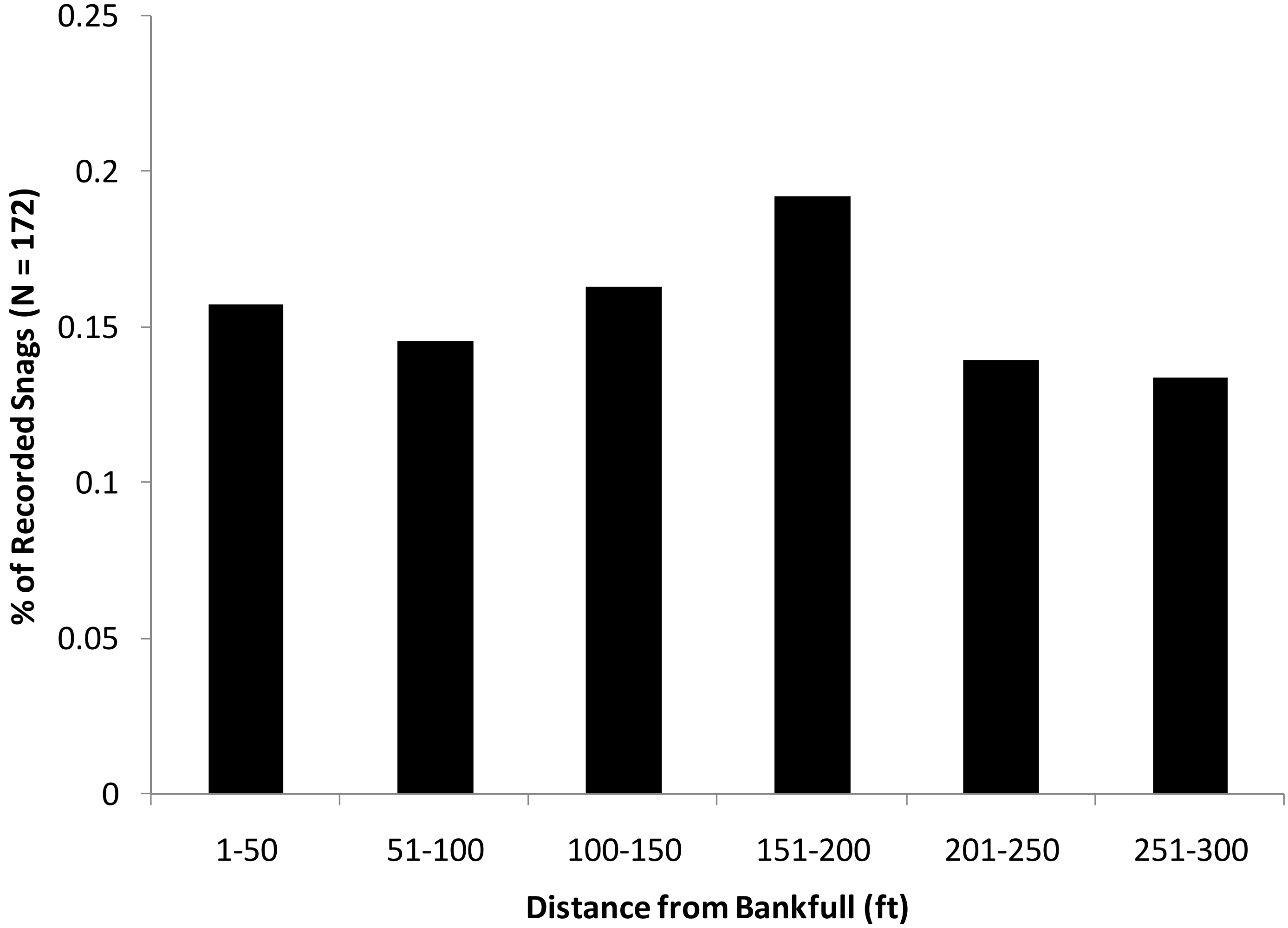


Figure 4: The floodplain distribution of standing dead timber (i.e., snags) with a diameter at base height of 6" or greater. *Snags seemed to be more or less evenly distributed across the floodplain.*

In sum, well-developed floodplain forests in our area, aside from being visited, at least on their peripheries, by edge or aquatic species, harbor a set of forest species. We predict that our up-coming work in less-developed floodplain forests will show an expansion of edge species at the expense of forest dwellers. Floodplain forest may help water-dependent species by providing nesting sites or by improving the quality or abundance of aquatic foods. For example, Common Merganser (observed at three sites if one includes data outside of formal avian surveys), Hooded Merganser (observed at three sites outside of surveys) and Woodduck (observed outside of surveys in one backwater) are all cavity nesters and so might be favored by the presence of large, rotting trees. Such trees are probably absent from unforested or recently-forested floodplains. Understanding the feedback from floodplain forest to creek and hence back to creek-associated wildlife is beyond the scope of this study, but other researchers have documented the two-way interactions between streams and adjacent forest (e.g. Nakano and Murakami 2001).

Table 7: Birds observed during floodplain forest work in Columbia County*. Species highlighted in yellow are edge or openland species, those highlighted in green are forest species, those in blue occur around water, while those without highlighting (i.e., white) are widespread.*

	Total Number of Individuals Noted	**Occurrence Across Sites** Num. of Sites (% of Sites)	**% of Observations within 50' of Water** (Standardized for Num. of Surveys)
Song Sparrow	77	14 (93%)	78
American Crow	35	12 (80%)	55
Grey Catbird	34	11 (73%)	70
Common Yellowthroat	16	11 (73%)	54
Chickadee	21	10 (67%)	32
Wood Pewee	20	10 (67%)	59
White-Breasted Nuthatch	17	10 (67%)	34
Red-Eyed Vireo	23	9 (60%)	43
Northern Flicker	15	9 (60%)	37
Red-Bellied Woodpecker	15	9 (60%)	9
American Robin	14	9 (60%)	34
Northern Cardinal	11	9 (60%)	33
Blue Jay	19	8 (53%)	56
Tufted Titmouse	9	8 (53%)	41
Mourning Dove	14	7 (47%)	65
Wood Thrush	18	5 (33%)	25
Belted Kingfisher	13	5 (33%)	100
American Goldfinch	11	5 (33%)	37
Veery	14	4 (27%)	43
Pileated Woodpecker	4	4 (27%)	70
Mallard	8	3 (20%)	100
Warbling Vireo	7	3 (20%)	70
Red-Winged Blackbird	4	3 (20%)	70
Blue-Headed Vireo	3	3 (20%)	100
Eastern Phoebe	3	3 (20%)	100
Great Blue Heron	3	3 (20%)	70
Ovenbird	4	2 (13%)	0
Common Grackle	3	2 (13%)	100
Downy Woodpecker	3	2 (13%)	100
Yellow Warbler	3	2 (13%)	100
Blue-Gray Gnatcatcher	2	2 (13%)	0
Least Flycatcher	2	2 (13%)	100
Scarlet Tananger	2	2 (13%)	54
Spotted Sandpiper	2	2 (13%)	100
Common Merganser	6	1 (7%)	ND
American Redstart	5	1 (7%)	ND
Cedar Waxwing	4	1 (7%)	100
Baltimore Oriole	2	1 (7%)	100
Brown-Headed Cowbird	1	1 (7%)	0
Field Sparrow	1	1 (7%)	100
Great-Crested Flycatcher	1	1 (7%)	ND
Green Heron	1	1 (7%)	100
Killdeer	1	1 (7%)	100
Louisiana Waterthrush	1	1 (7%)	100
Rose-Breasted Grosbeak	1	1 (7%)	100
Ruby-Throated Hummingbird	1	1 (7%)	0

Dragonflies & Damselflies (i.e., the "odonates"): Odonate ecology intimately mixes aquatic and terrestrial ecology. This is because the larvae are aquatic whereas the adults are airborne, flying, feeding, perching, and breeding in and around the banks of the streams that they emerge from (although potentially far upstream from the sites of their emergence).

We observed 44 species of Odonates during our study of the 15 floodplain forest sites (Table 8). The list below is provisional; it is based in part on the identification of shed skins ('exuvia'), and these identifications will need further confirmation. We divided the species we observed into two, gross ecological groups: stream or river odonates (highlighted in blue below; these are, at the least, riverine-obligate species, although they may not be floodplain forest obligates) and more widespread species which, while they may occur in the backwaters or even along the main branch of streams, are also found around other wetlands (without highlighting in the table below; i.e., 'waterbody-adapted, floodplain forest facultative species'). It is amongst the former species, those of more specialized habitat requirements, that one finds the rarer species. While none of the species which we found are currently state listed, three of them (the Brook Snaketail, the Spine-Crowned Clubtail, and the Arrow Clubtail) are considered species of conservation interest. We cannot say which of these species actually rely on any of the ecological conditions created by floodplain forest. Approximately (some of our IDs may need correction) one quarter of the species we recorded are new county records. This is not a reflection on our particular skills, rather it shows how rarely these floodplain forests are explored in our area.

Odonate conservation is complex because it requires conservation of both their aquatic and terrestrial habitats and recognition of the interactions between the two. For example, the larvae of some species of flowing water dragonflies, such as the Arrow Clubtail, require clear streams with rocky bottoms. Loss of floodplain forests has resulted in extensive in-stream sedimentation with significant negative consequences for species such as this. However, it is likely that, in terms of water quality and larval habitat, the dragonflies encountered along a particular reach reflect upstream conditions as much as or even more than immediate bank conditions. The dragonflies that we have reported from our sites are thus perhaps more indicative of the water quality flowing through the sites than of on-site factors. Nevertheless, in the immediate neighborhood of these reaches, the larvae must find adequate banks for emergence and the adults must encounter prey and the physical structure that they are accustomed to. In some cases, it appears that eggs are laid some miles upstream from the emergence sites, larvae then migrate downstream during the aquatic portion of the organism's life (which may be three years or more long). While the relationship between dragonfly larvae and water quality have been explored in some detail, the importance of emergent and adult habitat seems less widely understood, possibly because it is, in fact, less critical.

Table 8: Odonates (dragonflies and damselflies) found during our floodplain work*. Blue highlighted species are ones who appear, based on the literature, to be tied to riverine or stream environments.*

Species	Occurrence at our 15 Sites (%)	Species	Occurrence at our 15 Sites (%)
Ebony Jewelwing	14 (93%)	Familiar Bluet	2 (13%)
Least Clubtail	9 (60%)	Rusty Snaketail	2 (13%)
Variable Dancer	9 (60%)	Slender Spreadwing	2 (13%)
Fawn Darner	8 (53%)	**Spine-crowned Clubtail	2 (13%)
Stream Bluet	8 (53%)	Spreadwing sp.	2 (13%)
Illinois River Cruiser	7 (47%)	12-spotted Skimmer	1 (7%)
Black-shouldered Spinyleg	5 (33%)	**Arrow Clubtail	1 (7%)
**Brook Snaketail	5 (33%)	Azure Bluet	1 (7%)
Common Whitetail	5 (33%)	Black Saddlebags	1 (7%)
Eastern Forktail	4 (27%)	Common Green Darner	1 (7%)
Fragile Forktail	4 (27%)	Eastern Amberwing	1 (7%)
Powdered Dancer	4 (27%)	Emerald Spreadwing	1 (7%)
"Red" Meadowhawk	3 (20%)	Harpoon Clubtail	1 (7%)
Blue Dasher	3 (20%)	Lance-tipped Darner	1 (7%)
Dragonhunter	3 (20%)	Lilypad Clubtail	1 (7%)
Eastern Pondhawk	3 (20%)	Mustached Clubtail	1 (7%)
Ophiogomph spp.	3 (20%)	Riffle Snaketail	1 (7%)
River Jewelwing	3 (20%)	Shadow Darner	1 (7%)
Zebra Clubtail	3 (20%)	Superb Jewelwing	1 (7%)
Ashy Clubtail	2 (13%)	Twin-spotted Spiketail	1 (7%)
Common Baskettail	2 (13%)	Umber Shadowdragon	1 (7%)
Dusky Clubtail	2 (13%)	Widow Skimmer	1 (7%)

**- A New York State species of "greatest conservation interest"

Amphibians & Reptiles (known together as "herps"): As noted earlier, our surveys for amphibians and reptiles were largely sporadic. Our results are hardly exhaustive but do given an idea of the herps most conspicuous in these habitats. We recorded 13 species (Table 9). Toads were the most common herp we found at our sites. We found adults, juveniles, and tadpoles of this species, and so believe they passed most if not all of their life cycle in this habitat. In most cases, based on calls and morphology, we believe that these were American Toads. However, in at least two cases, at two different sites, these may have been Fowler's Toads. Most of the toads we observed were young, and these two species are especially difficult to distinguish at that age. Toads feed upon a variety of invertebrates including the slugs that were so common in our forests (see "other invertebrates" below)

The Two-lined Salamanders were found during our streamside and in-stream salamander surveys. Most of the specimens observed were larval. We saw no examples of Dusky Salamanders during this study, although we have found these two species together in other, generally smaller, creeks in the County. Red-backed Salamanders are terrestrial, moist forest species which are frequently found under rocks in our region. We occasionally found them during impromptu bouts of rock flipping, and a few were encountered under our cover boards. At one site, we found eggs of a species of Ambystoma salamander (probably a Spotted Salamander). These Salamanders occupy wooded areas with access to the vernal pools which are their typical breeding habitat.

Most of the frogs we observed in the floodplain forests are relatively widespread. Green Frogs are commonly found around a wide variety of water bodies, from ponds to lakes to streams. Unlike toads or Wood Frogs, they rarely stray far from open water. Wood Frogs are often found jumping about in upland and lowland forest. Aside from adequate forest, their main limitation appears to be suitable temporary (or, at least, fish-less) ponds for reproduction. We found no evidence that this species was reproducing on the floodplain, although they may well have utilized some floodplain backwaters. Pickerel Frogs, while not as common as Green Frogs, are regularly found in our area. The rarest frog we encountered was the Northern Leopard Frog. This species was found along the grassy banks of a Claverack Creek site near Hudson. Previously, we had only found Leopard Frog at a wet meadow site a few miles east of Hudson. Young Leopard Frogs were abundant in the grassy areas that fringed this floodplain forest and heralded their uniqueness by hopping ***away from*** the water, rather than ***towards it*** like Green Frogs.

Table 9: A summary of the amphibians and reptiles encountered during our floodplain work.

Species	Number of Sites where Observed (% of 15 sites)
American Toad	10 (67%)
Green Frog	8 (53%)
Two-lined Salamander	7 (47%)
Red-backed Salamander	5 (33%)
Wood Frog	4 (27%)
Pickerel Frog	3 (20%)
Wood Turtle	3 (20%)
Garter Snake	2 (13%)
Northern Leopard Frog	1 (7%)
Peeper	1 (7%)
Ambystoma salamander	1 (7%)
Snapping Turtle	1 (7%)

We found two turtle species at our sites. Snapping Turtles are found in ponds, marshes and streams in our area. Wood Turtles are rarer. Indeed, we never saw one alive, noting their presence only by an old carapace in one case and by tracks in the two other instances. The life cycle of this species is reportedly closely tied to the medium-sized creeks where they typically hibernate. Agriculture and other development on floodplains have apparently impacted their populations substantially.

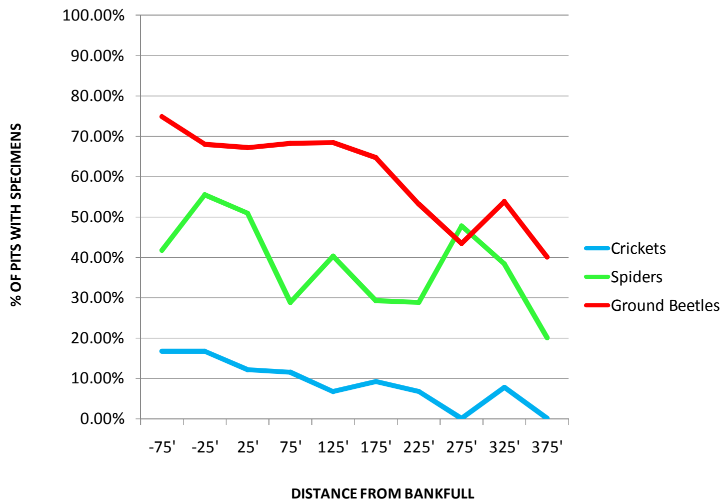
Finally, we happened upon at least two Garter Snakes during our fieldwork. These are common, widespread snakes in our region, and our relatively low encounter rates suggest they were not particularly common in the floodplain forests.

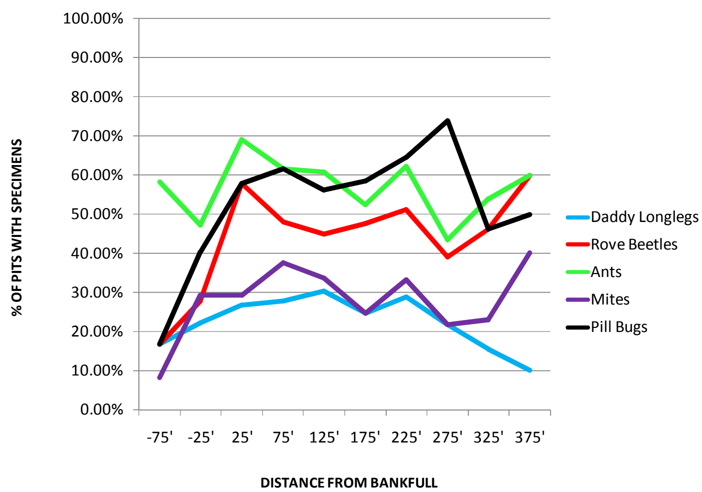
Other Invertebrates: Time and ignorance have so far prevented us from doing extensive taxonomic analyses of the other organisms captured in our beetle traps. We did however tally the occurrence of other invertebrate groups. Among the most common groups are those listed in Table 10. In a few cases, we were uncertain of even which order certain insects belonged to, these were omitted from the table. Obviously, the taxa included here represent varying taxonomic levels from families (e.g., ground beetles) to classes (e.g., worms and snails); they also include widely differing number of species. However, this table gives one a picture of the ground-dwelling and puddle- or rot-attracted (e.g., flies) invertebrates in these forests.

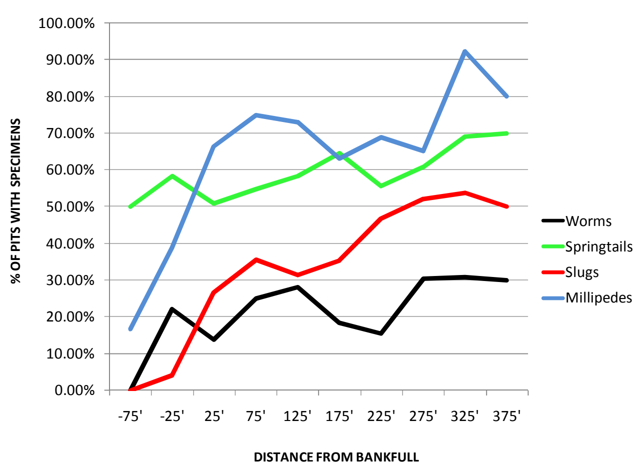
Any patterns in these data are surely blurred by the differing ecologies of the various species involved. We will look in more depth at the patterns in occurrence ground beetle and other invertebrates later in this report. For now, we simply present three graphs (Figs. 5-7) indicating the general distribution of these groups relative to distance from the creek's bankfull. The first two categories of each diagram (i.e., the negative numbers) represent pit traps located on the beach, and

Table 10: A summary of the invertebrates captured in pit traps set for ground beetles in the floodplain forests*. Food habit information is from the literature.*

Taxa	Number of Pits where Found (% of 549 total pits)	General Food Habits
Flies	364 (66%)	various
Millipedes	357 (65%)	primarily feed on plant debris
Ground Beetles	355 (65%)	primarily predators
Ants	324 (59%)	primarily predators
Collembola	322 (59%)	primarily feed on soil microbes
Pill Bugs	307 (56%)	primarily on dead plant matter
Rove Beetles	254 (46%)	primarily feed on ground insects
Spiders	220 (40%)	predators
Mites	168 (31%)	often herbivores
Slugs	167 (30%)	herbivores, scavengers
Beetle Larvae	131 (24%)	predators
Worms	116 (21%)	feed on soil microbes and nutrients
Grasshoppers & Crickets	89 (16%)	herbivores
Wasps	66 (12%)	nectar/pollen eaters
Snails	32 (6%)	herbivores, scavengers







Figures 5-7: The distribution of various invertebrate groups relative to distance from bankfull. *Certain groups seemed to favor waterside, others were distributed across the floodplain, and finally others seemed to prefer lands farther from the creekside. Microhabitat selection is explored in more detail later in this report.*

those further to the right are most apt to be upland sites. Crickets, spiders, and ground beetles tended to be most common on the beach or close to the beach/forest margin. Ants and springtails, while not at their most common on the beaches, were also relatively numerous. It is not uncommon to find these insects as one turns stones on rocky beaches. Towards the edges of the floodplain, where upland begins to appear, slugs and millipedes seemed to increase.

At this point, we can do little more than speculate about the community ecology of the floodplain invertebrates. Other researchers have documented the influx of animal and, to some degree, plant materials that accumulate along or near shorelines. These are important resources not only for the terrestrial invertebrates themselves, but for many of their predators. During some times of year, there are substantial hatchings of insects like dragonflies, damselflies, caddisflies, stoneflies and mayflies, who leave the water for a relatively brief adult life of breeding and, sometimes, feeding. Walking along a shoreline during one such period, we regularly observed spiders poised at the water's edge, a lucky few already had prey, such as damselfly tenerels, in mouth.

Given the concern for the ecological effects of non-native earthworms, it is worth noting their general abundance in our sites. Occasionally, whole patches of ground appeared to have been 'ploughed' by earthworms. At only one of our 15 sites did we find no worms in the floodplain (although they were present in the adjacent uplands). We did incidentally observe the introduced, earth-worm eating flatworm, *Bipalium adventitium*, at two of our earthworm-populated sites.

We have begun looking at a few more groups in greater detail. Our data is sparse and we hope to develop it further. Among the predominant ant genera which we have found so far are *Lasius* and *Myrmica* – two ecologically widespread genera – with lesser numbers of *Ponera, Stenamma, Tapinoma, Campanotus, Prenolepis, Aphaenogaster* and *Amblypone*. Most of these are forest-dwellers. A couple live most of their lives in the soil, where they feed upon soil invertebrates. Most are generalized predators or scavengers. Interestingly, *Aphaenogaster* is reported to be an important seed disperser for some of the flowering spring ephemerals (such as Spring Beauty, Bloodroot, Bellwort, and Violets) which are so common on certain floodplains.

Martin Holdrege sampled for bees at five of our floodplain forest sites. The spring ephemerals of these forests offer an early, but passing, source of nectar and pollen for the bees. Martin also trapped for bees later in the year on area farms, many of which had adjacent floodplain forest. Below is his complete table of results showing not only the bees he captured in the floodplain forests ("ff"), but also the bees he found on area farms.

Out of a total of 114 species, 60 were recorded only on farms, 24 were encountered during both farm and floodplain forest sampling, while 30 were only observed in floodplain forests. This comparison is potentially (our data are still incomplete) interesting because it makes two points: first, many of the species that may later be on-farm pollinators, kick off their year

Table 11: Wild bees captured at five of our floodplain forest sites and at cropland sites during the same year. *Species registered only from floodplains are denoted by "ff", those found only on farms are indicated by a "farm" designation, and finally those found at both sites are described as "farm & ff".*

Species	Habitat	Species	Habitat	Species	Habitat
Agapostemon texanus	farm	*Lasioglossum nymphaearum*	farm	*Lasioglossum planatum*	farm & ff
Andrena alleghaniensis	farm	*Lasioglossum pectorale*	farm	*Lasioglossum quebecense*	farm & ff
Andrena carlini	farm	*Lasioglossum perpunctatum*	farm	*Lasioglossum rohweri*	farm & ff
Andrena cressonii	farm	*Lasioglossum pilosum*	farm	*Lasioglossum tegulare*	farm & ff
Andrena fragilis	farm	*Lasioglossum subviridatum*	farm	*Lasioglossum versans*	farm & ff
Andrena nuda	farm	*Lasioglossum truncatum*	farm	*Lasioglossum zephyrum*	farm & ff
Andrena pruni	farm	*Lasioglossum viridatum group*	farm	*Osmia pumila*	farm & ff
Andrena sp. 11 male	farm	*Lasioglossum zonulum*	farm	*Sphecodes sp. A, female*	farm & ff
Andrena sp. E, female	farm	*Lasioglossum zophops*	farm	*Andrena erigeniae*	ff
Andrena wilkella	farm	*Megachile latimanus*	farm	*Andrena sp.1 ,male*	ff
Anthidium oblongatum	farm	*Megachile mendica*	farm	*Andrena sp.10 ,male*	ff
Apis mellifera	farm	*Megachile montivaga*	farm	*Andrena sp.12 ,male*	ff
Augochlora pura	farm	*Megachile relativa*	farm	*Andrena sp.2 ,male*	ff
Augochloropsis metallica	farm	*Megachile rotundata*	farm	*Andrena sp.3 ,male*	ff
Bombus bimaculatus	farm	*Melissodes bimaculata*	farm	*Andrena sp.4 ,male*	ff
Bombus citrinus	farm	*Osmia lignaria*	farm	*Andrena sp.5 ,male*	ff
Bombus fervidus	farm	*Paranthidium jugatorium*	farm	*Andrena sp.7 ,male*	ff
Bombus impatiens	farm	*Peponapis pruinosa*	farm	*Andrena sp.8 ,male*	ff
Bombus pensylvanicus	farm	*Perdita halictoides*	farm	*Andrena sp.9 ,male*	ff
Bombus vagans	farm	*Sphecodes heraclei*	farm	*Andrena vicina*	ff
Calliopsis andreniformis	farm	*Sphecodes sp. C, female*	farm	*Andrena violae*	ff
Holcopasites calliopsidis	farm	*Xylocopa virginica*	farm	*Bombus perplexus*	ff
Hoplitis producta	farm	*Agapostemon virescens*	farm & ff	*Colletes inaequalis*	ff
Hoplitis spoliata	farm	*Andrena crataegi*	farm & ff	*Lasioglossum atlanticum*	ff
Hylaeus affinis	farm	*Andrena nasonii*	farm & ff	*Lasioglossum carlini*	ff
Hylaeus mesillae	farm	*Augochlorella aurata*	farm & ff	*Lasioglossum laevissimum*	ff
Hylaeus sp. 1	farm	*Bombus ternarius*	farm & ff	*Nomada bidentate sp. A*	ff
Hylaeus sp. 2	farm	*Ceratina calcarata*	farm & ff	*Nomada bidentate sp. B*	ff
Hylaeus sp. 3	farm	*Ceratina dupla*	farm & ff	*Nomada bidentate sp. C*	ff
Lasioglossum admirandum	farm	*Ceratina strenua*	farm & ff	*Nomada depressa*	ff
Lasioglossum anomalum	farm	*Halictus confuses*	farm & ff	*Nomada white spine 1*	ff
Lasioglossum bruneri	farm	*Halictus ligatus*	farm & ff	*Nomada wt sp. 2*	ff
Lasioglossum cinctipes	farm	*Halictus rubicundus*	farm & ff	*Nomada wt sp. 3*	ff
Lasioglossum crossoni	farm	*Lasioglossum cattellae*	farm & ff	*Osmia atriventris*	ff
Lasioglossum foxii	farm	*Lasioglossum coriaceum*	farm & ff	*Osmia bucephela*	ff
Lasioglossum leucozonium	farm	*Lasioglossum cressonii*	farm & ff	*Osmia cornifrons*	ff
Lasioglossum lineatulum	farm	*Lasioglossum imitatum*	farm & ff	*Sphecodes sp. B female*	ff
Lasioglossum macoupinense	farm	*Lasioglossum obscurum*	farm & ff	*Sphecodes sp. D female*	ff

in natural areas like floodplain forests, where early-season pollen and nectar resources are available; second, there are nonetheless some bees which rarely if ever appear in adjacent field habitats later in the year (e.g., many of the *Andrena* species, whose flight season is very short and who may complete their entire life cycle in the floodplain forests).

Mammals: We looked at the mammals of the floodplains for two basic reasons: first, from a conservation perspective, to know which species found these areas to be useful habitat; and, secondly, to begin understanding the role of some of these animals (i.e., deer and beaver) in shaping the vegetation of these forests. The top portion of Table 12 are the results of the formalized track surveys at each site; the bottom portion includes the results of our small mammal trapping, insect pit trapping, and bat recording, and notes from incidental observations.

Table 12: The occurrence of mammals at our floodplain forest study sites

Mammal	Number of Sites Where Observed (% of 15 sites)
Deer	15 (100%)
Racoon	12 (80%)
Squirrel*	11 (73%)
Chipmunk	10 (67%)
Muskrat	9 (60%)
Mink	7 (47%)
Beaver	7 (47%)
Mole (Star-nosed?)	4 (27%)
Opposum	2 (13%)
Fox**	2 (13%)
Skunk	1 (7%)
House Cat	1 (7%)
Otter	winter tracking
Cottontail	winter tracking; at at least three sites
Masked Shrew	caught in insect pits
Water Shrew	tracks seen near one site
Short-tailed Shrew	live-trapped
Deer Mouse	live-trapped
Woodland Jumping Mouse	incidentally observed
Eastern Pipestrelle	Anabat recording; common at one site
Little Brown Bat	Anabat recording; common
Northern Myotis	Anabat recording; common
Probable Big Brown Bat	Anabat recording; common
Eastern Small-footed Bat	Anabat recording; occasional
Eastern Red Bat	Anabat recording; occasional

* - Grey, Red, or Flying
** - Red or Grey

Several of the mammals that we observed concentrate their activity in or around water, although none are restricted to forested floodplains.

Evidence of Beaver was found at about half of our sites. In all cases, this was along streams too large for a Beaver to dam. Presumed lodges were found along stream banks. Beaver do rely upon woody vegetation for much of their diet, but shrubs and bushes can satisfy their diet, and they are able and willing to move into uplands in search of food. Beaver have been returning to the Northeast after near extermination during the heights of colonial fur trapping.

We were surprised by the abundance of muskrat. Based upon fur-bearer returns[11], current populations in many habitats seem to be roughly 1/6th of what they were 20 years ago. Hence, we were surprised to find it as commonly as we did along the medium-sized streams which we studied. The most obvious sign of their presence were the clusters of droppings filled with ground vegetation which we found along logs projecting in or near the water. One of the most common proposed explanations for muskrat decline asserts that invasive phragmites has been replacing their favored cattails. While this could have a large effect on marsh populations, riverine muskrat normally eat a more diverse diet and phragmites rarely accounts for a large portion of it; it may be that riverine populations thus have been somewhat buffered from the declines that have occurred in marshes.

Mink seem to patrol many of the stream banks in our area, although we have also tracked them as they make substantial upland forays. Mole tunnels were observed at three of our sites. Based upon habitat, we supposed them to be those of the Star-nosed Mole. This mole is generally found around low muddy areas, although not solely at forested sites; much of their diet is composed of earthworms and aquatic insects. No definite Otter sign was observed during our summer fieldwork, however, Otter tracks were observed at three of our sites during the winter (not all sites were surveyed for winter tracks); slides and latrines made Otter presence relatively conspicuous at that time of year. Like Beaver, Otter seem to be returning to our waters after their populations were reduced by trapping. As a top predator, Otter populations may also have been especially impacted by aquatic pollutants. The Water Shrew's presence was presumed based on snow tracks found slightly upstream from one of our sites (but adjacent to a separate, small patch of floodplain forest). Little is known about the distribution and ecology of Water Shrews in the Northeast. In general, this species is said to favor relatively small, forested streams, but has also been found around ponds, bogs and marshes.

Many of the mammals recorded from our study sites are common throughout a variety of habitats in the Northeast. White-tailed Deer occurred at all of our sites and probably had an appreciable impact on the vegetation of our sites. We looked at deer browsing in more detail in the section on plants, below. Several wide-ranging general carnivores were also present at our sites, these included Raccoons, Foxes, Opossums, and Skunks. Squirrels, Deer Mice (*Peromyscus maniculatus* or *leucopus*; in our area, these two common species are very difficult to distinguish while alive and no specimens were kept; habitat would suggest Deer Mouse) and Chipmunks are common, forest-dwelling seed eaters in our region. Deer Mice were abundant at the sites which we live trapped, and we suspect they occurred at all of our sites. The Masked Shrew and Short-tailed Shrew are widespread terrestrial insectivores. Woodland Jumping Mouse (presumed species identification, a *Zapus* or *Napeozapus* was briefly observed in closed forest; the habitat makes *Napeozapus* most likely) seems to favor the Jewelweed thickets that dominated some of our sites.

Bat species forage widely for insects, and none is confined to floodplain forests for its foraging or roosting. Night-time Anabat recordings at four of our study sites did produce diverse recordings, with Little Brown Bat, Big Brown Bat, and Long-eared Bat apparently the most common. Eastern Pipestrelle was fairly common at one site, while the Small-footed Bat and Red Bat appeared to occur once or twice at one site. The Little Brown Bat has been our most common species

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[11] e.g., The Journal Pioneer, Prince Edward Island, http://www.journalpioneer.com/index.cfm?sid=96539&sc=120 ; PA Game Commision, http://www.pgc.state.pa.us/pgc/cwp/view.asp?Q=166680&A=11&pp=12&n=1; Connecticut Wildlife, March/April 2008

(although white-nose fungus is reportedly decimating their populations); it is traditionally a widespread forager. Big Brown Bat is also relatively common, and has been found foraging over water and elsewhere. At least one publication listed Eastern Pipstrelle and Northern Myotis as bats which frequent floodplain forests, while others specifically claimed the latter did not frequent such habitat. In truth, little appears to be known about the foraging behavior of either of these species. The Eastern Small-footed Bat and Red Bat were identified based upon one or a few relatively distinct echolocation calls, but neither appeared to be foraging regularly near the floodplains during the time of our recordings.

It is difficult to claim that any mammal is a floodplain forest obligate. However, for several species it is likely that stream corridors are an important component of their overall habitat needs.

Deer Browsing

We found signs of deer browsing at every study site. Based upon a comparison of plant species browsed and plant species occurring at our sites, deer seemed to prefer Jewelweed, Blue Cohosh, Spicebush, Multiflora Rose, Ash, and Choke Cherry. They strongly avoided Ostich Fern, Dame's Rocket, Garlic Mustard, Skunk Cabbage, White Snakeroot, Virginia Creeper, Sycamore, Purple Loosestrife, Norway Maple, and Black Cherry. Elm, Stinging Nettle, Jumpseed and Smooth Goldenrod were also somewhat avoided. Honewort, Zig-zag Goldenrod, Wood Nettle, and White Wood Aster were browsed proportional to their availability. Côté et al. (2004) give an excellent overview of the variety and potential magnitude of ecological impacts of deer browsing. Amongst other effects, it has been well documented that deer browsing can lead to shifts in forest composition, e.g., Sugar Maple replaced Eastern Hemlock, and Black Cherry became dominant in mixed hardwoods in various studies cited in Côté et al. (2004). It also has been demonstrated that the extent to which deer deplete a plant population can depend on the abundance of the plant. Augustine et al. (1998, cited in Côté et al. 2004) showed that deer browsing had only a moderate impact on Woodnettle when this plant was common, but led to extirpation when it was rare. The impact of deer browsing on overall plant diversity seems to depend on the browsing intensity. Moderate browsing can sometimes increase overall plant diversity, while intense browsing seems to always diminish plant diversity (Côté et al. 2004). All we can say at this point about the floodplain forests in Columbia County is that deer are omnipresent and likely impact the ecological community in a variety of ways. Our study was not designed to explore the nature and magnitude of these impacts in any detail, but their potential influence should not be discounted.

Part 4: Variation Within and Between Floodplain forests.

In the preceding section, we have largely treated floodplain forests as if they were a single, monotypic entity which harbored the above-listed plants and animals. They are not, in fact, so uniform. The forests of our sites differed in significant ways amongst locations in the County, while, within each site, differences in microtopography, flood history and canopy cover resulted in an intricate mosaic of herbaceous plants and invertebrates.

It is important to explore these two scales of variation (i.e., among site and within site) in more detail, because they largely reflect processes that can be influenced by human action. For example, differences in forest type might relate not only to intrinsic differences in physical conditions, but also to the differing disturbance histories of the sites. Within sites, localized variation is largely due to flooding regime – its frequency and intensity; flooding regime is both directly and indirectly influenced by humans. Therefore, understanding variation amongst and within floodplain forests can help us begin to understand our own influence on these areas. Our work was not designed to expressly test such relationships, but in the section below we classify the general floodplain forest types that we found, and explore our evidence for physical and biological determinants of herbaceous plant and ground beetle communities.

Distinction of Four Floodplain Forest Types

The variation in tree composition within the floodplain forests was explored through a hierarchical cluster analysis (PC-Ord) that grouped the 45 study transects by similarity in their tree species composition (trees >= 2” dbh). Four floodplain forest types could be described that differed in the relative abundance[12] and relative frequency [13] of certain tree species. The indicator value[14] of each tree species in each of the floodplain forest types was calculated and a Monte Carlo simulation was performed to help select those tree species with indicator values that were significantly higher in one of the forest types than expected at random (PC-Ord, Indicator Species Analysis). Indicator species analyses then also served to identify those herbaceous species and woody seedlings that were significantly associated with certain forest types. Canonical correspondence analysis was used to identify the physical factors influencing tree distributions.

Based on their tree indicator species, the following four forest types were distinguished in Columbia County’s ancient floodplain forests:

- **Sugar Maple-dominated Floodplain Forest**
- **Elm – Sugar Maple Floodplain Forest**
- **Ash - Sycamore – Cottonwood Floodplain Forest**
- **Green Ash – Silver Maple Floodplain Forest**

[12] average abundance of a given species in a given group of transects over the average abundance of that species in all transects, expressed as a percentage value
[13] percentage of transects in a given group where a given species is present
[14] product of relative abundance and relative frequency

Table 13 below shows the tree species that were significantly associated with different floodplain forest types.

Please note that not all of these indicator trees were exclusive to a single floodplain forest type: American Elm, Bitternut, Cottonwood, and Ash[15] trees were found in all of the forest types, but were significantly more common in one of them. Sugar Maple was dominant in the **Sugar Maple-dominated** forests, but also commonly occurred in the **Elm – Sugar Maple** forest.

Other common tree species occurred across all four floodplain forest types without statistically significant differences. Of these, Norway Maple tended to be more common in **Sugar Maple-dominated** forests, while Red Oak, White Ash, Black Cherry, and Basswood tended to be more common in the **Elm – Sugar Maple** forests. Large individuals of Poison Ivy tended to be most common in the **Ash - Sycamore – Cottonwood** forests and large Grapes were characteristic of **Green Ash - Silver Maple** forests. Appendix 3 lists all the tree species documented in the standardized inventories and shows each species' contribution to each forest type.

Table 13: Indicator values of tree species (dbh > 2") associated with the different floodplain forest types identified in 15 ancient floodplain forest sites throughout Columbia County. *(* p<0.1; ** p<0.05). The indicator value is calculated based upon both a species' abundance at any one site and its occurrence across sites, and is reported as "% perfect indication".*

	Floodplain Forest Type			
	Sugar Maple - dominated	Elm - Sugar Maple	Ash - Sycamore - Cottonwood	Green Ash - Silver Maple
Sugar Maple	71**	22	4	0
Ironwood	37**	0	1	1
Slippery Elm	0	49**	14	0
American Elm	9	51**	20	17
Musclewood	21	42**	1	0
Bitternut	21	38*	8	14
Ash	3	11	56**	3
Sycamore	14	11	56**	0
Black Locust	1	0	40**	0
Boxelder	0	0	40**	22
Cottonwood	3	10	32*	1
Green Ash	0	2	14	79**
Silver Maple	0	1	6	71**
Black Ash	0	0	0	29**
Nannyberry	0	1	6	27*

Table 14: Physical Environment and Structural Characteristics of the four floodplain forest types

[15] In the tree inventories, we were not always able to distinguish between Green Ash and White Ash. Whenever possible, we identified the Ashes to species, but if that was not possible, we recorded them as "Ash".

Forest Type	Physical and Structural Characteristics							
	Elevation relative to bankfull (feet)	Soil Texture Rank	Canopy Cover	Herb Cover	Height of Herbs (feet)	Tree Density (number of trees >2" dbh per acre)	Tree Size (dbh in inches)	Largest Tree (dbh in inches)
Sugar Maple - dominated	0.50	3.4	85%	38%	1	275	7.69	30.36
Elm - Sugar Maple	0.00	3.0	81%	61%	2	316	7.03	25.67
Ash - Sycamore - Cottowood	-0.30	3.2	70%	69%	3	225	8.58	32.00
Green Ash - Silver Maple	0.58	2.1	67%	87%	3	178	8.83	30.70

Table 14 compares some variables describing the physical environment and structural characteristics of the four floodplain forest types. The values are averages for transects belonging to each Forest Type.

Sugar Maple – dominated floodplain forests were found along the middle reaches of the Kinderhook and Claverack Creeks and their tributaries at elevations of at least 200 feet and a distance of at least 17 creek-miles from the Hudson (Appendix 1; see also Figure 15a). Secondary channels located in these forests provide for quick drainage of floodwater back into the main channel. Appendix 4 shows the toposequences of the Sugar Maple – dominated transects. Most of the transects had steep banks and the bankfull stage was on a levee between 10 and 35 feet from the water's edge. The average height of all these transects was 0.5 feet above bankfull, but there was substantial variation in toposequences, with some transects located mostly above bankfull, some largely hovering around bankfull with occasional lower areas, and some transects located almost entirely below bankfull. The soil texture was on average comparatively coarse (Table 14) due to the presence of sandy depressions and gravelly secondary channels within the matrix of mostly loamy and sandy-loam soils (Appendix 8). Sugar Maple – dominated floodplain forests had an intermediate tree density and average tree size (Table 14).

The Sugar Maple – dominated forest was composed of up to 70% of Sugar Maple (Appendix 3); this species was well represented in all size classes. More than 60% of the biggest trees in this forest type were Sugar Maple[16] and seedlings of this species were significantly more common here than in any other forest type (Appendix 9). Bitternut, American Elm, Cottonwood, Basswood and Ash co-occured in low densities and all but the last were observed amongst the biggest trees in this forest type. Musclewood and Ironwood were present in small numbers in the understory; Ironwood was almost

[16] For each transect in this forest type, the five biggest trees were identified, and the average was calculated across transects within the forest type.

exclusively found in this floodplain forest type. See Appendix 3 for other woody plants (> 2" dbh) found in this forest type.

The spring flora of the Sugar Maple – dominate forest was dense and diverse (Appendix 10). Broad-leaved Toothwort and White Wood Aster were ranked higher than in any other forest type during our spring inventories. During the summer, the canopy was closed, and herbaceous plant cover was relatively sparse (Table 14). White Wood Aster remained the herb most significantly associated with this forest type, although a variety of rich mesic forest herbs occurred here in small densities. Zig-zag Goldenrod and White Snakeroot were common here and in the Elm – Sugar Maple forest (Appendix 11). Tree seedlings were relatively common, most of them being Sugar Maple, White Ash, Black Cherry, Bitternut, and Elm. The first three were significantly more common here than in any of the other forest type. This forest type was also the only one with any Honeysuckle (Appendix 9).

Elm – Sugar Maple floodplain forests were found along all three tributaries, mostly at similar elevations and distances from the Hudson as the Sugar Maple – dominated forests, sometimes even at the same site (Appendix 1; see also Figure 15b). Appendix 5 shows the toposequences of the Elm - Sugar Maple transects. The average height of all these transects was at bankfull stage, but there was substantial variation along the toposequences, The soil texture was on average somewhat finer than in the Sugar Maple – dominated forests (Table 14). The matrix of mostly loamy soils was punctuated by both, fine-textured and gravelly secondary channels (Appendix 8). These forests had the highest tree density and smallest average tree size of the four floodplain forest types.

The Elm – Sugar Maple floodplain forest was composed of approximately similar proportions of Elms (21% American and 6% Slippery Elm) and Sugar Maple (24%), and had significantly more Bitternut (12%) and Musclewood (7%) than other floodplain forests (Table 13). White and Green Ash, Sycamore, Cottonwood, and Basswood were the most common other trees in this forest type (4-5%, each; Appendix 3). The biggest trees in this forest type were mostly these same species, only 10% of the biggest trees were American Elm and less than 10% were Sugar Maple[16]. Although the largest trees in this forest type did not reach the size of the largest trees in the other types, the Elm trees were of significantly larger diameter here than in the other floodplain forest types. The spring flora was quite similar to that in the Sugar Maple – dominated forests, with a dense and diverse cover of rich mesic forest species, but markedly less White Wood Aster and Broad-leaved Toothwort (Appendix 10). During the summer, the canopy was also quite closed, but the herbaceous plant cover was denser (Table 14). Wild Leek, Blue Cohosh, Blue Violets (*V. sororia* and/or *V. cucullata*), Honewort, Common Enchanter's Nightshade, as well as small individuals of Virginia Creeper were significantly associated with this floodplain forest type. It shared a high density of Zig-zag Goldenrod and White Snakeroot with the Sugar Maple – dominated forest and a high density of Garlic Mustard with the Ash – Sycamore – Cottonwood forest (Appendix 11). Stinging Nettle, Clearweed, Woodnettle, which were all significantly more common in other forest types, were also present. Bitternut and Hickory seedlings, as well as Grey Dogwood, Raspberries and Virginia Creeper, were significantly more common in this forest type. Sugar Maple seedlings were approximately half as common as in the Sugar Maple – dominated floodplain forest. Notable was the low number of Elm seedlings in this forest type with the most and biggest Elm trees (Appendix 9); Elm in general did not appear to be recruiting below Elm.

Ash – Sycamore – Cottonwood forests were documented along all three creeks, between 180 - 380 ft elevation and at distances between 8 – 28 river miles from the Hudson (Appendix 1; see also Figure 15c). At three sites, this forest type occurred with one of each of the other floodplain forest types, at three sites it was the only forest type represented. These forests were found at sites with extensive gravel bars and beaches up to 100 ft wide between the water's edge and the bankfull stage. On average, these transects were located 0.5 feet below bankfull stage, although Appendix 6 illustrates the variation in toposequences. Average soil texture was intermediate between the two already discussed forest types, but the Ash – Sycamore – Cottonwood forest had the most variation in soil texture (Appendix 8). The matrix of mostly loamy soils found near bankfull elevation was punctuated by patches of low-lying sandy soils and by some gravelly and some fine-textured secondary channels. This forest type also tended to have gravelly creek banks and beaches. Tree density was lower than in the above discussed forest types (but not as low as in the Green Ash – Silver Maple forests described below) and the largest individuals tended to be found here (Table 14).

The Ash – Sycamore – Cottonwood forest was composed of 29% Ash (8% Green Ash, < 1% White Ash, 20% not distinguished between White and Green), 12% Sycamore, 11% Cottonwood, 7% Boxelder, and 7% Black Locust, all of which were significantly associated with this forest type. It also had 9% American Elm, 5% Bitternut and Sugar Maple, and 4% Silver Maple (Appendix 3). The biggest trees in this forest type were almost exclusively composed of Ash, Cottonwood, and Sycamore[16]. The diversity and density of spring ephemerals seemed to be somewhat lower than in the other forest types, but Ostrich Fern, Dutchman's Breeches, and Blue Violets (*V. sororia* and *V. cucullata*) were ranked highest in this forest type during our spring surveys (Appendix 10). In summer, the canopy is markedly more open than in the above-discussed forest types, and herb cover was, on average, slightly greater than in the Elm – Sugar Maple forest and the herbs tended to be taller (Table 14). This was the forest type with the largest amounts of Stinging Nettle, Pennsylvania Bittercress, Ditch Stonecrop, Common Water Purslane, Fleabane, Waterpepper, and the invasives Purple Loosestrife and Japanese Stiltgrass. The invasive Garlic Mustard was most common here and in the Elm – Sugar Maple forest, while White Grass, Wood Sorrel and the regionally rare Ostrich Fern, which occurred in all floodplain forest types, were most prominent here and in the Green Ash - Silver Maple floodplain forest described below (Appendix 11). Other common herbs in this forest type were Jumpseed, Clearweed, Hog Peanut, Virginia Creeper and Common Enchanter's Nightshade, all of which where significantly more common in another forest type. Generally, it was characterized by a somewhat "weedy" set of herbaceous wetland or moisture-loving species. It was also the only floodplain forest type were we documented the common introduced agricultural weeds Common Chickweed, Common Horsetail, Burdock, and Cocklebur, as well as the native agricultural weeds Common Ragweed, Fleabane and Dotted Smartweed. Multiflora Rose was significantly more common here than in the preceeding forest types (and equally common in the Green Ash – Silver Maple forest). A set of seedlings, composed of Sycamore, Cottonwood, Hackberry, and Black Locust, was documented exclusively in this forest type, mostly on sand or gravel bars. Elm seedlings grew in the same microhabitats and were significantly more common than in the other forest types (App 9); in general, Ash was not recruiting below Ash.

Green Ash – Silver Maple floodplain forest showed a curious geographic pattern of occurrence. It was the sole or dominant forest type at the study sites closest to the Hudson (8 river miles) both along the Kinderhook and the Claverack Creeks (Appendix 1; see Figure 15d), while along the Roeliff-Jansen Kill it occurred at the two most upriver sites (almost at 500 feet elevation; 28 and 29 river miles from Hudson) (App 1). The average elevation of these transects was slightly higher relative to the bankfull stage than that of the infrequently flooded Sugar Maple – dominated forests (Table 14). The toposequences in Appendix 7 illustrate that this forest type usually occurred in riparian areas with steep banks and a floodplain (located slightly above or slightly below bankfull stage) with little topographic variation. This was the floodplain forest type with the lowest tree density, but the trees were on average bigger than in the other floodplain forests (Table 14).

The trees in the Green Ash – Silver Maple floodplain forest were composed to 39% of Green Ash and 20% Silver Maple, both of which occurred here in significantly higher densities than in the other floodplain forest types[17] (Table 13). Co-occurring with Green Ash and Silver Maple were American Elm and Bitternut (both were much more common in the Elm – Sugar Maple forest), and Boxelder (which was almost as common as in the Ash – Sycamore – Cottonwood forest) (Appendix 3). Notable was the relative abundance of big Grapes. The spring flora was rich and diverse. During spring, Jewelweed seedlings, False Hellebore, Jumpseed, Jack-in-the-Pulpit, Woodnettle and Virginia Waterleaf were ranked densest at these sites (Appendix 10). In the summer, this forest type had the most open canopy and the densest and tallest herb cover (Table 14). Woodnettle, Clearweed, Jumpseed, Common Woodreed and 12 other herbs were significantly more common here than in any other forest type. Ostrich Fern, White Grass, and Wood Sorrel were common both here and in the Ash – Sycamore – Cottonwood forest (Appendix 11). Multiflora Rose was as common here as in the Ash – Sycamore – Cottonwood forest, and Poison Ivy and Spicebush were significantly more common here than in any other forest type. This was also the only floodplain forest type where we found Silver Maple seedlings (Appendix 9).

We can speculate somewhat on the likely flooding regime of the four floodplain forest types although we did not collect direct information on flooding patterns. Based on our anecdotal observations of flood events at some of our study sites during 2008 and considering their average elevation within the floodplain, the predominant soil texture, and the presence/absence of debris piles and scoured/deposited sediments, as well as their plant community. Our best guess is that Sugar Maple – dominated floodplain forests have the least frequent flooding (probably less than once a year on average) of the shortest duration (several hours to a day?). The presence of gravelly secondary channels in most of the Sugar Maple – dominated forests we studied leads us to believe, that they are flooded by relatively fast-flowing waters that come and go quickly.

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[17] Likely, most of the Ash in the Ash – Sycamore – Cottonwood forest, that had not been identified to species, were also Green Ash, which would make the difference in Green Ash densities between the last two forest types less pronounced. However, the almost complete absence of Sycamore and Cottonwood in the Green Ash – Silver Maple forest keeps it well defined and distinguishable from the Ash – Sycamore – Cottonwood forests, even if down the road we have to alter the name of the latter to Green Ash – Sycamore – Cottonwood forest.

The Elm – Sugar Maple floodplain forests are in many respects very similar to the Sugar Maple – dominated type, but their lower average elevation within the floodplain likely corresponds to more frequent (probably on average at least once a year, typically during the "spring flood") and possible somewhat prolonged flooding (a few days?).

The low-lying Ash – Sycamore – Cottonwood floodplain forests likely receive the most frequent floods (on average at least once a year, possibly more) and, judging from the exposed mineral soil, sorted sediments, and woody debris piles, seem to be subject to fast-flowing water and intense scouring and sediment movement.

Finally, the Green Ash – Silver Maple floodplain forests seem to largely occupy the quiet backwater parts of the floodplain. Their fine-textured soils suggest flooding with relatively slow-flowing water. Their moisture-loving plants indicate good moisture-holding capacity of the soil. Their relatively high average elevation within the floodplain seems somewhat of a puzzle, but as Metzler and Damman (1985) pointed out, high-lying parts of the floodplain can be subject to prolonged flooding and water retention in backwater areas, if the water can not freely drain back into the river, but has to percolate or evaporate.

It is also important to note, that within the forest types (represented by transects perpendicular to the creek bed), tree species were not always evenly distributed (see Figures in Appendix 15). For example, several of the Sugar Maple – dominated forests had a small stand of Ash – Sycamore – Cottonwood near the water's edge. In general, Sycamore, Cottonwood, Green Ash, Boxelder and Black Locust tended to be significantly more common near the creek than expected at random (Chi-square test, $p<.05$), while Sugar Maple, Silver Maple, and Slippery Elm were more common in the floodplain away from the creek. American Elm, White Ash, Basswood, and Bitternut showed no pattern in their distribution relative to the creek. Within Elm – Sugar Maple forests, the Elm and the Sugar Maple tended to occur in relatively well-separated stands. The Green Ash – Silver Maple forest on one high-lying floodplain was basically a Green Ash forests with a lining of Silver Maples along the steep creek bank, while in lower-lying examples of this forest type, the two species mixed well along the transect.

Comparing our observations with descriptions of floodplain forests from other regions, we found certain general similarities, but it also became obvious just how much local variation is found in the vegetation growing in seemingly very similar environments. Our four forest types fit well within the broad description of the floodplain forest community presented in Edinger et al. (2002) and summarized by the New York Natural Heritage Program[18]. No state-wide classification of different floodplain forest types in New York has yet been published.

Our Ash – Sycamore – Cottonwood floodplain forest corresponds largely with the "Riverine Island Floodplain" defined by Kearsley (1999) in her classification of Massachussetts floodplain forests and with the "Acer negundo – Matteucia struthiopteris" community described from coarse-textured levees along larger rivers in Vermont (Sorenson et al. 1998, cited in Kearsley 1999). Our Green Ash – Silver Maple floodplain forest corresponds very well to the "Transitional Floodplain Forests" recognized by Kearsley (1999) as transitional between "Major" and "Minor River Floodplain Forests"

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[18] see NYNHP Conservation Guide – Floodplain Forest at www.acris.nynhp.org

in Massachussetts. This type also falls into the broad category of the "A. saccharinum – U. americana – O. sensibilis temporarily flooded forest community" described for the Northeast (Sneddon et al. 1998, cited in Kearsley 1999). None of the other floodplain forests described by Kearsley (1999) from Massachussetts corresponded to our Sugar Maple – dominated or Elm – Sugar Maple type. These latter types seem to fit roughly within the definition of "Hardwood River Terrace Forests" described from Maine[19]. Sycamore seemed to establish best on open banks, and lines of mature trees seemed to outline past creek shores.

Our Sugar Maple – dominated floodplain forest had some similarity with the Sugar Maple/Ironwood/Short Husk floodplain forests described from sites along major rivers in New Hampshire (Bechtel and Sperduto 1998). In New Hampshire, the Sugar Maple types had also the densest canopy cover and sparsest herbaceous vegetation of all floodplain forest types. Ironwood was a good indicator for this forest type in both studies, and Basswood was an associated species both studies found in common, but there were also some differences in the other tree species co-occurring with the Sugar Maple (e.g., in our study, we found very little Red Oak, White Pine, Yellow Birch, and White Ash mixing with the Sugar Maple. Bitternut, one of the more common species co-occurring with Sugar Maple in Columbia County's floodplain forests, barely reaches south-western New Hampshire). The differences in the herbaceous community seemed to be even more pronounced. Our strongest indicator species for this forest type, the White Wood Aster, was not observed in the Sugar Maple/Ironwood/Short Husk forest in New Hampshire, and we never documented Short Husk Grass (one of the indicators in NH) or Wild Sarsaparilla (one of the dominant herbs in NH) in any of our floodplain forests. Interestingly, the New Hampshire study describes another floodplain forest type with co-dominant Sugar Maple and Silver Maple, two tree species that were rarely observed growing together in Columbia County. Our Green Ash – Silver Maple floodplain forest corresponds in many aspects well with the Silver Maple/Ostrich Fern – Wood Nettle floodplain forest described from New Hampshire. Both had fine-textured soils, open canopy, big grapes, dense herbaceous vegetation, and a high density of Woodnettle, Woodreed, Jewelweed, Jack-in-the-Pulpit, and Ostrich Fern. The latter was common in our Green Ash – Silver Maple forest, but by no means exclusively associated with it. Both, in New Hampshire and in Columbia County, this forest type was one of the places where the rare Green Dragon was found. However, in our study, this was also the forest type with significantly more Poison Ivy, a species that was most common in New Hampshire in a Silver Maple-dominated forest without Woodnettle. While Green Ash was the ash species most consistently co-occurring with Silver Maple in Columbia County floodplains, it seemed to be replaced by White Ash in the corresponding forest type in New Hampshire. None of the floodplain forest types described from New Hampshire corresponded well to our Elm – Sugar Maple type. Sycamore barely reaches southern New Hampshire and an example of a Sycamore floodplain forest from one of the minor rivers there resembled our Ash – Sycamore – Cottonwood floodplain forest in its physical characteristics, but differed in the tree canopy and understory associates of Sycamore (Nichols et al. 2000). Aside from that, none of our floodplain forest types had much resemblance with any of the minor river floodplain forest types described from New Hampshire by Nichols et al. (2000).

[19] Natural Community Fact Sheets, Maine Natural Areas Program (www.maine.gov/doc/nrimc/mnap)

Micro-habitat Variation within the Floodplain Forests

The variation of microhabitats within the floodplain forests was explored by using hierarchical clustering to split the 594 sampling points into groups according to the axis values for each point calculated by a Canonical Correspondence Analysis (CCA). CCA identifies those physical parameters that seem to be most closely reflected in biotic variation. By clustering on the matrix of CCA values, we hoped to identify microhabitats groups based on the most biologically-relevant physical variation in the environment. This process resulted in the distinction of seven microhabitats with different physical characteristics and different plant species composition.

Figures 8 illustrates the grouping of the 594 sample plots into similar microhabitats.

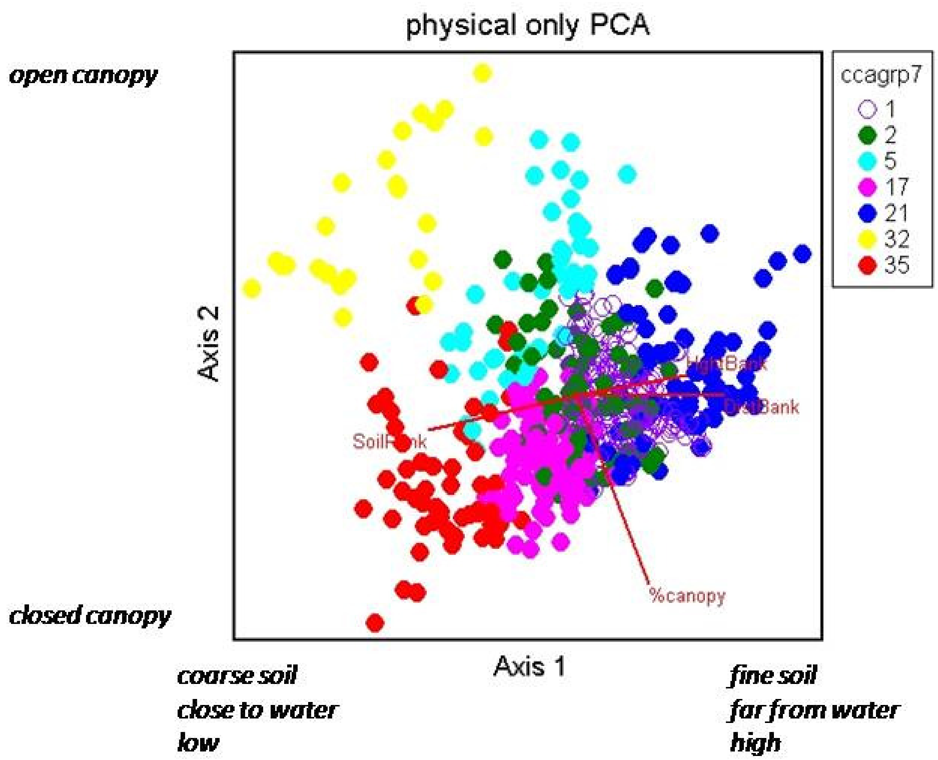


Figure 8: Distribution of the 594 study plots along the first two axes of a principal component analysis. *Each of the microhabitat groups, see Table 15 for number code explanations, occupied a distinct portion of physical space.*

Please consult Table 15 for a description of the microhabitats corresponding to the code numbers used in this plot.

Axis 1 in Figure 8 is negatively correlated with soil texture (coarse soils are on the left, fine-textured soils on the right) and positively correlated with distance from creek and elevation within the floodplain (plots close to the creek are on the left, plots far from the creek and higher in the floodplain are on the right). Axis 2 is negatively correlated with canopy cover (sunny plots are in upper part, shaded plots are towards the bottom).

Table 15 compares and summarizes the key physical characteristics of the seven microhabitats.

Table 15: Physical characteristics of the seven microhabitats distinguished in ancient floodplain forests in Columbia County.

Microhabitat		Physical Characteristics			
Code	Description	elevation above bankfull	distance from creek	soil texture	canopy
21	closed forest on high terrace	highest	farthest	intermediate	closed
1	closed forest on levees and low terrace	above	intermediate	fine	closed
5	rel. open forest on very low terrace	just above	not far	intermediate	rel. open
2	fine-textured 2nd channels	well below	far	fine	fairly closed
17	closed forest on low-lying sandy soils	slightly below	not far	sandy	closed
35	shaded gravelly shores and 2nd channels	below	near	gravel	fairly closed
32	sunny beaches	well below	nearest	pebbles	very sunny

Appendix 12 gives the average values for these and additional characteristics of the microhabitats. Their variation within each microhabitat and the degree of overlap between different microhabitats can be gleaned from Figure 8 above.

Appendix 13 compares the indicator values of herbaceous plant species in the seven microhabitats and shows, which of these values are significantly higher than expected at random. Herbaceous plants without an affinity for one of the microhabitats were not included in this appendix. Some of this information is summarized in the microhabitat descriptions below.

The **closed forest on high terraces** had on average 61% herbaceous cover of an average maximum height around two feet. It was significantly associated with a group of native forest plants, including Mayapple, Blue Cohosh, Wild Leek, Sweet Cicely, Zig-zag Goldenrod, Common Enchanter's Nightshade, Yellow Wood Violet and White Avens. The invasive Garlic Mustard occurred in significantly higher densities in this microhabitat than anywhere else in the riparian corridor, although it was also quite common in the other microhabitats with fine-textured soils.

The understory of the **closed forest on levees and low terraces** was structurally not distinguishable from that of the above microhabitat. However, its species composition was significantly different, and it did not have many strong herbaceous indicator species. Jack-in-the-Pulpit and Nodding Fescue were the species which were significant indicators of this microhabitat.

The **relatively open forest on very low terraces** was characterized by a significantly higher density of Ostrich Fern, Yellow Yewelweed, White Grass, Canada and Late Goldenrod, Hedge Bindweed, Wood-sorrel, False Buckwheat, Money-wort, Coltsfoot, the regionally-rare American Germander, and the common invasive Dame's Rocket.

The **fine-textured secondary channels** had a set of significant native indicator species. Various combinations of Skunk Cabbage, Clearweed, Orange Jewelweed, Wood-nettle, Ditch Stonecrop, and Jumpseed were characteristic of this microhabitat.

The **closed forest on low-lying sandy soils** had only one significantly associated herbaceous indicator: the White Wood Aster. However, Ostrich Fern (which was significantly associated with the relatively open forest on very low terraces) also occurred quite commonly in this microhabitat.

The **shaded gravelly shores and secondary channels** had more than ten significant indicators, including native grasses such as Forest-Muhly, Streambank Wild Rye, Knotroot Foxtail, and herbs such as Dwarf Saint John's-wort, White Vervain, and Three-seeded Mercury. Other indicators of this microhabitat were common agricultural weeds, such as Barnyard Grass, Foxtail (*S. glauca*), Long-bristled Smartweed, Horsetail, and Broad-leaved Plantain.

Finally, the **sunny beaches** had a multitude of herbaceous plants that seemed to thrive best or even exclusively in the exposed soil and intense light of this microhabitat of the riparian corridor. Less than a third of the 36 plants that occurred in significantly higher densities on sunny beaches are native to our area. These include Boneset, White Snakeroot, Hempnettle, and the regionally-rare Giant Ragweed. The other indicators of this microhabitat tend to be common weeds in agricultural fields and along road-sides, including several Smartweed species (both native and introduced) as well as the very invasive Purple Loosestrife and Japanese Knotweed.

The distribution of small woody plants (< 2" dbh) in the seven microhabitats can be gleaned from Appendix 14. Only two of the microhabitats had a distinct set of associated small woody plants. The **relatively open forest on very low terraces** has significantly more Honeysuckle, Multiflora Rose, Poison Ivy, Grape, and Silver Maple seedlings, than the other microhabitats. On the **sunny beaches**, Sycamore, Elm, Cottonwood, Red Maple, Pignut, and Honey Locust seedlings were found significantly more than in other microhabitats.

The distribution of the seven microhabitats in the four floodplain forest types is given in Table 16.

Table 16: Distribution of seven microhabitats in the four floodplain forest types distinguished in the ancient floodplain forests of Columbia County.

Microhabitat		**ForestType**			
Code	Description	Sugar Maple - dominated	Elm - Sugar Maple	Ash - Sycamore - Cottonwood	Green Ash - Silver Maple
21	closed forest on high terrace	**24**	**23**	15	19
1	closed forest on levees and low terrace	40	**48**	**45**	**55**
5	rel. open forest on very low terrace	9	6	11	**21**
2	fine-textured 2nd channels	*6*	16	**37**	21
17	closed forest on low-lying sandy soils	**47**	19	30	*8*
35	shaded gravelly shores and 2nd channels	14	**24**	15	*1*
32	sunny beaches	5	*2*	**17**	*1*

All microhabitats did occur, at least occasionally, in each of the forest types. Closed forest on low-lying fine-textured soils (Code # 1 in above Figure 8) seemed to be the most ubiquitous microhabitat throughout all floodplain forest types. **Sugar Maple – dominated** and **Elm – Sugar Maple** forests both had a good representation of closed forests on high-lying fine-textured soils (Code # 21). The former included many microhabitats on low-lying sandy soils (Code # 17), while the latter had more shaded gravelly shores and secondary channels (Code # 35). Sunny beaches were only common in **Ash - Sycamore – Cottonwood** forests, which also had the highest amount of fine-textured secondary channels, and a good representation of closed forests on low-lying fine-textured soils. The microhabitats with coarse-textured soils (Code #s 17, 35 and 32) occurred rarely in the **Green Ash - Silver Maple** forests.

Patterns of Ground Beetle Occurrence in Relation to Herbaceous Microhabitats

Our sampling for ground beetles was too sparse and spotty to justify attempting a separate classification of small-scale habitats based on beetles alone. Instead, we took the microhabitat classification described above, and asked, 'to what degree do ground beetle communities appear to parallel the herbaceous communities that we identified?'

In order to answer this question, we assigned each pit trap to one of the seven microhabitats based upon how its vegetation had been classified in the above herbaceous analyses. We than ran an indicator species analysis and summary statistics to identify those ground beetle species who served as significant indicators of particular microhabitats and to describe the beetle communities associated in our trapping with each plant community. These plant microhabitat-ground beetle associations should be seen as very tentative. Longer sampling periods (to eliminate the effects of happenstance) and at least two sampling periods during the active season (because there are distinct early-season and later-season beetle communities) would be needed in order to derive more definitive results.

Table 17. The distribution of ground beetles across mircohabitats identified by analysis of the herbaceous vegetation. *Statistically significant indicator species are indicated by yellow (p<.05); potential indicators (p= .05 - .10) are identified in orange.*

	Microhabit (Number of Pits)						
	Closed Forest on Levees & Low Terrace (95)	Fine-textured Secondary Channels (43)	Relatively Open Forest on Very Low Terrace (32)	Closed Forest on Low-lying Sandy Soils (52)	Closed Forest on High Terrace (33)	Open Beaches (15)	Shaded Gravelly Shores & Secondary (31)
Agonum extensicolle	0.02	0.09	0.03	0.35	0.00	0.67	0.45
Agonum ferreum	0.01	0.00	0.00	0.00	0.03	0.00	0.00
Agonum melanarium	0.07	0.51	0.28	0.15	0.03	0.00	0.29
Agonum muelleri	0.01	0.00	0.03	0.00	0.03	0.00	0.00
Agonum palustre	0.00	0.02	0.03	0.04	0.06	0.00	0.03
Amara aenea	0.00	0.02	0.00	0.00	0.03	0.00	0.00
Amara exarata	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Amphasia interstitialis	0.13	0.00	0.03	0.04	0.15	0.00	0.10
Anisodactylus discoideus	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Anisodactylus sanctaecrucis	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Anisodactylus verticalis	0.02	0.00	0.00	0.04	0.00	0.00	0.00
Apristus subsulcatus	0.00	0.00	0.00	0.00	0.00	1.67	0.00
Asaphidion curtum	0.01	0.00	0.00	0.04	0.00	0.00	0.00
Bembidion castor	0.00	0.00	0.03	0.00	0.00	0.13	0.00
Bembidion chalceum	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Bembidion frontale	0.02	0.14	0.00	0.00	0.12	0.00	0.00
Bembidion nigrum	0.00	0.00	0.00	0.00	0.00	0.13	0.00
Bembidion quadrimaculatum opp.	0.14	0.00	0.09	0.15	0.00	0.00	0.03
Bembidion tetracolum	0.21	0.09	0.19	0.17	0.03	0.00	0.03
Brachinus cordicollis	0.00	0.00	0.00	0.00	0.00	0.07	0.03
Brachinus cyanipennis	0.03	0.02	0.03	0.33	0.00	0.80	0.32
Brachinus fumans	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Brachinus janthinipennis	0.00	0.05	0.13	0.12	0.00	1.00	0.10
Bradycellus atrimedeus	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Bradycellus rupestris	0.02	0.00	0.00	0.02	0.00	0.00	0.00
Chlaenius aestivus	0.12	0.14	0.16	0.46	0.12	0.33	0.23
Chlaenius brevilabris	0.00	0.02	0.00	0.00	0.00	0.53	0.65
Chlaenius cordicollis	0.00	0.00	0.00	0.00	0.00	0.40	0.29
Chlaenius emarginatus	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Chlaenius impunctifrons	0.06	0.19	0.22	0.04	0.09	0.20	0.16
Chlaenius lithophilus lithophilus	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Chlaenius pennsylvanicus pen.	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Chlaenius sericeus sericeus	0.00	0.07	0.00	0.08	0.00	0.67	0.13
Chlaenius tricolor	0.10	0.16	0.13	0.10	0.00	0.27	0.03
Dyschirius pilosus	0.06	0.00	0.03	0.04	0.00	0.00	0.00
Dyschirius sphaericollis	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Elaphropus anceps	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Elaphropus incurvus	0.01	0.00	0.00	0.04	0.00	0.20	0.00
Elaphropus tripunctatus	0.00	0.00	0.00	0.00	0.00	0.07	0.00
Elaphrus californicus	0.00	0.05	0.00	0.00	0.00	0.00	0.00
Harpalus pensylvanicus	0.00	0.00	0.00	0.02	0.03	0.20	0.00
Loricera pilicornis	0.01	0.00	0.06	0.00	0.00	0.00	0.00
Nebria lacustris lacustris	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Nebria pallipes	0.07	0.21	0.00	0.14	0.03	0.00	0.65
Omophron americanum	0.00	0.33	0.09	0.06	0.00	0.33	0.10
Oxypselaphus pusillus	0.04	0.02	0.03	0.00	0.09	0.00	0.00
Paratachys scitulus	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Patrobus longicornis	0.02	0.19	0.03	0.02	0.03	0.00	0.00
Platynus hypolithos	0.14	0.07	0.31	0.15	0.33	0.00	0.00
Poecilus lucublandus	0.13	0.02	0.19	0.08	0.18	0.07	0.00
Pterostychus adoxus	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Pterostychus caudicalis	0.04	0.05	0.00	0.02	0.00	0.00	0.00
Pterostychus coracinus	0.01	0.02	0.00	0.00	0.00	0.00	0.00
Pterostychus corvinus	0.00	0.05	0.03	0.02	0.00	0.00	0.00
Pterostychus luctuosus	0.00	0.05	0.06	0.00	0.03	0.00	0.00
Pterostychus melanurius	0.03	0.07	0.06	0.08	0.09	0.07	0.07
Pterostychus mutus	0.48	0.09	0.16	0.27	0.18	0.00	0.03
Pterostychus stygicus	0.44	0.23	0.31	0.39	0.94	0.07	0.13
Schizogenius lineolatus	0.00	0.00	0.00	0.00	0.00	0.60	0.00
Sphaeroderus stenosomus	0.00	0.00	0.00	0.02	0.00	0.00	0.00

The basic division that was evident in our beetle data was the differentiation between forest and beach/edge sites. As shown in the above table, a distinct set of beetles was associated with open beaches. Our results coincide with those of LaRochelle and Lariviere (2003) and of Krinsky and Oliver (2001) who described all of our 'beach beetles' as species of open shores, although some also occurred in other habitats . A pair (our two species in the genus *Nebria*) seemed to be associated with the higher, gravelly shores; aptly enough, LaRochelle and Lariviere (2003) described these as species of shaded shorelines. The two species (*Agonum melanarium* and *Patrobus longicornis*) that may have been associated with the 'fine textured secondary channels' are both species that LaRochelle and Lariviere (2003) described as favoring clay-bearing soils, however they were hardly the only species so described. More specific microhabitat selection may well be occurring with these beetles, but it was not apparent in our data (clustering analyses based on the beetle species distribution, rather than based on the plant-determined microhabitats given above, produced even less definition).

An analysis of our information on other invertebrate taxa in the pit traps highlighted the forest openings as places of particularly high invertebrate activity – snails, wingless wasps, beetle larvae, millipedes, rove beetles, and flies were all significant indicators of this habitat, with the first three groups being more than twice as apt to occur in this microhabitat as in any other. Slugs and collembola favored the higher portions of the floodplain, while spiders and grasshoppers were significant indicators of the beach microhabitat. Forest openings can produce dramatic bursts of vegetation on what is often a somewhat barren forest floor. It is not surprising that forest invertebrates key-in on this localized abundance (see Figure 9).

Figure 9. A sun fleck marks a patch of lush floodplain forest vegetation. Not only plants but also invertebrates key-in on this resource.

Table 18: The distribution of invertebrate groups across the microhabitats identified by herbaceous vegetation analyses. *Those groups which were significant indicators are highlighted in yellow.*

PERCENTAGE OCCURRENCE

	Closed Forest on Levees & Low Terrace (176)	Fine-textured Secondary Channels (78)	Relatively Open Forest on Very Low Terrace (44)	Closed Forest on Low-lying Sandy Soils (102)	Closed Forest on High Terrace (79)	Open Beaches (21)	Partially Shaded Gravelly Shores & Secondary Channels (49)
Snails	5	6	16	2	8	5	4
Slugs	41	24	34	17	51	0	8
Worms	26	18	25	27	15	5	10
Mites	39	15	30	32	39	10	16
Daddy Longlegs	28	22	11	34	28	5	25
Spiders	40	35	61	35	35	71	35
Millipedes	72	60	82	68	72	14	39
Pillbugs	63	47	61	57	63	19	43
Collembola	57	41	66	44	80	76	57
Hemiptera	3	1	9	6	4	14	10
Orthoptera except Crickets	2	6	2	8	5	19	16
Crickets	8	9	11	10	14	5	16
Winged Wasps	11	12	18	12	14	14	6
Wingless Wasps	26	23	57	25	24	43	25
Ants	63	39	66	68	66	29	57
Beetle Larvae	23	19	48	22	22	29	18
Rove Beetles	54	39	66	43	49	14	29
Ground Beetles	65	60	77	60	60	81	69
Flies	67	62	84	61	73	71	55

Part 5: Patterns in Overall Diversity & Preliminary Management Considerations

Our study was designed largely as a descriptive exploration of the floodplain forests. The sections above provide a rough outline of what occurs where. However, in designing this work we were also curious to increase our understanding of the factors influencing the floodplain diversity of native organisms. Because of their diversity and our ability to survey them in a relatively thorough and standardized manner, we have focused our initial exploration on the factors affecting the diversity of herbaceous plants.

Our initial hypothesis was that biological diversity and physical diversity would be correlated, the logic being that more physical diversity would result in more niches and hence more species. We measured physical diversity in various ways: number of microhabitat types, the Shannon-Wiener habitat diversity index (based on microhabitats), the standard deviation of elevation and soil texture, and micro-topographical roughness measured as the number of ups and downs per foot of transect. We compared these values to rarefied measures of species richness ('rarefication' adjusts a site's species count based upon the number of plots sampled, because chance alone would dictate that the more plots one samples at a site, the higher the total number of species one will record).

No significant patterns between these measures of biological and physical diversity were immediately evident in our data. At the same time, the rarefied diversity of native herbaceous species documented in our sample plots varied fairly dramatically between sites, ranging from 32 to 54 species, and this motivated us to look further for potential explanations.

In our data set, the strongest predicator of native herb diversity was the abundance (as measured by average per plot coverage) of non-native plants. Native herb diversity decreased significantly as non-native abundance increased (see Figure 10; linear regression of ln(rarefied native species abundance) on the arcsin transformation of % non-native cover; beta=-.52, R2=.27, p=.046). Native herb diversity did tend to increase as average coverage of *native* species increased, but the relationship was not statistically significant (linear regression on transformed values, beta=.378, R2=.16, p=.16) and so non-native species coverage was deemed the stronger predictor.

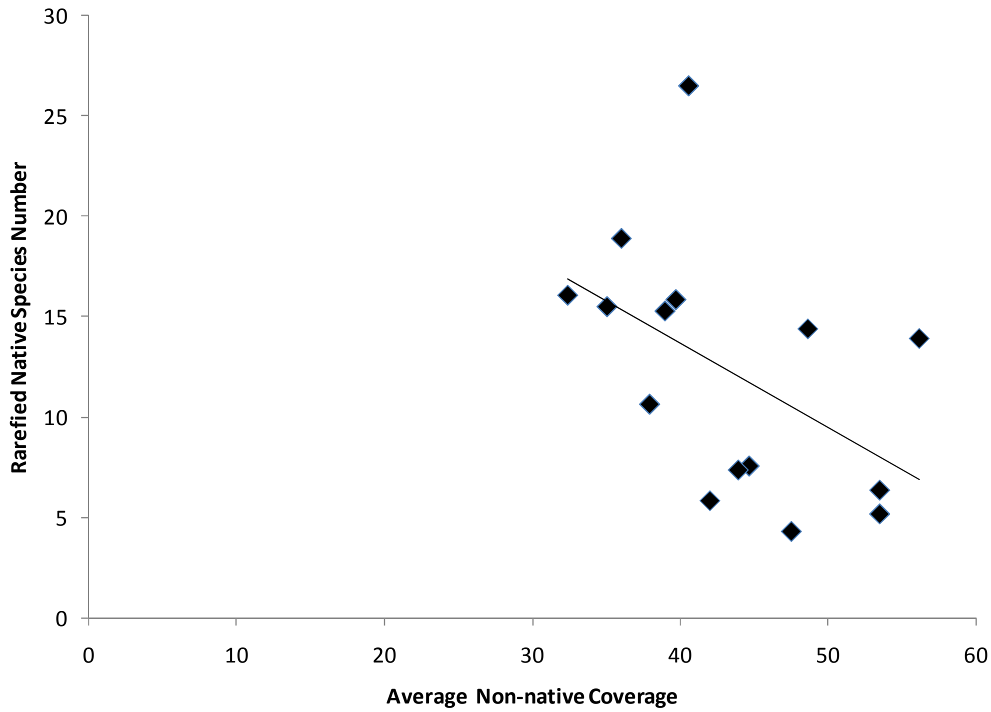


Figure 10: The relationship between rarefied native species diversity and average non-native herbaceous coverage.

This could imply that non-native plants are, as has been widely explored in the literature, reducing the ecological space available for native species. Plants compete for sunlight, water and soil nutrients, and it is thus readily understandable that a high abundance of one group of plants might reduce that of another. The abundance of non-native plants was also negatively correlated with native *abundance* (not just with diversity). However, as noted, native species diversity was not significantly correlated with native species abundance. We cannot claim cause and effect from what is only correlation; it is conceivable, for example, that both native species diversity and non-native abundance are responding in inverse ways to the same, unmeasured ecological factor. For example, disturbance in and of itself might favor non-natives and disfavor natives.

If we assumed that non-native abundance was, in fact, influencing native diversity, then we wanted to better understand the factors influencing non-native plant abundance. At least two factors were related to non-native herbaceous plant occurrence in our data: canopy cover and 'floodedness'.

The strongest predicator of non-native abundance was canopy cover: the more open the canopy, the more abundant the non-native (and the native) herbs (see Figure 11; multiple regression of transformed values, beta=-.64, $R2=.41$, $p=.010$). In floodplain forests, open canopy is indicative of disturbance. That disturbance can be natural (e.g., tree falls, flood scouring) or human-caused (e.g., logging). These results thus suggest that the abundance of non-native plants was encouraged by disturbance. Interestingly, after canopy openness was included in the model, non-native plant abundance did increase significantly (multiple regression, $p<.05$, $N=15$) with measures of site physical variability, perhaps because more variability offered more possible habitats for colonization or because our variability measures also reflected aspects of disturbance.

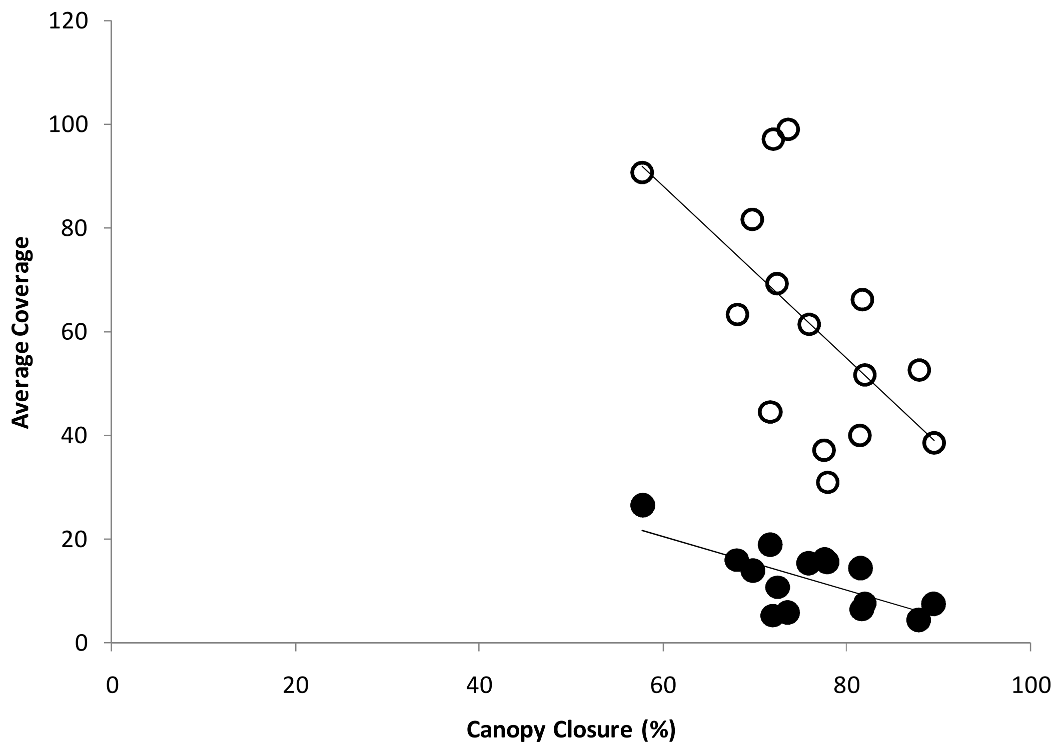


Figure 11: The relationship between canopy closure and the average coverage of native (open circles) and non-native species (closed circles).

We now have two pieces of evidence suggesting that non-native plants benefit from disturbance: the correlation between non-native diversity and canopy opening just mentioned, and the correlation reported near the beginning of this report, between forest age and our crude measure of non-native woody plant diversity. In this section, we have added the implication that this abundance of non-native plants is related to or at least correlated with a reduction in native species diversity.

A caveat and confession – when we measured “non-native abundance” we removed Japanese Stiltgrass from our consideration. This was done based on an inspection of our data and realizing that this one non-native sometimes accounted for huge amounts of non-native abundance and yet was not clearly correlated with native species diversity. It may be that the sites occupied by this species or the nature of its ecological demands reduce its competition with native species; it may be we are simply guilty of "massaging" our data until a pattern was created. In any case, given our relatively small sample size (15 sites), it is important to take the relationships we describe above as hypotheses for further testing, rather than established patterns.

One last nuance in the diversity of herbaceous plants is hinted at by our data. It appears that intermediate 'floodedness' (as estimated by the percent of plots at each site that are below bankfull) may be especially favorable for non-native plants in the floodplain (see Figures 12 and 14). In other words, sites with high or low floodedness may exhibit lower numbers of non-native herbaceous species than those with middle-level floodedness. Similar patterns seem to exist between floodedness and non-native *abundance*. However, ***native*** herbaceous plants do not show such clear patterns – neither native diversity nor abundance showed a clear peak at middle values of apparent floodedness (see Figures 13 and 14). As our earlier considerations suggest, many of the non-native plants are disturbance-loving but not necessarily floodplain-adapted species (i.e., they are 'disturbance-adapted, facultative floodplain forest species'); they may be favored by the disturbance created by occasional floods, but often unable to tolerate intensive flooding. (We are talking about the group as whole here, there are clearly some non-native species which are well able to tolerate flooding.)

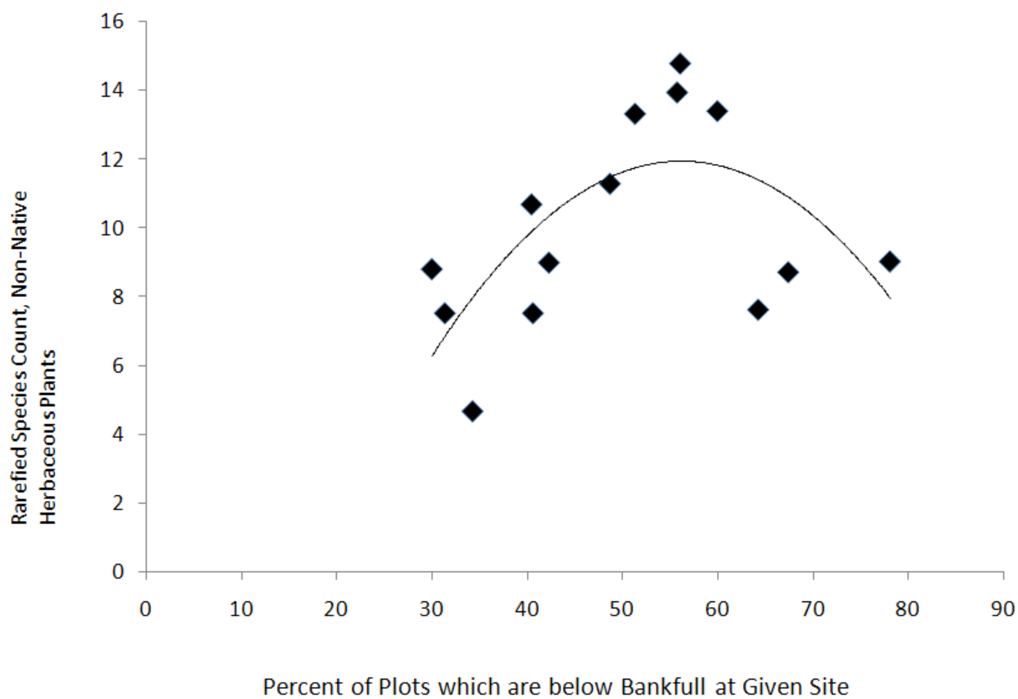


Figure 12. The rarefied, non-native species count for herbaceous plants at each site versus the percent of plots below bankfull at the given site. *Sites with relatively high or low floodedness appeared to have higher non-native diversity.*

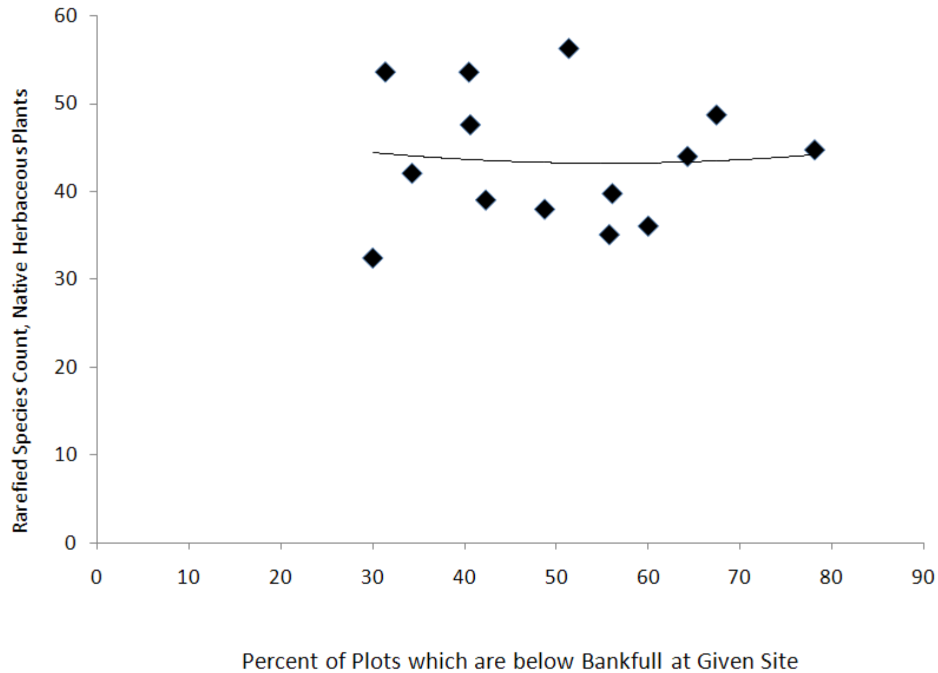


Figure 13. The rarefied, native species count for herbaceous plants at each site versus the percent of plots below bankfull at the given site*. There was little evidence of a mid-floodedness peak in native species diversity.*

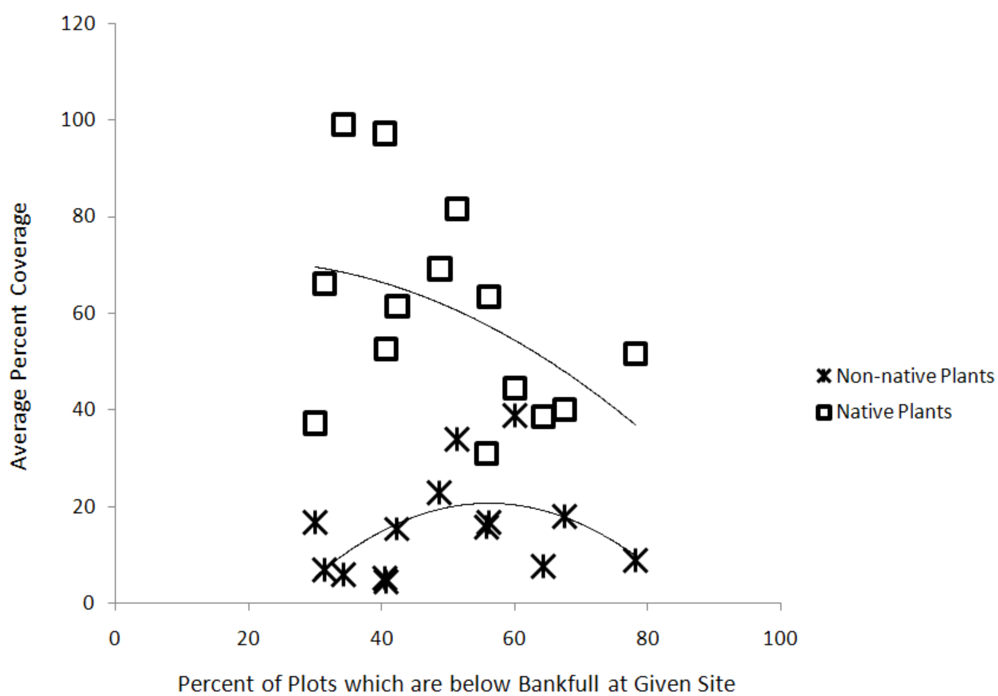


Figure 14. Average percent cover for herbaceous plants versus the percent of plots below bankfull at the given site. *Non-native plant cover seemed to peak at mid-levels of floodedness, native plant cover did not.*

Our data are only partial and only suggestive. For example, our figures showing the patterns exclude one outlier - our highest site which had only 3% of its plots below bankfull and yet was relatively high in non-native species. Perhaps, higher and drier sites are home to a distinct set of dry-land exotic species, or perhaps we are yet again simply guilty of data massage. Furthermore, these are only correlations. It may be, for example, that these patterns in plant occurrence relate directly to soil moisture rather than any specific aspect of the flooding regime. The fifteen additional sites that we hope to include in our upcoming work and the broader range of non-native species densities that these will add to our data set should help us distinguish real patterns from mirages.

Floodplain forests have a relatively unique relationship with non-native species for at least three reasons:

1) They are one of our few native habitats that is so regularly exposed to natural disturbance. Most of the non-native species which have spread across our landscape are disturbance-loving species. They come into ploughed fields, regularly cut lawns and fields, trampled paths, etc. Obviously, they are also capable of taking advantage of some of the natural disturbance that so often occurs in the floodplain. Our data suggest, however, that they may not be adapted to high-levels of floodedness..
2) No floodplain is an 'island'. In terms of the pool of non-native seeds and propagules to which they are exposed, floodplains forest patches are essentially continuous with the upstream watershed. This means that they are not only regularly disturbed but that disturbance comes together with a broadly collected inocculum of non-native plants.
3) Despite the naturalness of floodplain disturbance (presumably seasonal flooding has long been characteristic of floodplains), the characteristics of floodplain disturbance in our area have probably changed dramatically over the past 300 years. The quotes provided in the history section of this report document the increased rates of sedimentation. Likewise, a report on Hudson River sedimentation rates (Pederson *et al.* 2005) estimated that sedimentation rates following European settlement were double to triple those immediately preceding such settlement. This means that the native floodplain forest species, ones presumably adapted to some level disturbance, are facing not only potential competition from non-natives but also levels of floodwater sediment deposition that are relatively novel for them. The conditions on a recently mud-laden floodplain might, in some ways, be more similar to those in recently ploughed fields (where so many of our non-native exotics flourish) than to the thinner, relatively rockier soils that may have been more typical of pre-European settlement floodplain.

The factors influencing floodplain native plant diversity are surely various and operate at different scales of time and space. The potentially large role that we have suggested for non-native species is a hypothesis for further exploration. During the up-coming field season, we plan to explore more floodplain sites, and we will explicitly be including younger forest sites with higher abundances of non-native species. The results of that fieldwork should either strengthen or question the patterns we have proposed above.

Non-native species are probably in our landscape to stay. Many serve valuable ecological roles for native animal species. From the perspective of native organism conservation, management may need to be, as it has already been, largely on a species by species basis. That is, we need to understand which species are having the largest negative ecological effects and focus control efforts on those species – this reasoning is the logic behind the categorization of some non-native species as "invasive". Further exploration of our data, in which we look at the patterns between the abundances of specific exotic species and native diversity, may help us focus within-floodplain efforts. However, broader levels of management might also be relevant. For example, if, as we suggested above, silt-laden flooding is especially conducive to the establishment of non-natives, then another impetus for controlling streambank and floodplain erosion becomes evident. It is our hope that a larger data set from a more diverse collection of sites will help us understand these considerations more fully.

Conclusions

Like many natural communities, floodplain forests are complex and defy simple descriptions and explanations. Even very simplified diagrams of 4 of our 45 transects (see Figures 15 a - d) are difficult to comprehend. And yet, our data do suggest some of the value of these areas in terms of the more or less unique species these communities harbor and of the complexity of the factors influencing that diversity.

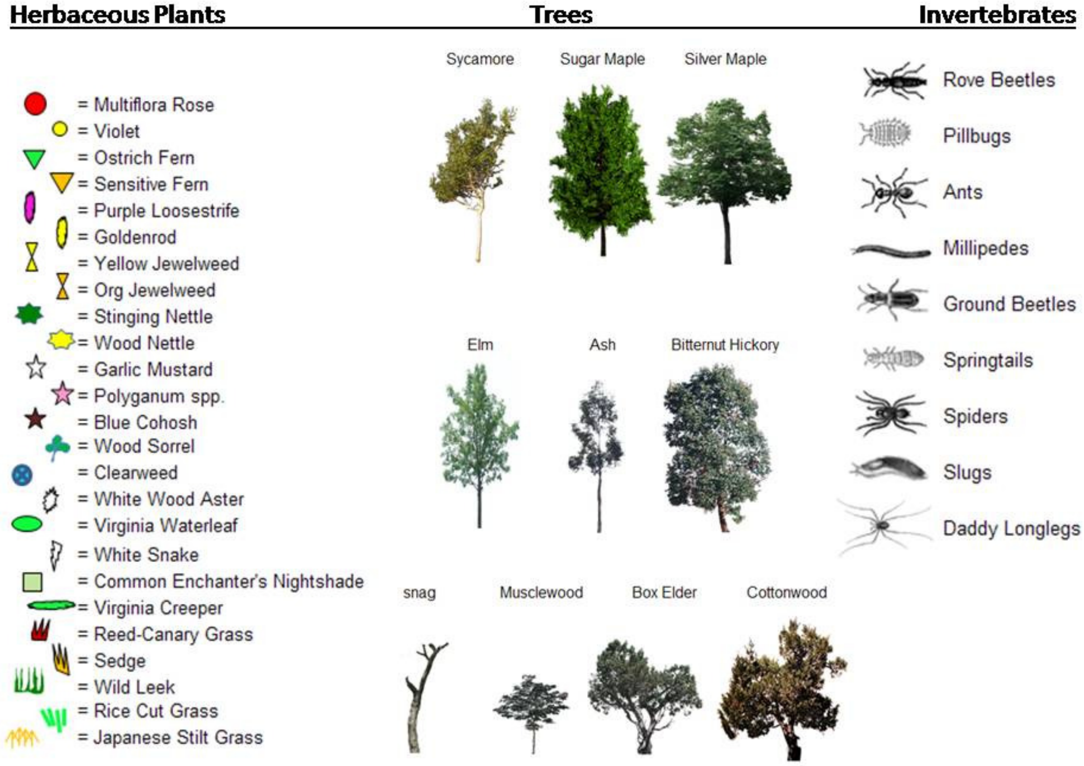
We began this report by describing the value of these forests in terms of their biodiversity. Certain plants and animals reach peaks of local abundance in floodplain forests. The destruction of such forests, while perhaps not immediately spelling the local extinction of such species, would be a severe blow to their demographics. In terms of animals, species such as the hackberry-dependent American Snout and Hackberry Emperor, the Leopard Frog, the Louisiana Waterthrush, and perhaps even the Muskrat (see discussion earlier in this report) may currently find their demographic heartlands in these forests. No doubt there are further species amongst the ground beetles, native bees, and ants which also are largely reliant on these forests, however our current state of knowledge regarding these and other groups of invertebrates is so scanty as to hinder generalization. Amongst the plants, certain herbaceous and woody species (e.g., False Mermaid Weed, Green Dragon, Ostrich Fern, Marsh Pea, Leatherwood, and Silver Maple and others listed in Tables 1 and 2) are likewise largely limited to these communities and would likely largely disappear from the landscape were floodplain forests to disappear.

As our transect figures illustrate and as our vegetation analyses describe, floodplain forests are neither internally homogenous nor identical across sites. Much of our descriptive work focused on highlighting the small-scale physical variation within these forests. Flooding dramatically re-works the surface of these sites, forming the side channels and backwaters that are evident in our diagrams and that often result in a patchwork of soil textures. At the same time, as largely closed-canopy forests, much of the patterning of ground level life is a reflection of sunlight's access to the forest floor. Herbaceous cover and invertebrate abundances increased where canopy openings provided access to the sun's energy. Overlain on these patterns are probable moisture gradients (we did not study soil moisture directly) and gradients of access to stream-originating nutrients. An example of these distributions is evident in our illustration of the “Alt C” transect, where Blue Cohosh occurs on the higher portions while smartweeds (*Polyganum* spp.) are found on the lower portions. Likewise, Elm gives way to Sugar Maple over the same higher land to lower land transition. Amongst the invertebrates, the abundance of ground beetles along the beaches and the tendency for organisms such as pillbugs to be away from the creek edge is also apparent. Some of these animals’ distributions may be due to moisture gradients, but personal observation and the work of others (Sabo and Powers 2002; Marczak and Richardson 2007) has documented the importance of emerging stream insects as prey for spiders.

As the variation of herbaceous plant and tree symbols in our pictures illustrate, the overall diversity of species varies among sites. We have tried to make sense of those variations in diversity by classifying our forest types and identifying those microhabitats which influence herbaceous diversity. To a certain degree, these artificial classifications let us predict, or at least begin to comprehend, plant diversity. It is hardly surprising that a transect such as Sam E (Figure 15d), which essentially goes downhill from bankfull (implying that it has extensive backwaters), should differ from one such as Alt C (Figure 15b) which gradually climbs from bankfull. The first typifies a Green Ash-Silver Maple forest, while the latter is an Elm –Sugar Maple forest. More dynamic transects such as Onl C (Figure 15c), which is almost an island in cross-section, is home to an Ash-Sycamore-Cottonwood Forest while Mlt C (Figure 15a), without the higher lands evident on Alt C but also without distinct lower lands, is an example of a Sugar Maple-dominated forest. As is amply evident from our diagrams, these are probably not biogeographic forest types, but rather convenient partitions used to categorize forests that result from the intergrading of individual tree species in a shared species pool. Similarly, herbaceous plants are responding to microtopography, soil texture and canopy opening in classifiable ways – note how Clearweed is found on relatively open but low sites, and how Jewelweeds may shun the higher hillocks while Enchanter’s Nightshade may favor them. As we expand our data set and refine our analyses, such apparent patterns may disappear or may strengthen our abilities to predict the consequences of different physical structures and hence, by extrapolation, of certain management regimes.

Additionally, although not readily evident in our transect diagrams, inter-site comparisons indicate that non-native species may be influencing the distributions of native species in these communities. It is not a far cry from a fine-soiled, semi-forested floodplain that is frequently ‘fertilized and turned’ by flooding to the ploughed and synthetically fertilized cornfields that sometimes replace those forests. Certain weeds, some of which may have initially found home in those croplands, find floodplains an ecologically analogous habitat and are regularly planted there by the floodwaters. These species may, in turn, be influencing the distribution and abundance of native species. The factors affecting non-native plant distribution and the interactions between non-native and native species are complex and not always clearcut, yet their role in shaping the native diversity of floodplains is worthy of further investigation, especially as attempts at floodplain forest restoration occur.

Key to Symbols



Sugar Maple – Dominated Forest (Mlt C transect)

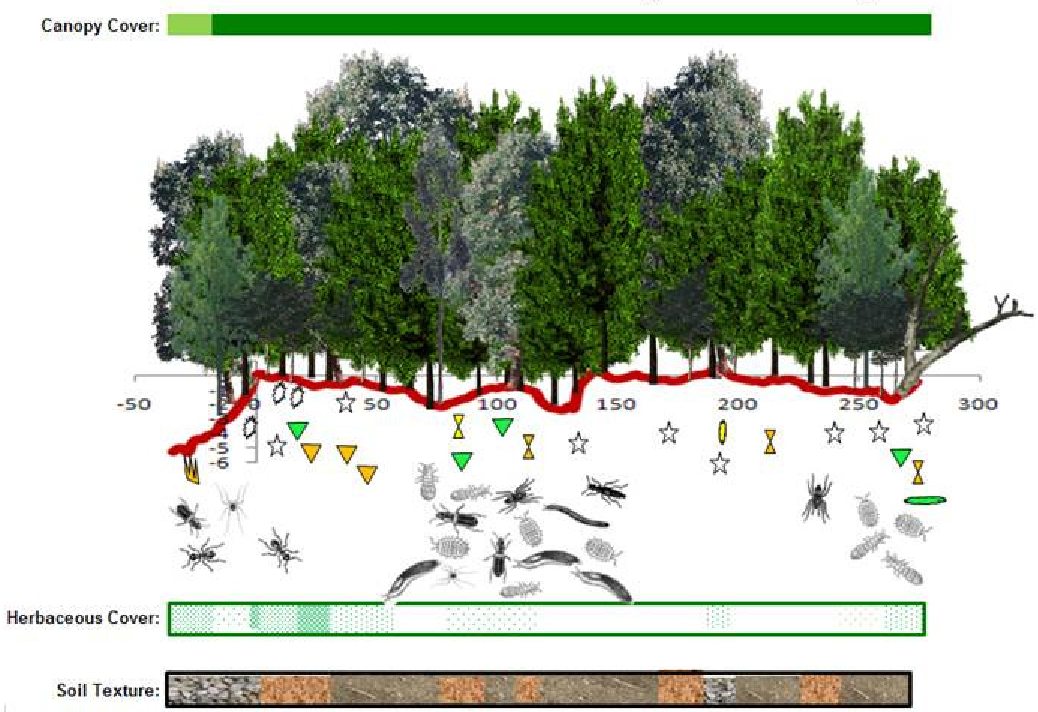


Fig. 15a

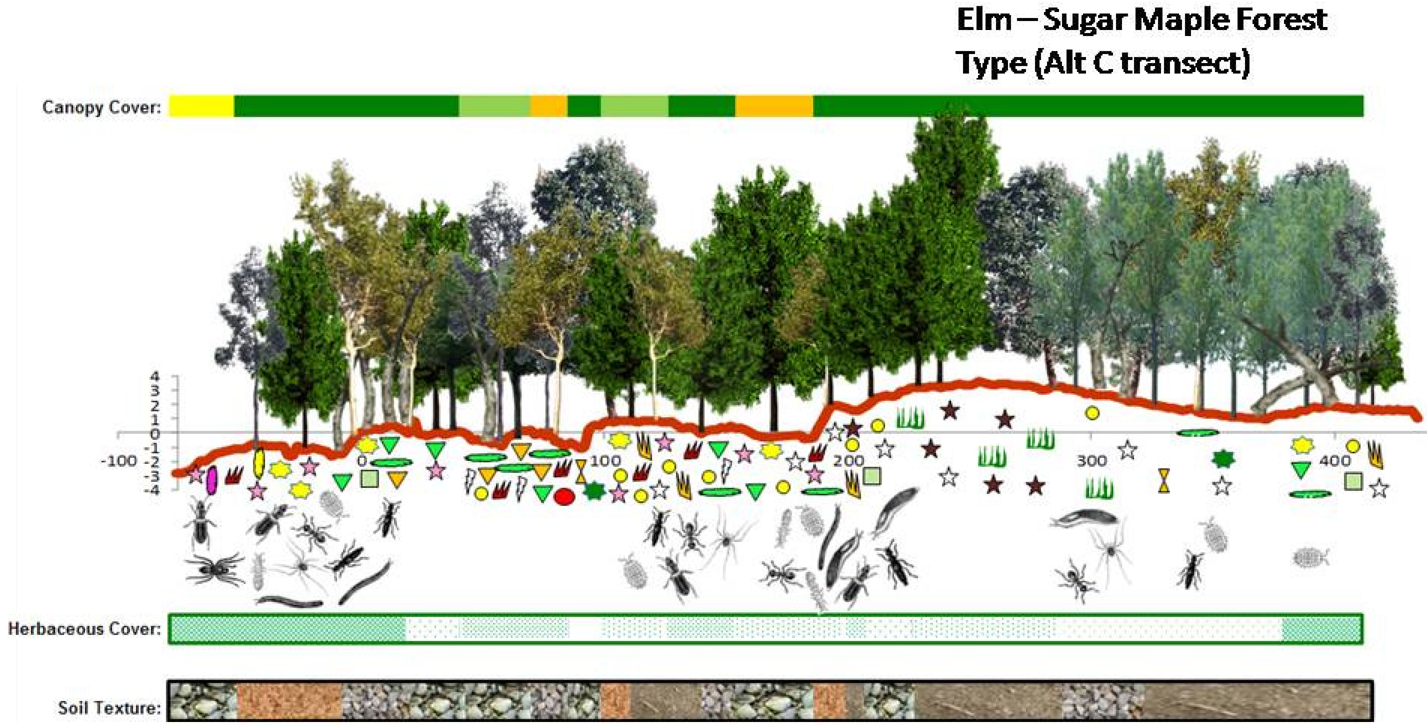


Fig. 15b

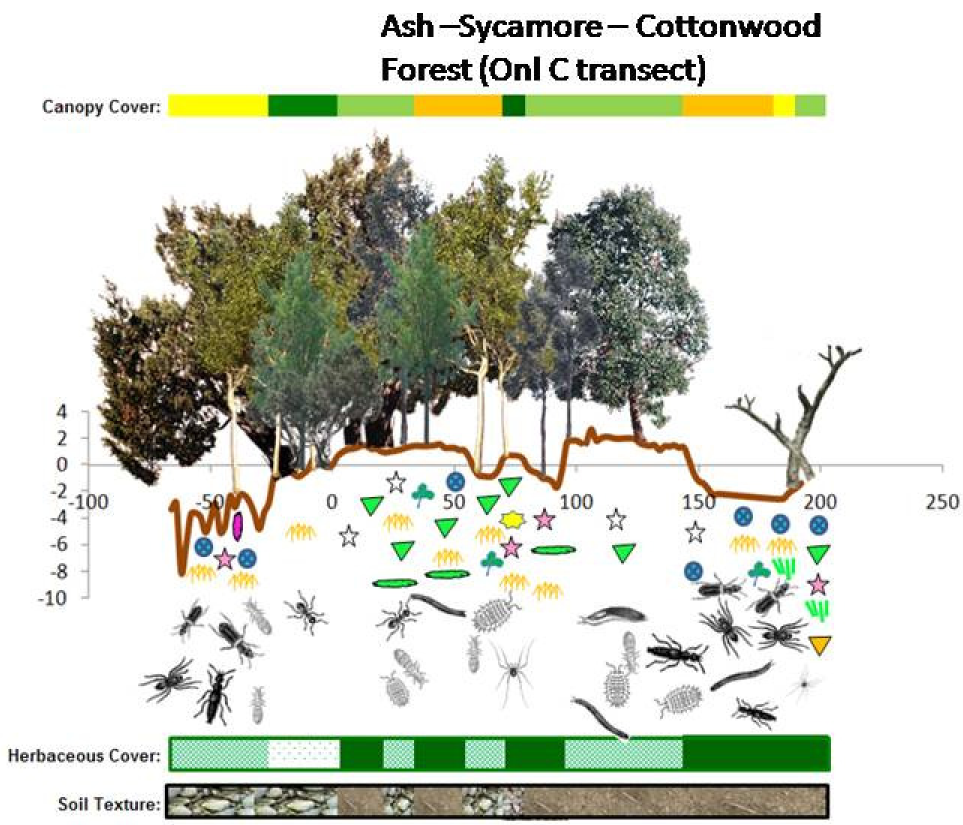


Fig. 15c

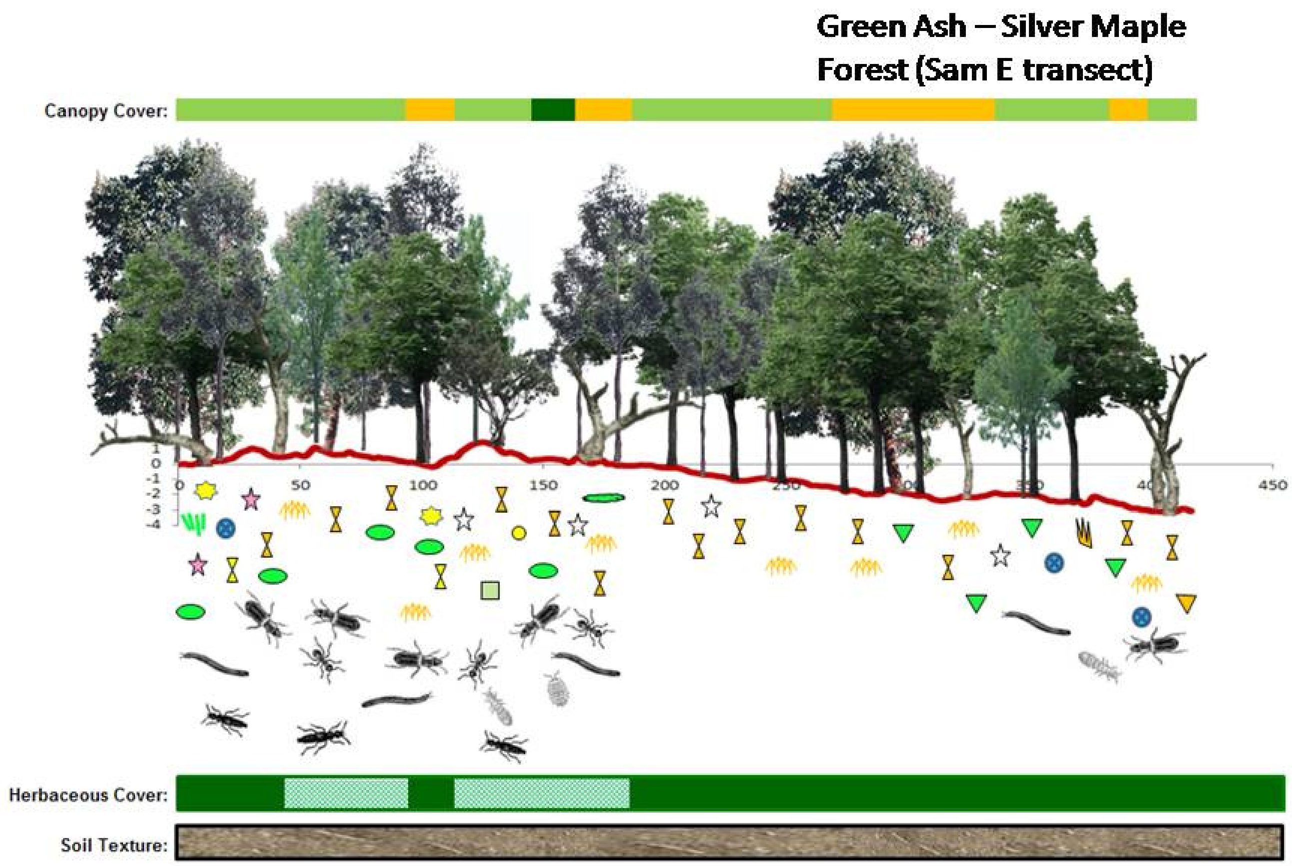


Fig. 15d

Figures 15 a – d. Diagrammatic representations of four of our 45 transects illustrating the actual distributions of canopy cover (darkest green = most closed canopy, yellow = most open), herbaceous ground cover (the denser the green shading, the denser the herbaceous cover), soil texture (four textures from fine/silty, sandy, small stones, and small cobbles are indicated by the corresponding images along the bar), trees, herbaceous plants and invertebrates. *The distributions of the organisms has been somewhat simplified; a key to the organisms depicted is presented in the initial pane of the figure.*

Finally, there are biogeographical considerations. The rich soils and possibly somewhat tempered climates make river corridors the last refuges of certain southerly species reaching the local northern limits of their distributions. Hackberry, for example, extends up our stream sides and, as a consequence, so too do the Hackberry-dependent butterflies. *Asaphidon curtum*, an exotic ground beetle first reported from a Long Island garden, has apparently pushed inland along such corridors. Furthermore, as illustrated by our bird work, floodplain forests are also rich forest relicts. We do not yet have county-wide estimates of the extent of ‘ancient’ and rich forests (as opposed to dry upland forests) in the County, but floodplain forests, protected and battered by flooding, may also be landscape refuges for mesic forest plants, such as Mayapple, Wild Leek, Bloodroot and many others listed in Table 4, which may not be confined to floodplains, but which thrive therein when complete clearing has not occurred.

The way forward in researching the conservation value of floodplain forests is inwards and outwards. 'Inwards' in so far as we need a better understanding of the factors affecting within-floodplain diversity – our upcoming work should give us a better understanding of the influence of past human disturbances and of non-native species; 'outwards' in so far as understanding the conservation value of floodplain forests in the landscape requires understanding that landscape context more completely - for which species are the floodplains true demographic refuges?

One key applied conservation recommendation that does emerge from our work and that echoes the work of ecologists in other habitats is the importance of conserving ancient floodplain forests. Historical ecologists have long realized that disturbance history can be a huge determinant of a site's flora and perhaps fauna; several botanists have done detailed work on this theme in the Northeast (e.g., the works of Gordon Whitney, David Foster, Peter Marks and their colleagues). Based on their work, and our on-going work, we would recommend that historical land use studies be incorporated into any conservation prioritization of floodplain forest sites. "Ancientness" should not be the only criterion (we have found rich, apparently young floodplain forest as well), and we need to realize that, more than most other forested habitats in our area, floodplains continue to be exposed to substantial *natural* disturbance, however given their potential ecological value and their shrinking extent, ancient floodplain forests deserve recognition and conservation. We also believe that such sites are, socially, a good starting point for conservation. These are not sites that are currently in use by agriculture or other activities, hence, more than anything, this approach involves attaching value to something that has largely been ignored (but might not continue to be ignored in the future). Restoration and more active forms of conservation may become appropriate in the future, but ***our primary recommendation is to seek out and facilitate the conservation of these forgotten backwaters***.

Ultimately, public appreciation will be a key component of any conservation efforts. As we stated at the beginning, these can be messy places, but they can also be deeply beautiful places with their flush of spring ephemerals and the cathedral-like structure of mid-summer forests with closed canopies. Floodplains lurk, but we hope that studies such as these, when coupled with readily-accessible outreach materials, can help make these communities a bit more prominent in the minds of the public.

Acknowledgements

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Literature Cited

Adams, M.S., R.E. Acciavatti, and R.L. Davidson. 2001. Ground-beetles (Coleoptera: Carabidae) in riparian habitats of the Catskill Region. Pp. 133-137 in Catksill Ecosystem Health. M.S. Adams, ed., Purple Mountain Press, Fleischmanns, NY.

Augustine, D.J., Frelich, L.E., and P.A. Jordan. 1998. Evidence for two alternate stable states in an ungulate grazing system. Ecol.Appl. 8: 1260-69.

Bartram, John (personal letter) in Jared Eliot, 1748, *Essays on Field Husbandry in New England*, as quoted by Angus McDonald in Early American Soil Conservationists. 1941. USDA Misc. Publication No. 449.

Bechtel, D.A. and D.D. Sperduto. 1998. *Floodplain forest natural communities along major rivers in New Hampshire*. Submitted to the Environmental Protection Agency by The New Hampshire Natural Heritage Inventory Program, Concord, NH. 54 p.

Côté, Steeve D., T.P. Rooney, J.-P. Tremblay, C. Dussault, and D.M. Waller. 2004. Ecological impacts of deer overabundance. Annu. Rev. Ecol. Evol. Syst. 35: 113-47.

Crassus, L. 1802. *Notes on the Natural History of Kinderhook***.** Balance and Columbian Repository Jan 19, 1802.

Donahue, B., 2004. *The Great Meadow: Farmers and the Land in Colonial Concord.* Yale University Press, New Haven, CT.

Edinger, G.J., D.J. Evans, S. Gebauer, T.G. Howard, D.M. Hunt, and A.M. Olivero (editors). 2002. *Ecological* *communities of New York State.* Second edition. A revised and expanded edition of Carol Reschke's Ecological Communities of New York State. (Draft for review). New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY

Gleason, H.A. and A. Cronquist. 1991. *Manual of vascular plants of Northeastern United States and adjacent Canada*. 2nd. ed. The New York Botanical Garden, Bronx, NY.

Hammer, O., Harper, D.A.T., and P.D. Ryan. 2001. PAST: Palaeontological Statistics software package for education and data analysis. *Palaeontologia Electronica* 4(1): 9pp.

Harrelson, C.C., Rawlins C.L., and J.P. Potyondy. 1994. *Stream channel reference sites: an illustrated guide to field technique*. Gen. Tech. Rep. RM -245. U.S. Dept. of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Hunt, P., C. Foss, and D. Wells. 2001. Use of floodplain forest habitats by breeding and migrating birds. Report to the Audubon Society of New Hampshire.

Inman, R.L., H.H. Prince, and D.B. Hayes. 2002. Avian communities in forested riparian wetlands of southern Michigan, USA. Wetlands 22: 647-660.

Kearsley, J.B. 1999. Inventory and vegetation classification of floodplain forest communities in Massachussetts. Rhodora (101): 105-135.

Kiviat, E. and G. Stevens. 2001. *Biodiversity assessment manual for the Hudson River Estuary Corridor*. Hudsonia Ltd. Annandale, NY. 507p.

Krinsky, W.L., and M.K. Oliver. 2001. *Ground Beetles of Connecticut (Coleoptera: Carabidae, excluding Cicindelini): An Annotated Checklist.* Bulletin State Geological and Natural History Survey of Connecticut, No. 117.

LaRochelle, A. and M.-C. Lariviere. 2003. *A Natural History of the Ground Beetles (Coleoptera: Carabidae) of America North of Mexico.* Pensoft. Sofia.

Marczak, L.B., and J.S. Richardson. 2007. Spiders and subsidies: results from the riparian zone of a coastal temperate rainforest. Journal of Animal Ecology 76:687-694.

McCune, B. and M. J. Mefford. 2006. *PC-ORD.Multivariate Analysis of Ecological Data.* Version 5.10 MjM Software, Gleneden Beach, Oregon, U.S.A

McVaugh, R. 1958. *Flora of the Columbia County Area, New York*. New York State Museum and Science Service, Albany, NY.

Metzler, K. J. and A. W. H. Damman. 1985. Vegetation patterns in the Connecticut River flood plain in relation to frequency and duration of flooding. Naturaliste can. (Rev. Ecol. Syst.) 112: 535-547.

Mortimer, J. 1721. *The Whole Art of Husbandry*. George Gierson. Dublin.

Nakano, S.H. and M. Murakami. 2001. Reciprocal subsidies: Dyanamic interdependence between terrestrial and aquatic food webs. Proceedings of the National Academy of Sciences 98:166-170.

Naimen, R.J., H. Decamps, M.E. McClain, and G.E. Likens. 2005. *Riparia*. Academic Press. Amsterdam.

Nichols, W.F., C.C. Sperduto, D.A. Bechtel, and K.F. Crowley. 2000. *Floodplain forest natural communities along minor rivers and large streams in New Hampshire*. A report submitted to the U.S. Environmental Protection Agency by the New

Hampshire Natural Heritage Inventory – DRED Division of Forests & Lands (Concord, NH) and The Nature Conservancy. 37 p.

Pederson, D.C., D.M. Peteet, D. Kurdyla, and T. Guilderson. 2005. Medieval Warming, Little Ice Age, and European impact on the environment during the last millennium in the lower Hudson Valley, New York, USA. Quaternary Research 63: 238-249.

Rackham, O. 2006. *Woodlands*. Collins. London.

Rosgen, D.L. 1994. A classification of natural rivers. Catena 22: 169-199.

Sabo, J.L. and M.E. Power. 2002. River-watershed exchange: Effects of riverine subsidies on riparian lizards and their terrestrial prey. Ecology 83: 1860-1869.

Sneddon, L., Anderson, M., and K. Metzler, eds. 1998. *International classification of ecological communities: terrestrial vegetation of the Eastern Region* (draft 2/98). Unpublished report. The Nature Conservancy, Eastern Regional Office, Boston, MA.

Sorenson, E., Lapin, E., Engstrom, B., and R. Popp. 1998. *Floodplain forests of Vermont: some sites of ecological significance.* Unpublished report submitted to the U.S. Environmental Protection Agency by the Vermont Nongame and Natural Heritage Program, Waterbury, VT.

Staicer, C. 2005. *The Role of Riparian Buffers in Forest Bird Conservation*. Final report to the Nova Forest Alliance. (available from www.novaforestalliance.com/media/documents/RiparianBuffers.pdf)

Weatherbee, P.B. 1996. *Flora of Berkshire County, Massachussetts*. The Berkshire Museum, Pittsfield, MA.

Young, S.M., ed. 2008. *New York rare plant status lists*. New York Natural Heritage Program, Albany, NY. 116p.

Appendices

Appendix 1: Characterization of Ancient Floodplain Forest Study Sites in Columbia County

Site	Mlt	Pol	Oom	Kin	Rox	HVF	Mrs	Bot	Tri	Sam	Wdh	Tho	Alt	Sto	Onl
Watershed[1)]	K	K	K	(K)	K	C	C	(C)	(C)	C	RJ	RJ	RJ	RJ	RJ
Distance from Hudson (mls)	38	18	13	17	8	25	17	19	17	8	29	28	22	15	8
Size Study Site (acres)	11	7	18	4	3	3	5	3	5	18	14	8	5	4	4
Elevation above sea level (feet)	623	295	246	312	180	689	197	262	213	115	492	492	377	246	180
Stream Order[2)]	2	3	4	3	4	2	3	2	2	4	3	3	3	3	3
Rosgen's Stream Class[3)]	C	C	C	~C	~C	~C	~C	~C	~C	C	C	C	C	C	C
Slope	0.003	0.001	0.002	0.016	0.001	0.010	0.003	0.003	0.003	0.001	0.001	0.001	0.002	0.001	0.001
Entrenchment Ratio	6.8	5.5	10.2	5.7	3.3	3.4	2.9	2.3	6.0	4.5	8.8	5.2	10.2	4.6	4.8
Width/Depth Ratio	34	26	28	21	44	39	61	47	49	36	18	20	30	40	35
Sinuosity	1.4	1.5	1.5	1.7	1.2	1.0	1.1	1.1	1.2	1.9	1.8	1.6	1.7	1.6	1.6
Landuse within a 2000ft radius															
% Forest	60	20	50	30	40	40	10	20	20	30	20	30	50	30	20
% Fields & Orchards	20	>75	>45	>65	59	50	80	70	70	50	>75	>65	40	40	>75
% Residential Dev't	10	<5	<5	<5	1	10	10	10	10	20	<5	<5	10	30	<5
total length of black-top roads (ft)	8,400	5,300	1,800	3,300	0	5,600	5,800	11,000	5,000	2,200	5,300	4,650	3,600	10,800	0
Forest Type	Sugar M.-dominated	Elm-Sugar M./ Sugar M.-dom.	Ash-Sycamore- Cottonw.	Sugar M.-dominated	Green A.-Silver M.	Elm-Sugar M.	Sugar M.-dom./ Ash-Syc.-Cottonw.	Elm-Sugar M./ Ash-Syc.-Cottonw.	Sugar M.-dom./ Elm-Sugar M.	Green A.-Silver M./ Elm-Sugar M.	Green A.-Silver M.	Green A.-Silver M./ Ash-Syc.-Cottonw.	Elm-Sugar M.	Ash-Sycamore- Cottonw.	Ash-Sycamore- Cottonw.

1) K=Kinderhook, C=Claverack, RJ=Roeliff Jansen Kill; bracets indicate tributaries to the respective stream

2) these are minimum stream orders identified from aerial photos; we might have overlooked small headwater creeks that would push the classification up one order

3) most sites classified perfectly as class C in all respects; ~C indicate sites with less sinuosity than typical for class C rivers (>1.4) as defined by Rosgen (1994)

Appendix 2 (page 1 of 9): List of plants documented in 15 ancient floodplain forest study sites in Columbia County

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia County	rarity[3]	protected	Freq.[4]
Agrimony	*Agrimonia sp.*	native				40%
Alder	*Alnus sp.*	native				7%
Allegheny monkey-flower	*Mimulus ringens*	native				53%
Alsike clover	*Trifolium hybridum*					13%
Alternate-leaved dogwood	*Cornus alternifolia*	native				7%
American elm	*Ulmus americana*	native				100%
American germander	*Teucrium canadense*	native	alm. excl. floodpl.	CCu		27%
Anise root	*Osmorhiza longistylis*	native	alm. excl. floodpl.	CCu		20%
Arrow-lvd tearthumb	*Polygonum sagittatum*	native				80%
Arrow-wood	*Viburnum dentatum var. lucidum*	native				7%
Asiatic dayflower	*Commelina communis*					27%
Barnyard-grass	*Echinochloa crusgalli*					20%
Barren strawberry	*Waldsteinia fragarioides*	native	rich mesic forests			7%
Basswood	*Tilia americana*	native	rich mesic forests			100%
Bellwort	*Uvularia grandiflora*	native	rich mesic forests	HuV-s?		7%
Birdsfoot trefoil	*Lotus corniculatus*					7%
Bitternut	*Carya cordiformis*	native	mostly floodplain			100%
Bittersweet	*Solanum dulcamara*	invasive				13%
Black ash	*Fraxinus nigra*	native	mostly floodplain	CCu		13%
Black bindweed	*Polygonum convolvulus*					7%
Black cohosh	*Cimicifuga racemosa*	native	rich mesic forests	CCr		7%
Black locust	*Robinia pseudoacacia*	invasive				47%
Black medick	*Medicago lupulina*					7%
Black mustard	*Brassica nigra*					7%
Black oak	*Quercus velutina*	native				7%
Black walnut	*Juglans nigra*	native	mostly floodplain			13%
Black willow	*Salix nigra*	native	mostly floodplain			7%
Blackberries	*Rubus allegheniensis*	native				20%
Bladder-nut	*Staphylea trifolia*	native	rich mesic forests	CCu		20%
Bloodroot	*Sanguinaria canadensis*	native	rich mesic forests		NYS protected	87%
Blue cohosh	*Caulophyllum thalictroides*	native	rich mesic forests	HuV-s		73%
Blue marsh violet	*Viola cucullata*	native				13%
Blue-stemmed goldenrod	*Solidago caesia*	native				20%
Boneset	*Eupatorium perfoliatum*	native				53%
Bottlebrush grass	*Elymus hystrix*	native	rich mesic forests			67%
Boxelder	*Acer negundo*		alm. excl. floodpl.			67%
Bristly crowfoot	*Ranunculus pensylvanicus*	native				7%
Broad-leaved dock	*Rumex obtusifolius*					60%
Broad-leaved sedge	*Carex platyphylla*	native				13%
Broad-leaved spring beauty	*Claytonia caroliniana*	native		CCu		7%
Bur-cucumber	*Sicyos angulatus*	native	mostly floodplain			7%
Bur-marigold	*Bidens cernua*	native				20%
Bur-reed sedge	*Carex sparganioides*	native				13%

Appendix 2 (page 2 of 9): List of plants documented in 15 ancient floodplain forest study sites in Columbia County

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia County	rarity[3]	protected	Freq.[4]
Butternut	*Juglans cinerea*	native	mostly floodplain?	CCu	NYS protected	20%
Canada brome	*Bromus altissimus*	native	alm. excl. floodpl.			27%
Canada goldenrod	*Solidago canadensis*	native				47%
Canada mayflower	*Maianthemum canadense*	native				13%
Canada thistle	*Cirsium arvense*	invasive				20%
Canada-sanicle	*Sanicula canadensis*	native	rich mesic forests			7%
Canadian anemone	*Anemone canadensis*	native				13%
Cardinal flower	*Lobelia cardinalis*	native	mostly floodplain	CCu	NYS protected	13%
Carrion flower	*Smilax herbacea*	native				33%
Catalpa	*Catalpa speciosa*	native				13%
Celandine	*Chelidonium majus*	invasive				53%
Chinese spindle-tree	*Euonymus fortunei*					7%
Choke cherry	*Prunus virginiana*	native				60%
Chokeberry	*Pyrus cf. melanocarpa*	native				7%
Christmas-fern	*Polystichum acrostichoides*	native			NYS protected	20%
Cinnamon-fern	*Osmunda cinnamomea*	native			NYS protected	7%
Clearweed, Richweed	*Pilea pumila*	native				100%
Cleavers	*Galium aparine*	native				53%
Cluster-sanicle	*Saniclula gregaria*	native				7%
Cocklebur	*Xanthium strumarium*	?				60%
Coltsfoot	*Tussilago farfara*	invasive				53%
Common blue heart-lvd aster	*Aster cordifolius*	native				7%
Common blue violet	*Viola sororia (incl. V. papilionaceae)*	native				60%
Common burdock	*Arctium minus*					20%
Common buttercup	*Ranunculus acris*					7%
Common chickweed	*Stellaria media*					73%
Common cinquefoil (or. Running five-finger)	*Potentilla simplex (or. P. canadensis)*	native				7%
Common dodder	*Cuscuta gronovii*	native				33%
Common elderberry	*Sambucus canadensis*	native				33%
Common enchanter's nightshade	*Circaea lutetiana*	native				100%
Common evening	*Oenothera biennis*	native				20%
Common flat-topped goldenrod	*Euthamia graminifolia*	native				7%
Common lamb's quarters	*Chenopodium album*					27%
Common mikweed	*Asclepias syriaca*	native				27%
Common mullein	*Verbascum thapsus*					7%
Common nightshade, Black nightshade	*Solanum nigrum*	native				13%
Common plantain	*Plantago major*					67%
Common poison-ivy	*Toxicodendron radicans*	native				100%
Common privet	*Ligustrum vulgare*	invasive				27%
Common quickweed	*Galinsoga quadriradiata*					13%
Common ragweed	*Ambrosia artemisiifolia*	native				53%
Common reed	*Phragmites australis*	invasive				7%

Appendix 2 (page 3 of 9): List of plants documented in 15 ancient floodplain forest study sites in Columbia County

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia County	rarity[3]	protected	Freq.[4]
Common sneezeweed	*Helenium autumnale*	native	alm. excl. floodpl.			7%
Common tansy	*Tanacetum vulgare*					13%
Common vervain	*Verbena hastata*	native				33%
Common water purslane	*Ludwigia palustris*	native				27%
Common woodreed	*Cinna arundinacea*	native				80%
Common Wood-sorrel	*Oxalis stricta*	native				100%
Cottonwood	*Populus deltoides*	native	mostly floodplain			80%
Crab-grass	*Digitaria sanguinalis*					7%
Crack willow	*Salix fragilis*		mostly floodplain			7%
Cuckoo-flower	*Cardamine pratensis*	?				20%
Cut-leaved toothwort	*Dentaria laciniata*	native	rich mesic forests			53%
Cut-leaved water-horehound	*Lycopus americanus*	native				20%
Dame's rocket	*Hesperis matronalis*	invasive	mostly floodplain			100%
Dandelion	*Taraxacum officinale*					47%
Davis's sedge	*Carex davisii*	native	alm. excl. floodpl.	NYS-S2	NYS protected	27%
Day lily	*Hemerocallis fulva*					53%
Deer tongue grass	*Panicum clandestinum*	native				53%
Dewberry	*Rubus flagellaris*	native				13%
Diamond willow	*Salix eriocephala*	native				7%
Ditch stonecrop	*Penthorum sedoides*	native				33%
Dock-leaved smartweed	*Polygonum lapathifolium*	native				47%
Dogbane	*Apocynum sp.*	native				7%
Dotted smartweed	*Polygonum punctatum*	native				40%
Dotted St. John's-wort	*Hypericum punctatum*	native				13%
Dutchman's breeches	*Dicentra cucullaria*	native	rich mesic forests	HuV-s?		60%
Dwarf St. John's-wort	*Hypericum mutilum*	native				13%
Early goldenrod	*Solidago juncea*	native				7%
Early meadow rue	*Thalictrum dioicum*	native	rich mesic forests			53%
Eastern bluebell	*Mertensia virginica*	native	mostly floodplain	CCr	NYS protected	7%
Eastern lined aster	*Aster lanceolatus*	native				40%
Eastern star sedge	*Carex cf. radiata*	native				20%
Eastern willow-herb	*Epilobium coloratum*	native				13%
Eastern woodland sedge	*Carex blanda*	native				33%
English plantain, "Rib Grass"	*Plantago lanceolata*					7%
European buckthorn	*Rhamnus cathartica*	invasive				13%
Fall panicum	*Panicum dichotomiflorum*	native				7%
False buckwheat	*Polygonum scandens*	?				47%
False hellebore	*Veratrum viride*	native				80%
False mermaid weed	*Floerkea proserpinacoides*	native	alm. excl. floodpl.	HuV-r		87%
False pimpernel	*Lindernia dubia var. dubia*	native	mostly floodplain			7%
False Solomon's seal	*Smilacina racemosa*	native				93%
False-nettle	*Boehmeria cylindrica*	native				73%
Field garlic	*Allium vineale*	invasive				67%
Field peppergrass	*Lepidium campestre*					7%
Figwort	*Scrophularia marilandica*	native	mostly floodplain	CCr		27%
Fireweed, Pilewort	*Erechtites hieraciifolia*	native				7%

Appendix 2 (page 4 of 9): List of plants documented in 15 ancient floodplain forest study sites in Columbia County

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia County	rarity[3]	protected	Freq.[4]
Flatsedge	*Cyperus sp.*	native				27%
Fleabane	*Erigeron sp.*	native				33%
Foam flower	*Tiarella cordifolia*	native	rich mesic forests			7%
Forest sunflower	*Helianthus decapetalus*	native	mostly floodplain			53%
Forest-goldenrod	*Solidago arguta*	native				13%
Forest-muhly	*Muhlenbergia sylvatica*	native	mostly floodplain			40%
Forked chickweed	*Paronychia canadensis*	native				7%
Fowl mannagrass	*Glyceria striata*	native				7%
Fragile fern	*Cystopteris fragilis*	native			NYS protected	20%
Frindged bindweed	*Polygonum cilinode*	native				20%
Fringed loosestrife	*Lysimachia ciliata*	native				33%
Fringed sedge	*Carex crinita*	native				33%
Garlic mustard	*Alliaria petiolata*	invasive				100%
Giant chickweed	*Stellaria aquatica*					73%
Giant foxtail	*Setaria faberi*					27%
Giant ragweed	*Ambrosia trifida*	native	alm. excl. floodpl.	HuV-s		47%
Gill-over-the-ground, Ground ivy	*Glechoma hederacea*	invasive				60%
Goblet aster	*Aster lateriflorus*	native				67%
Golden Alexanders	*Zizia aurea*	native				53%
Golden ragwort	*Senecio aureus*	native				13%
Gooseberry	*Ribes sp.*	native				33%
Goutweed	*Aegopodium podagraria*	invasive				7%
Graceful sedge	*Carex gracillima*	native				13%
Grape	*Vitis sp.*	native				87%
Gray's sedge	*Carex grayi*	native	mostly floodplain	HuV-s?		40%
Green ash	*Fraxinus pennsylvanica*	native	mostly floodplain?			80%
Green dragon	*Arisaema dracontium*	native	alm. excl. floodpl.	HuV-r	NYS protected	47%
Green foxtail	*Setaria viridis*	native				7%
Green-headed coneflower, Cut-leaf coneflower	*Rudbeckia laciniata*	native	mostly floodplain	HuV-s		13%
Grey-twig dogwood	*Cornus racemosa*	native				47%
Groundnut	*Apios americana*	native		CCu		13%
Hairgrass	*Deschampsia flexuosa*	native				7%
Hairy wild-rye	*Elymus villosus*	native	alm. excl. floodpl.			27%
Hairy-fruited sedge	*Carex trichocarpa*	native	mostly floodplain?	HuV-o?		27%
Halbert-lvd tearthumb	*Polygonum arifolium*	native				20%
Hawthorn	*Crataegus sp.*					33%
Heal-all	*Prunella vulgaris*					20%
Hedge bindweed	*Calystegia sepium*					27%
Hedge-nettle	*Stachys tenuifolia var. hispida*	native	alm. excl. floodpl.	CCu		13%
Helleborine	*Epipactis helleborine*					60%
Hemlock	*Tsuga canadensis*	native				7%
Hempnettle	*Galeopsis tetrahit*					27%
Herb-robert	*Geranium robertianum*	native	rich mesic forests			27%
Hispid buttercup	*Ranunculus hispidus*	native				20%
Hog-peanut	*Amphicarpaea bracteata*	native				73%
Honewort	*Cryptotaenia canadensis*	native	rich mesic forests			100%

Appendix 2 (page 5 of 9): List of plants documented in 15 ancient floodplain forest study sites in Columbia County

Common Name	Scientific Name	native[1)]/ invasive[2)]	Habitat in Columbia County	rarity[3)]	protected	Freq.[4)]
Honey locust	*Gleditsia triacanthos*					20%
Honeysuckle	*Lonicera sp.*	invasive				60%
Hooked crowsfoot	*Ranunculus recurvatus*	native				27%
Hop clover	*Trifolium sp.*					20%
Hop sedge	*Carex lupulina*	native				27%
Horse-balm	*Collinsonia canadensis*	native	rich mesic forests			13%
Horsetail	*Equisetum arvense*	native				33%
Hybrid vervain	*Verbena x engelmannii*	native		CCr		7%
Indian pipe	*Monotropa uniflora*	native				13%
Interrupted fern	*Osmunda claytoniana*	native			NYS protected	13%
Ironwood	*Ostrya virginiana*	native				47%
Jack in the pulpit	*Arisaema triphyllum*	native	rich mesic forests			100%
Japanese barberry	*Berberis thunbergii*	invasive				73%
Japanese hedge-parsley	*Torilis japonica*					27%
Japanese hops	*Humulus japonicus*	invasive	mostly floodplain			7%
Japanese knotweed	*Polygonum cuspidatum*	invasive	mostly floodplain			40%
Japanese stiltgrass	*Microstegium vimineum*	invasive	mostly floodplain			80%
Jerusalem Artichoke	*Helianthus tuberosus*	native				7%
Jumpseed	*Polygonum virginianum*	native				93%
Knotroot foxtail	*Setaria geniculata*	native				13%
Knotweed	*Polygonum aviculare*					13%
Lady-fern	*Athyrium filix-femina*	native			NYS protected	40%
Lady's thumb	*Polygonum persicaria*					87%
Leatherwood	*Dirca palustris*	native	mostly floodplain	HuV-r		7%
Live-forever	*Sedum purpureum*					7%
Long-bristled smartweed	*Polygonum caespitosum*	invasive				73%
Lopseed	*Phryma leptostachya*	native	mostly floodplain	HuV-r		33%
Low cudweed	*Gnaphalium uliginosum*					7%
Mad-dog skullcap	*Scutellaria lateriflora*	native				33%
Maidenhair fern	*Adiantum pedatum*	native	rich mesic forests	CCu	NYS protected	7%
Maple-leaved viburnum	*Viburnum acerifolium*	native				7%
Maple-leaved waterleaf	*Hydrophyllum canadense*	native	rich mesic forests	CCr		7%
Marsh buttercup	*Ranunculus hispidus var. caricetorum*	native				53%
Marsh pea	*Lathyrus palustris*	native	alm. excl. floodpl.	HuV-r		7%
Marsh pennywort	*Hydrocotyle americana*	native				7%
Mayapple	*Podophyllum peltatum*	native	rich mesic forests	HuV-s		20%
Meadow lily	*Lilium canadense*	native	mostly floodplain	HuV-s	NYS protected	47%
Moneywort	*Lysimachia nummularia*	invasive				80%
Moonseed	*Menispermum canadense*	native		HuV-s		20%
Motherwort	*Leonurus cardiaca*					7%
Mouse-ear chickweed	*Cerastium vulgatum*					13%
Mugwort	*Artemesia vulgaris*					20%
Multiflora rose	*Rosa multiflora*	invasive				100%
Musclewood, Blue beech	*Carpinus caroliniana*	native				67%
Nannyberry	*Viburnum lentago*	native				40%
Narrow-leaved spring beauty	*Claytonia virginica*	native	mostly floodplain?	HuV-s?		40%

Appendix 2 (page 6 of 9): List of plants documented in 15 ancient floodplain forest study sites in Columbia County

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia County	rarity[3]	protected	Freq.[4]
New York fern	*Thelypteris noveboracensis*	native			NYS protected	7%
New-England aster	*Aster novae-angliae*	native				7%
Nodding fescue	*Festuca subverticillata*	native				87%
Nodding trillium	*Trillium cernuum*	native	mostly floodplain	CCr	NYS protected	7%
Northeastern mannagrass	*Glyceria melicaria*	native				7%
Northern blueflag, Iris	*Iris versicolor*	native				40%
Northern hackberry	*Celtis occidentalis*	native	mostly floodplain	HuV-u[3]		20%
Northern water-horehound	*Lycopus uniflorus*	native				13%
Norway maple	*Acer platanoides*	invasive				40%
Oriental bittersweet	*Celastrus orbiculatus*	invasive				47%
Ostrich fern	*Matteuccia struthiopteris*	native	alm. excl. floodpl.	HuV-u[3]		87%
Panic grass	*Panicum lanuginosum*	native				13%
Panicled hawkweed	*Hieracium paniculatum*	native				7%
Pear	*Pyrus communis*					7%
Pennsylvania bittercress	*Cardamine pensylvanica*	native				60%
Pennsylvania sedge	*Carex pensylvanica*	native				13%
Pennsylvania smartweed	*Polygonum pensylvanicum*	native				20%
Perfoliate bellwort	*Uvularia perfoliata*	native				7%
Periwinkle	*Vinca minor*					20%
Pignut	*Carya glabra*	native				13%
Pigweed	*Amaranthus sp.*					7%
Pokeweed	*Phytolacca americana*	native				20%
Pubescent sedge	*Carex hirtifolia*	native	rich mesic forests			47%
Purple loosestrife	*Lythrum salicaria*	invasive				80%
Purple-flowering raspberry	*Rubus odoratus*	native				7%
Purplestem Angelica	*Angelica atropurpurea*	native				33%
Purplestem beggar-tick	*Bidens connata*	native				7%
Purple-stemmed aster	*Aster puniceus*	native				7%
Raspberries	*Rubus sp.*	native				73%
Rattlesnake weed	*Prenanthes sp.*	native				7%
Red baneberry	*Actaea rubra*	native	rich mesic forests	HuV-s	NYS protected	7%
Red garden current	*Ribes sativum*					7%
Red maple	*Acer rubrum*	native				53%
Red mulberry	*Morus rubra*	native		HuV-r?s?		7%
Red oak	*Quercus rubra*	native				67%
Red trillium	*Trillium erectum*	native			NYS protected	47%
Reed canary-grass	*Phalaris arundinacea*	invasive				100%
Rice cut-grass	*Leersia oryzoides*	native				13%
Round-lobed hepatica	*Hepatica americana*	native				20%
Rue anemone	*Anemonella thalictroides*	native	rich mesic forests			7%
Russian olive	*Elaeagnus angustifolia*	invasive				7%
Sandwort	*Arenaria lateriflora*	native				7%
Scouring rush	*Equisetum hyemale*	native				20%
Sensitive fern	*Onoclea sensibilis*	native				80%
Serviceberry	*Amelanchier spp.*	native				7%

Appendix 2 (page 7 of 9): List of plants documented in 15 ancient floodplain forest study sites in Columbia County

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia County	rarity[3]	protected	Freq.[4]
Sessile-leaved bellwort	*Uvularia sessilifolia*	native				40%
Shagbark hickory	*Carya ovata*	native				13%
Silky dogwood	*Cornus amomum var. amomum*	native				20%
Silky willow	*Salix sericea*	native				7%
Silver maple	*Acer saccharinum*	native	alm. excl. floodpl.			40%
Skunk cabbage	*Symplocarpus foetidus*	native				73%
Slippery elm	*Ulmus rubra*	native	mostly floodplain?			40%
Small-flowered crowfoot, Kidney-leaved buttercup	*Ranunculus abortivus*	native	rich mesic forests			27%
Smooth goldenrod, Late goldenrod	*Solidago gigantea*	native				93%
Soapwort	*Saponaria officinalis*					33%
Solomon's seal	*Polygonatum biflorum*	native				20%
Solomon's seal	*Polygonatum pubescens*	native				13%
Sow-thistle	*Sonchus sp.*					7%
Spicebush	*Lindera benzoin*	native				60%
Spotted jewelweed	*Impatiens capensis*	native				100%
Spotted Joe-pye-weed	*Eupatorium maculatum*	native				67%
Spotted knapweed	*Centaurea maculosa*	invasive				7%
Sprengel's sedge	*Carex sprengelii*	native	alm. excl. floodpl.	HuV-r?		13%
St. John's-wort	*Hypericum perforatum*					13%
Staghorn sumac	*Rhus typhina*	native				33%
Star-of-Bethlehem	*Ornithogalum umbellatum*					60%
Stickseed	*Hackelia virginiana*	native				53%
Stinging nettle	*Urtica dioica*	?				80%
Strawstem beggar-tick	*Bidens comosa*	native				13%
Streambank wild rye	*Elymus riparius*	native	mostly floodplain			40%
Sugar maple	*Acer saccharum*	native				93%
Swamp azalea	*Rhododendron viscosum*	native				7%
Swamp rose	*Rosa palustris*	native				7%
Swamp white oak	*Quercus bicolor*	native				27%
Swamp-milkweed	*Asclepias incarnata*	native				20%
Sweet cicely	*Osmorhiza claytonii*	native	rich mesic forests	CCu		27%
Sweet-scented bedstraw	*Galium triflorum*	native				7%
Sycamore	*Platanus occidentalis*	native	mostly floodplain			80%
Tall meadow rue	*Thalictrum pubescens*	native				53%
Three- seeded mercury	*Acalypha rhomboidea*	native				40%
Thyme-leaved speedwell	*Veronica serpyllifolia var. serpyllifolia*					27%
Toothwort	*Dentaria diphylla*	native	rich mesic forests			47%
Tree of heaven	*Ailanthus altissima*	invasive				13%
Trembling aspen	*Populus tremuloides*	native				7%
Trout lily	*Erythronium americanum*	native	mostly floodplain			100%
True forget-me-not	*Myosotis scorpioides*	invasive				47%
Turtlehead	*Chelone glabra*	native			NYS protected	53%
Tussock sedge	*Carex stricta*	native				33%
Twisted sedge	*Carex torta*	native	mostly floodplain			7%

Appendix 2 (page 8 of 9): List of plants documented in 15 ancient floodplain forest study sites in Columbia County

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia County	rarity[3]	protected	Freq.[4]
Virginia creeper	*Parthenocissus quinquefolia*	native				100%
Virginia waterleaf	*Hydrophyllum virginianum*	native	rich mesic forests			53%
Virgin's bower	*Clematis virginiana*	native	mostly floodplain			40%
Water speedwell	*Veronica anagallis-aquatica*					27%
Water-horehound	*Lycopus virginicus*	native				7%
Waterpepper	*Polygonum hydropiper*					93%
Water-plantain	*Alisma sp.*	native				20%
White ash	*Fraxinus americana*	native				67%
White avens	*Geum canadense*	native				47%
White baneberry	*Actaea alba*	native	rich mesic forests		NYS protected	13%
White birch	*Betula papyrifera*	native				7%
White clover	*Trifolium repens*					20%
White oak	*Quercus alba*	native				7%
White pine	*Pinus strobus*	native				0%
White snakeroot	*Eupatorium rugosum*	native				80%
White sweet clover	*Melilotus alba*					20%
White vervain	*Verbena urticifolia var. urticifolia*	native				73%
White wood aster	*Aster divaricatus*	native				73%
Whitegrass	*Leersia virginica*	native	mostly floodplain			93%
Whorled loosestrife	*Lysimachia quadrifolia*	native				7%
Wild black cherry	*Prunus serotina*	native				93%
Wild carrot, Queen Ann's Lace	*Daucus carota*					13%
Wild cucumber	*Echinocystis lobata*	native	mostly floodplain			13%
Wild geranium	*Geranium maculatum*	native	rich mesic forests			73%
Wild ginger	*Asarum canadense*	native	rich mesic forests	CCu		33%
Wild leek	*Allium tricoccum*	native	rich mesic forests			93%
Wild lettuce	*Lactuca canadensis*	native				13%
Wild madder	*Galium mollugo*					20%
Wild mint	*Mentha arvensis*					7%
Wild onion	*Allium canadense*	native	mostly floodplain			67%
Wild radish, Jointed charlock	*Raphanus raphanistrum*					20%
Wild rye	*Elymus canadensis*	native	mostly floodplain			33%
Wild rye	*Elymus virginicus*	native	alm. excl. floodpl.			40%
Wild stonecrop	*Sedum ternatum*					7%
Winged burning bush	*Euonymus alatus*	invasive				13%
Winged monkeyflower	*Mimulus alata*	native	alm. excl. floodpl.	NYS-S3	NYS protected	13%
Winter cress	*Barbarea vulgaris*					53%
Winterberry	*Ilex verticillata*	native			NYS protected	7%
Witch-hazel	*Hamamelis virginiana*	native				13%
Wood anemone	*Anemone quinquefolia*	native				33%
Wood-fern	*Dryopteris spinulosa*	native				13%
Wood-nettle	*Laportea canadensis*	native	mostly floodplain			87%
Wrinkle-leaved goldenrod	*Solidago rugosa*	native				13%

Appendix 2 (page 9 of 9): List of plants documented in 15 ancient floodplain forest study sites in Columbia County

Common Name	Scientific Name	native[1)]/ invasive[2)]	Habitat in Columbia County	rarity[3)]	protected	Freq.[4)]
Yellow bedstraw	*Galium verum*					7%
Yellow forest-violet	*Viola pubescens*	native				60%
Yellow foxtail	*Setaria glauca*					27%
Yellow touch-me-not	*Impatiens pallida*	native				93%
Yellow water-cress	*Rorippa palustris var. fernaldiana*	native	mostly floodplain			13%
Zig-zag aster	*Aster prenanthoides*	native	mostly floodplain	CCu		53%
Zig-zag goldenrod	*Solidago flexicaulis*	native	rich mesic forests			80%

[1)] native to Northeastern United States according to information given in Gleason & Cronquist (1991)

[2)] listed in the Invasive Plant Atlas of New England (http://nbii-nin.ciesin.columbia.edu/ipane/icat/catalogOfSpecies.do)

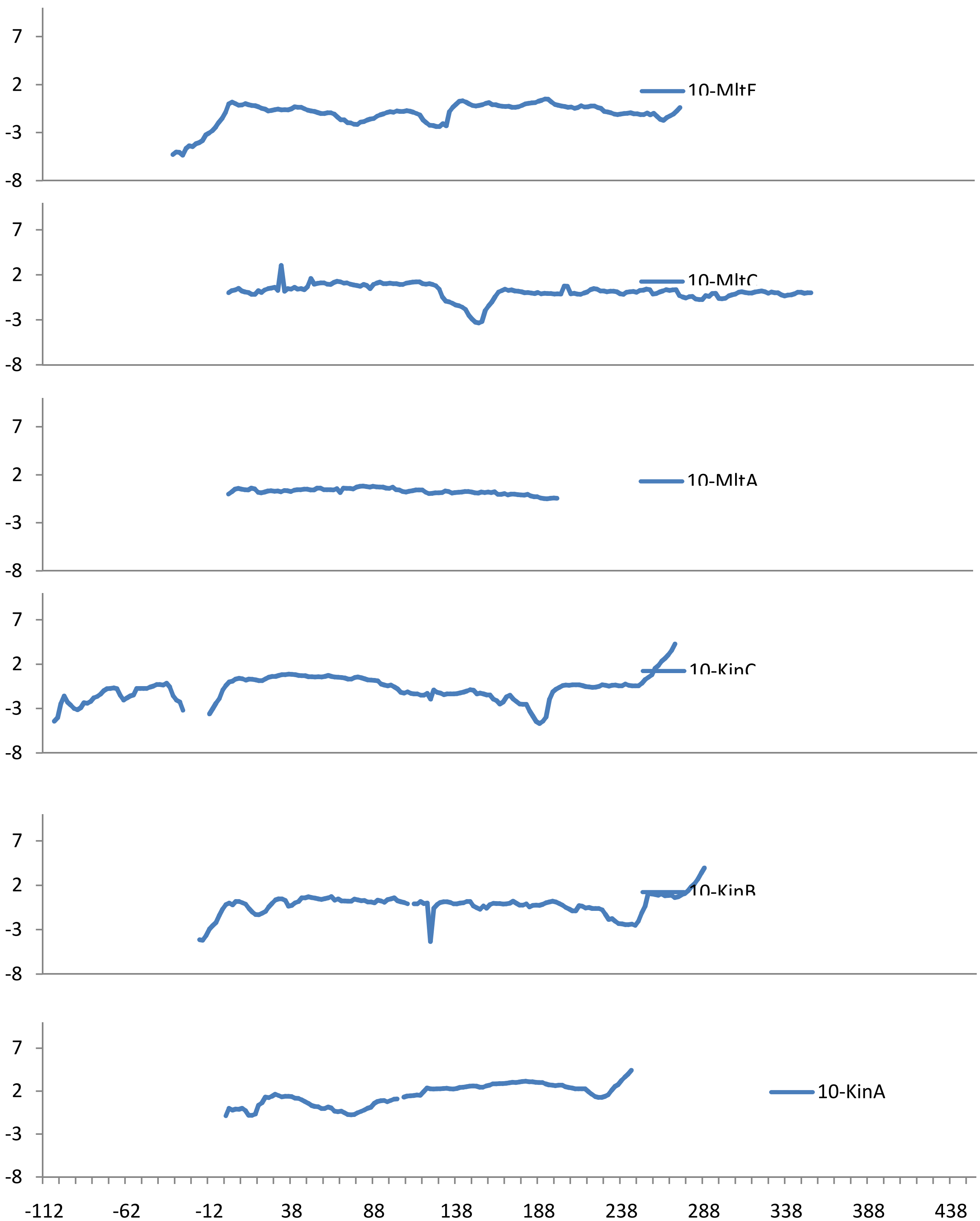
[3)] HuV-r: rare in Hudson Valley; HuV-S: scarce in Hudson Valley; HuV-o: occurrence uncertain in Hudson Valley (Kiviat and Stevens 2001); CCr: rare in Columbia County; CCu: uncommon in Columbia County (Knab-Vispo and Vispo pers. obs.) HuV-u: occurrence uncertain in Hudson Valley (Stevens, pers. com. 2009); NYS-S2: listed as threatened by New York State; NYS-S3: on New York Natural Heritage Watch List (Young 2008)

[4)] Percentage of study sites where plant species was observed during this study

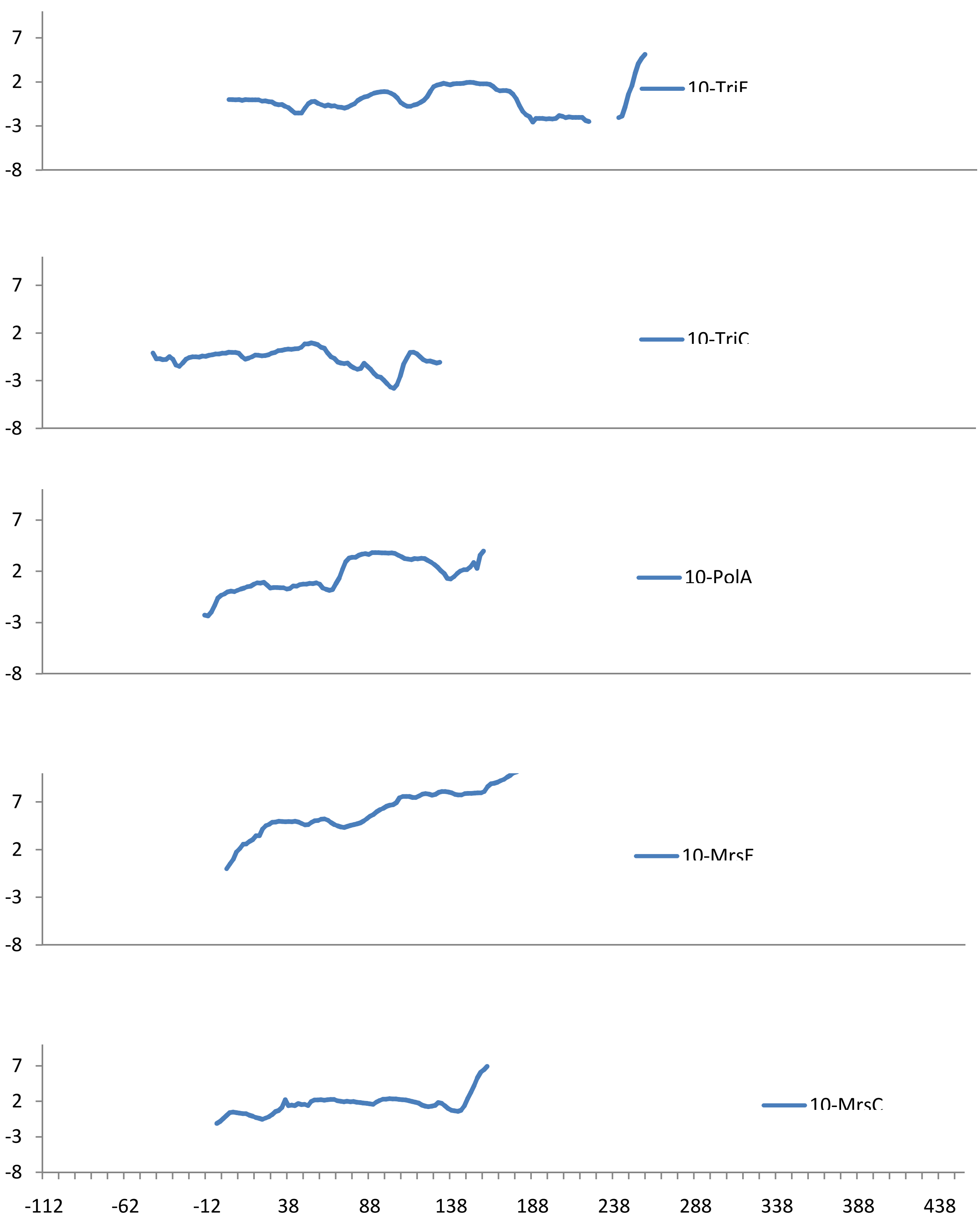
Appendix 3: Percentage of woody plants (>2” dbh) in four floodplain forest types

Forest Type	**Sugar Maple - dominated**	**Elm - Sugar Maple**	**Ash - Sycamore - Cottonwood**	**Green Ash - Silver Maple**
transects:	n=11	n=12	n=12	n=10
trees:	n=837	n=893	n=899	n=500
Woody Species	Percent of plants >2" dbh			
Sugar Maple	**70**	24	5	<1
Ironwood	**2**	<1	<1	<1
American Elm	4	**21**	9	8
Bitternut	6	**12**	5	6
Musclewood	3	**7**	1	
Slippery Elm	<1	**6**	2	
Ash sp. (White or Green Ash)	2	5	**20**	2
Sycamore	4	4	**12**	<1
Cottonwood	2	4	**11**	1
Boxelder	<1	1	**7**	6
Black Locust	<1	<1	**7**	
Basswood	2	4	1	3
White Ash	1	4	<1	1
Norway Maple	<1	<1	<1	<1
Red Oak	<1	1	<1	<1
Hawthorn	<1		<1	<1
Poison Ivy	<1	<1	1	<1
Choke Cherry	<1			<1
Grape sp.	<1	1	1	3
Spicebush	<1			1
Black Cherry	<1	1	1	1
Red Maple	<1	<1	1	1
Shagbark Hickory	<1	1	<1	1
Walnut	<1	<1	<1	
Catalpa	<1		<1	
Pignut	<1			
Witchhazel	<1			
Green Ash	<1	2	8	**39**
Silver Maple		1	4	**20**
Nannyberry		<1	1	**2**
Black Ash		<1		**3**
Swamp White Oak		<1	<1	<1
Butternut		<1	<1	<1
Elm sp.		<1	<1	
Honeysuckle		<1		
Tree of Heaven		<1		
White Birch		<1		
Black Oak		<1		
Serviceberry		<1		
Trembling Aspen		<1		
Hackberry			1	
Crack Willow			<1	
Honey Locust			<1	
Hemlock			<1	
Willow sp.			<1	
Alder			<1	
Bladdernut			<1	
Red Mulberry			<1	
Pear			<1	
Buckthorn				<1
White Oak				<1

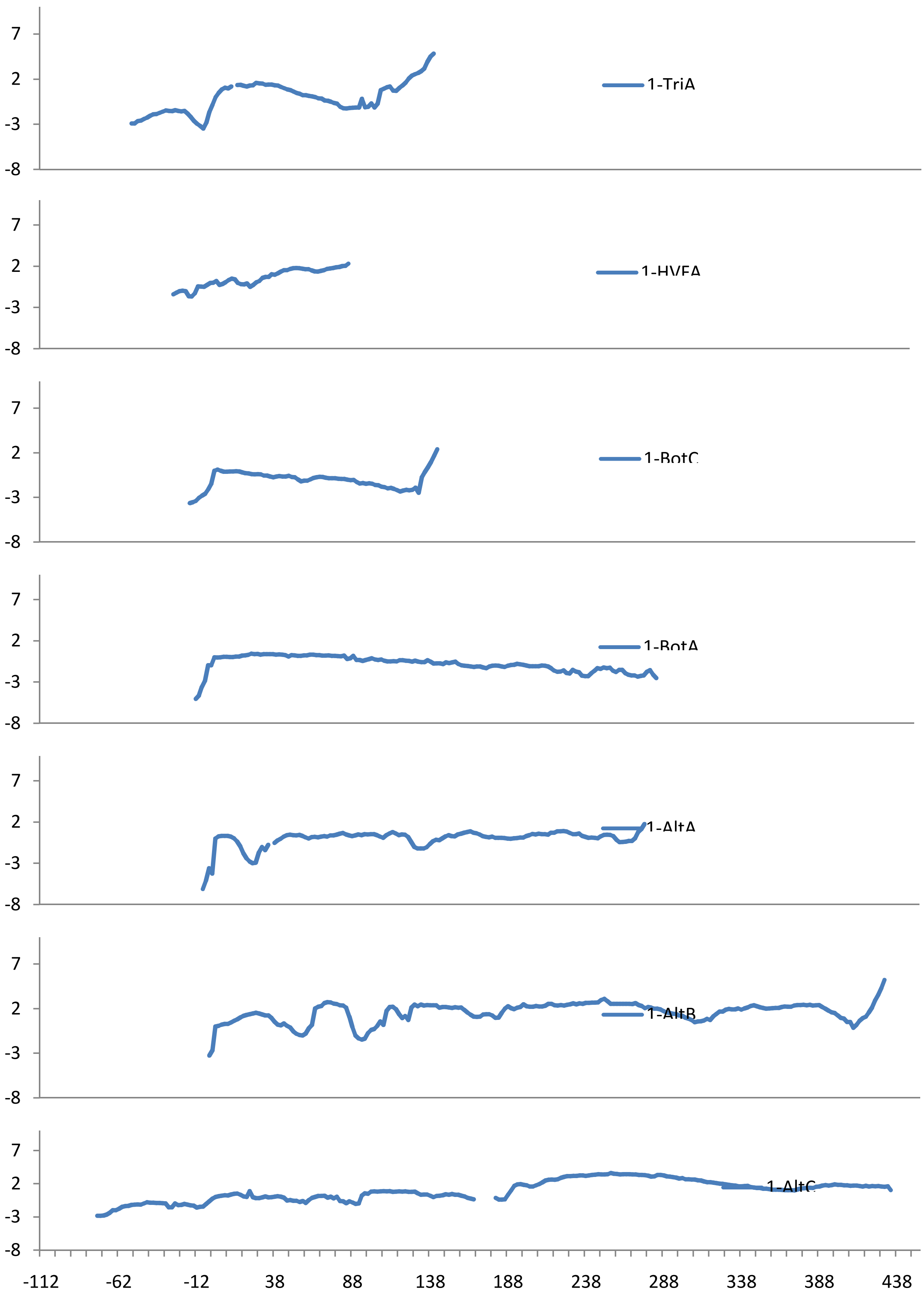
Appendix 4.1: Toposequences of Sugar Maple – dominated Floodplain Forest Transects



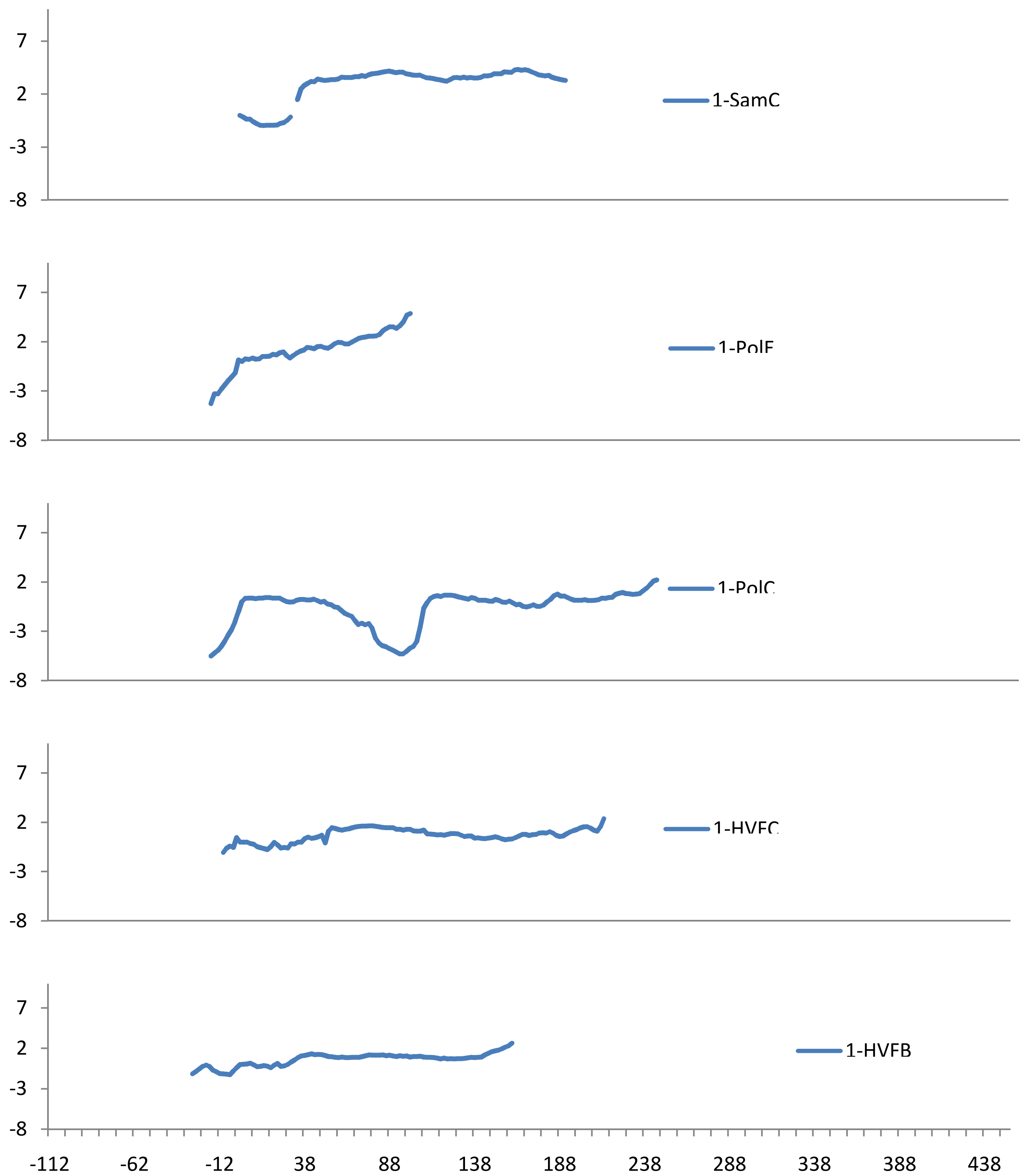
Appendix 4.2: Toposequences of Sugar Maple – dominated Floodplain Forest Transects



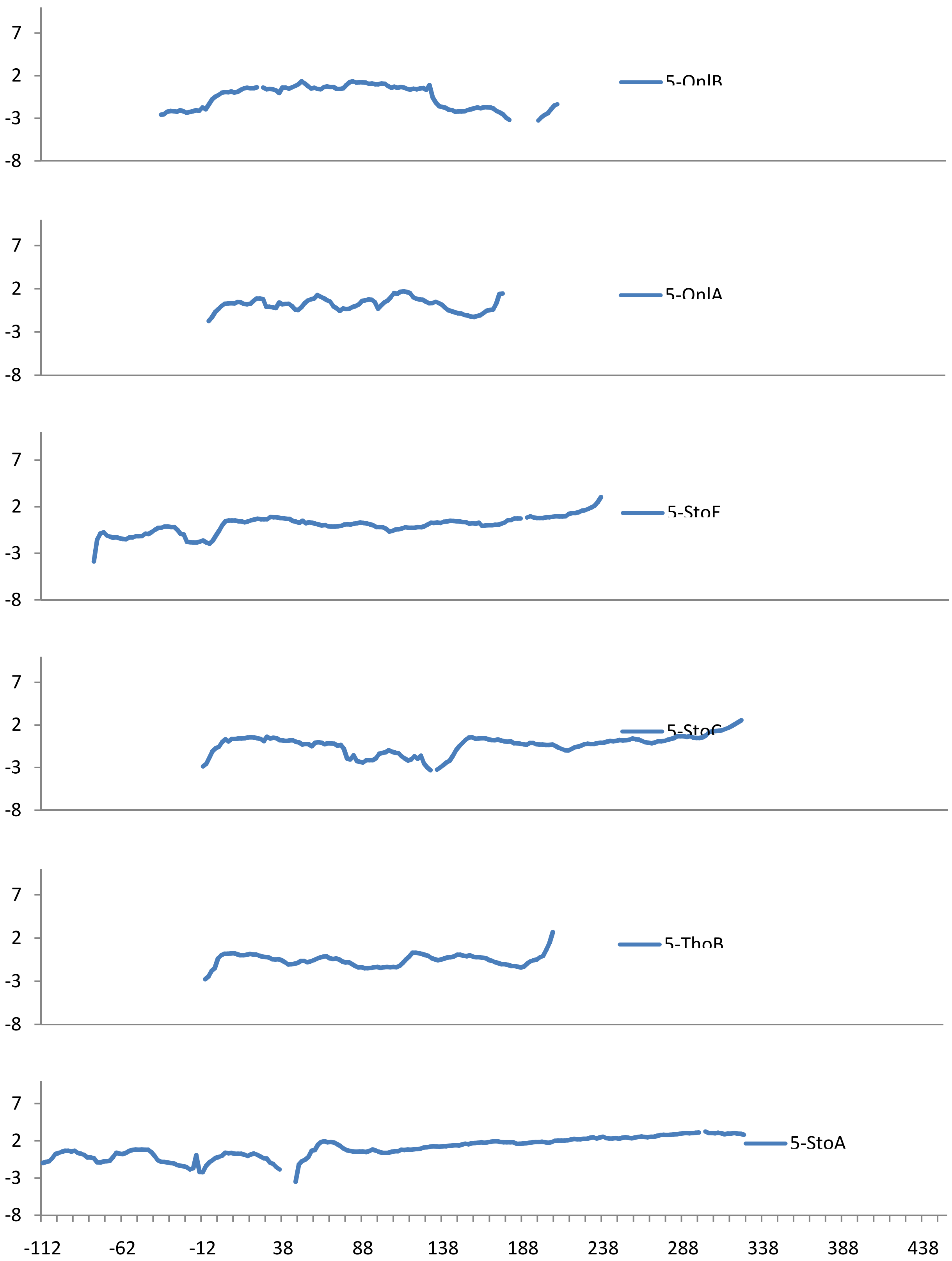
Appendix 5.1: Toposequences of Elm - Sugar Maple Floodplain Forest Transects



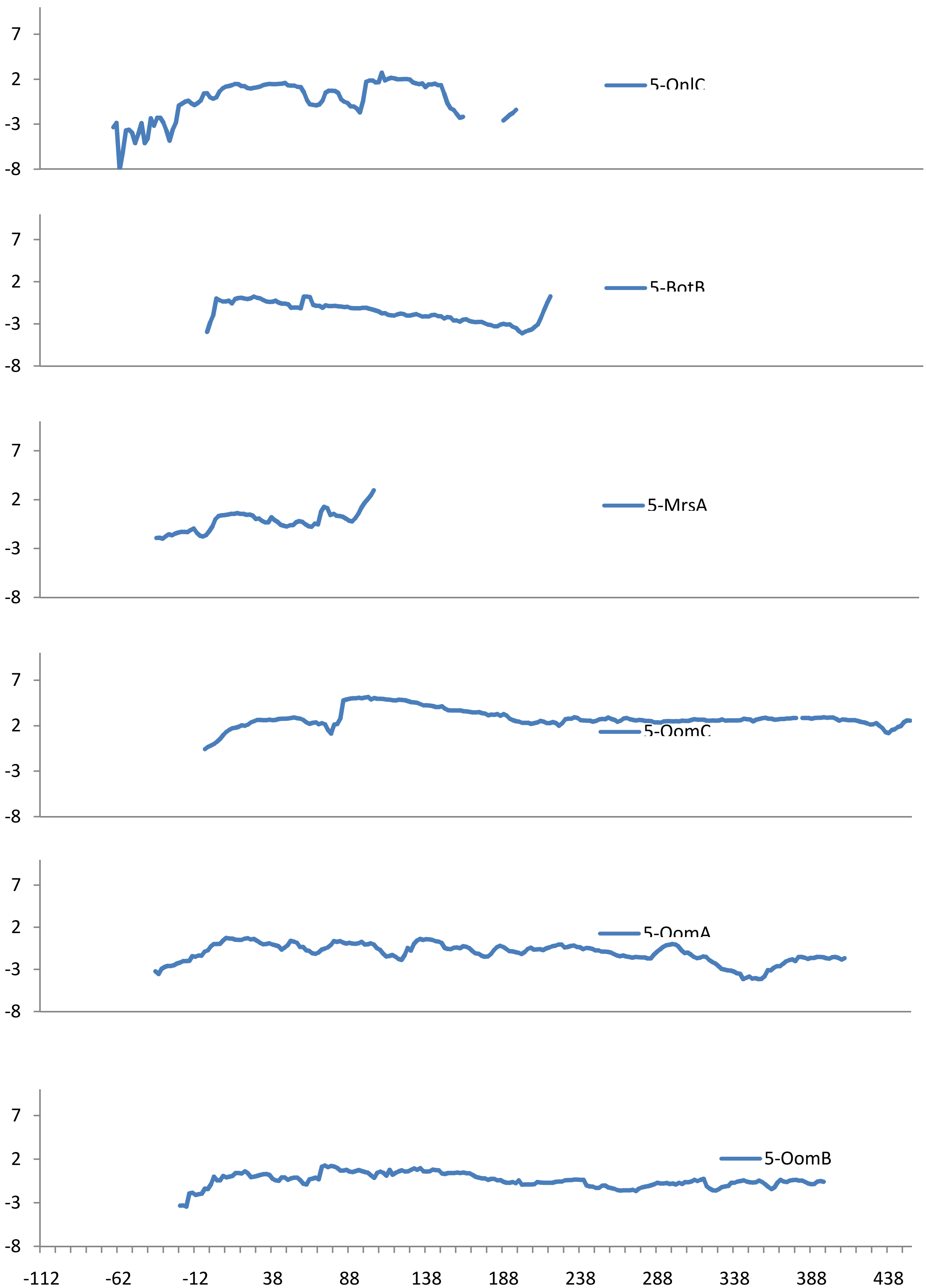
Appendix 5.2: Toposequences of Elm - Sugar Maple Floodplain Forest Transects



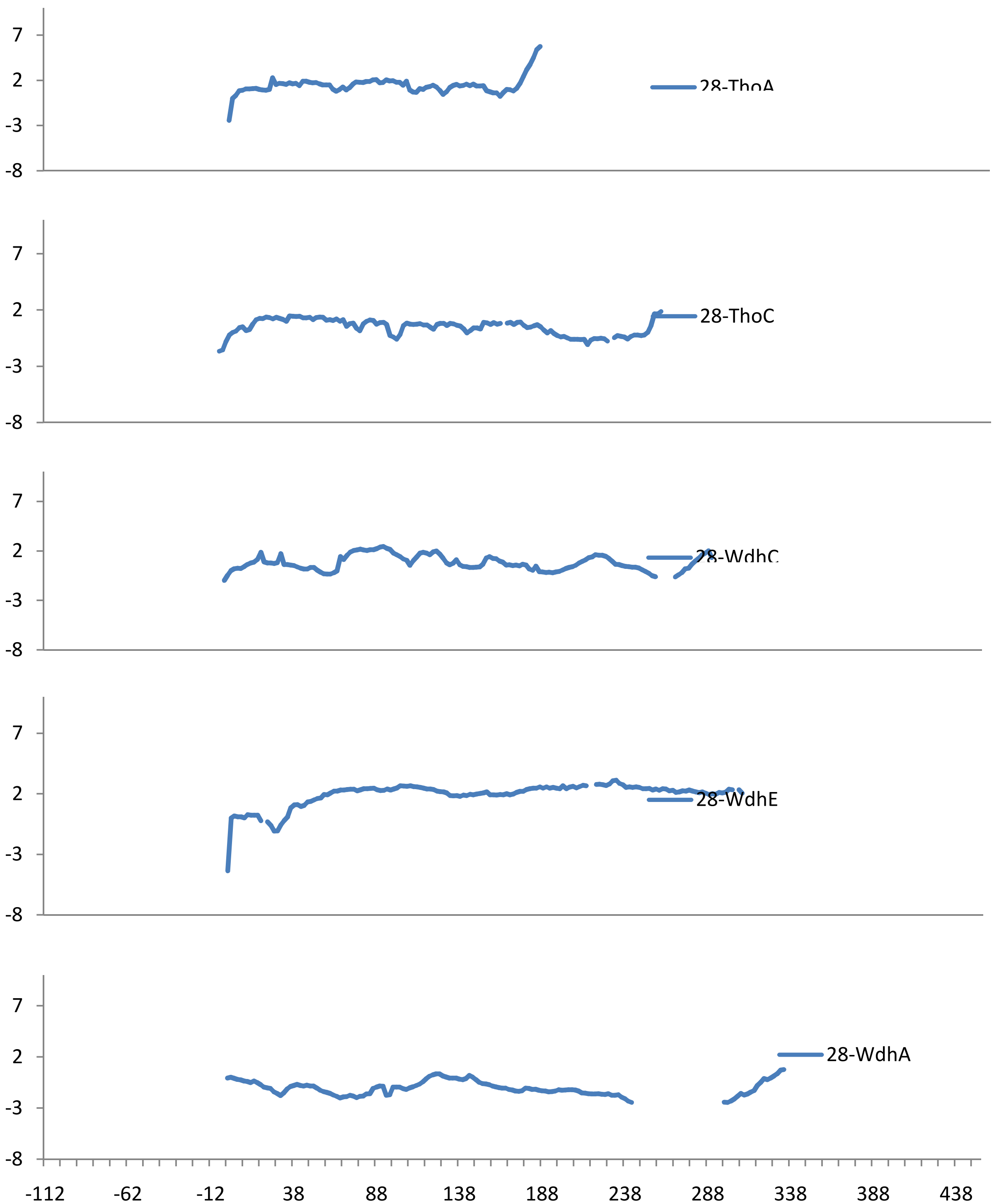
Appendix 6.1: Toposequences of Ash – Sycamore – Cottonwood Floodplain Forest Transects



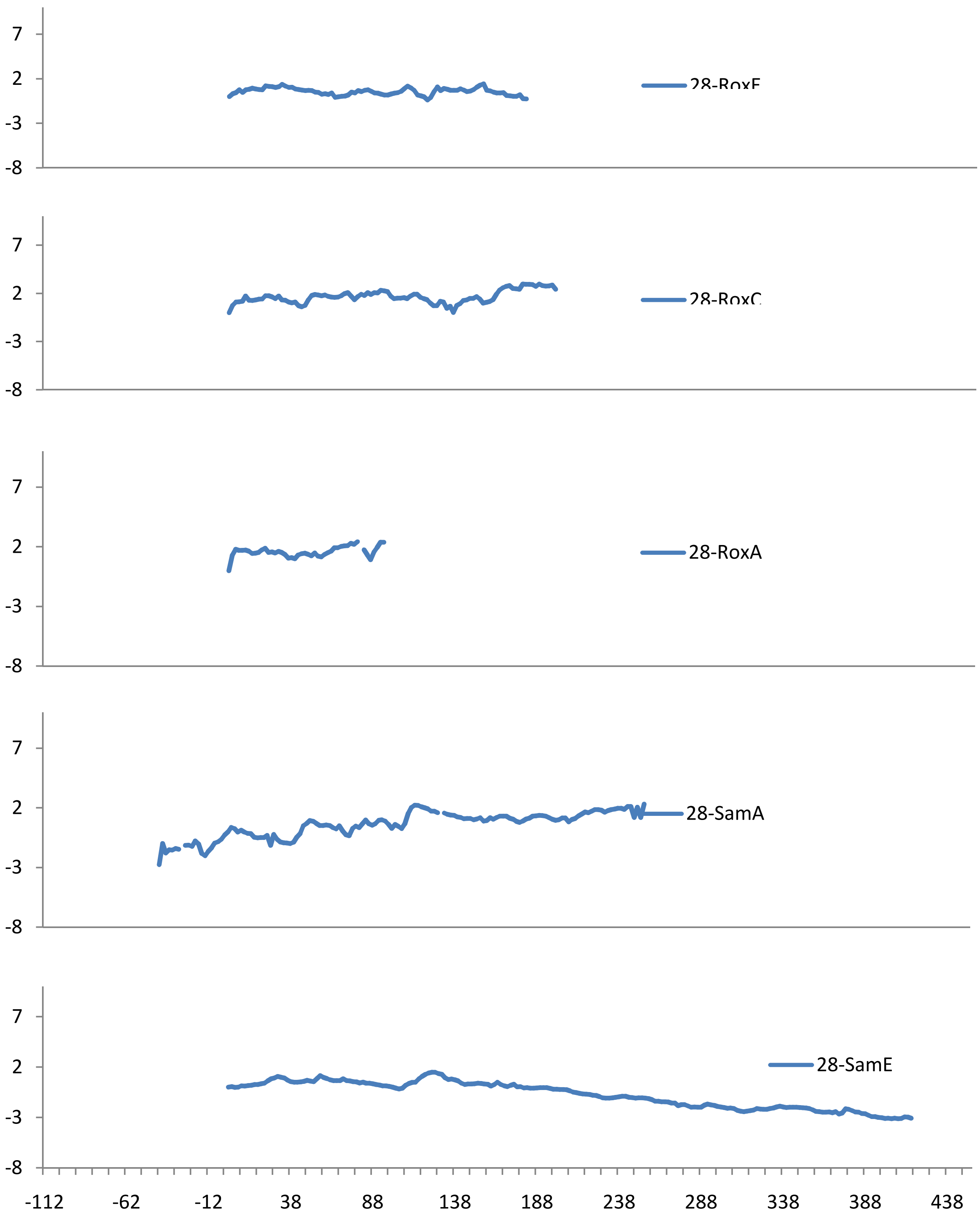
Appendix 6.2: Toposequences of Ash – Sycamore – Cottonwood Floodplain Forest Transects



Appendix 7.1: Toposequences of Green Ash – Silver Maple Floodplain Forest Transects



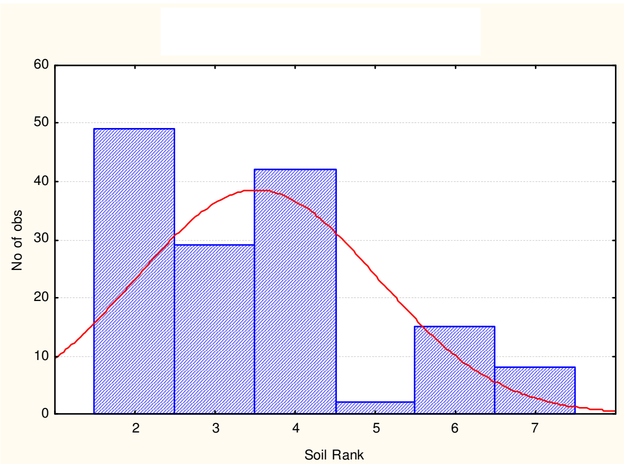
Appendix 7.2: Toposequences of Green Ash – Silver Maple Floodplain Forest Transects



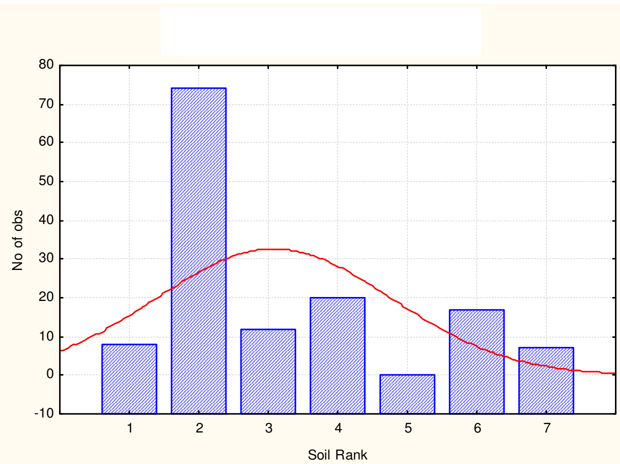
Appendix 8: Comparison of Soil Texture in Floodplain Forest Types

1: silt/clay; 2: loam; 3: sandy loam; 4: sand; 5: fine pebbles (to 1cm);
6: coarse pebbles (1-7cm); 7: cobbles (>7cm)

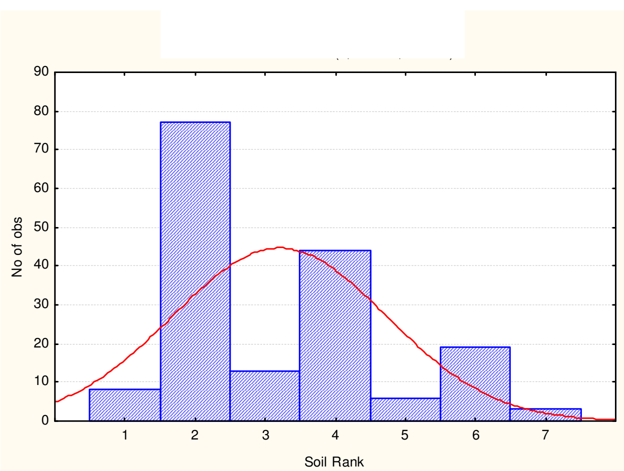
Sugar Maple – dominated Forest



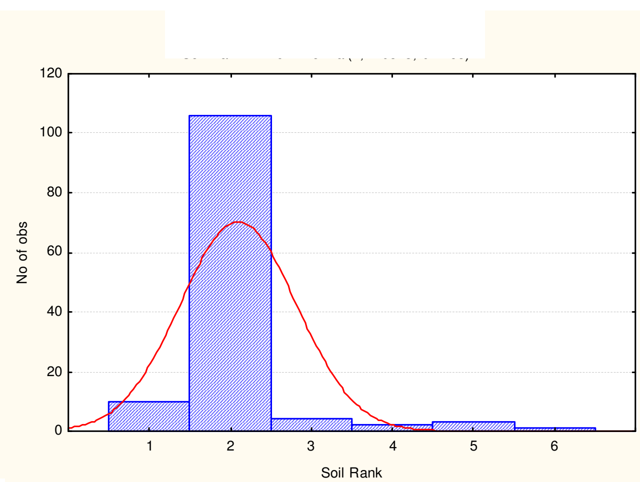
Elm – Sugar Maple Forest



Ash – Syc.– Cottonw. Forest



Grn. Ash – Silver Maple Forest



Appendix 9: Indicator values for those woody seedlings that showed a statistically significant difference in their distribution between the four floodplain forest types (*p<0.1; **p<0.05)

	Sugar Maple - dominated	Elm - Sugar Maple	Ash - Sycamore - Boxelder	Green Ash - Silver Maple
Honeysuckle	12**	0	0	0
Sugar Maple	22**	11	0	0
White Ash	18**	0	0	0
Black Cherry	9**	1	0	5
Ironwood	2**	0	0	0
Raspberry	0	8**	0	0
Virginia Creeper	0	24**	3	2
Bitternut	11	18**	2	4
Hickory	0	5**	0	0
Dogwood	0	4**	0	0
Hackberry	0	0	10**	0
Sycamore	1	0	8**	0
Elm (*Ulmus* sp.)	8	4	18**	0
Cottonwood	0	0	4**	0
Black Locust	0	0	4**	0
Multiflora Rose	1	3	11**	11**
Common Privet	0	0	0	6**
Poison Ivy	1	2	4	33**
Silver Maple	0	0	0	8**
Spicebush	2	3	2	19**
Nannyberry	0	0	0	4**
Bladder-nut	0	0	0	2*

Appendix 10.1: Spring Ephemerals by Site

Main Forest Type on Site	**Sugar Maple - dominated**	**Elm - Sugar Maple**	**Ash - Sycamore - Cottonwood**	**Green Ash - Silver Maple**
number of sites	n=4	n=4	n=3	n=4
Species	average abundance rank[1)]			
False mermaid weed	**3**	**3**	**3**	**2**
Reed canary-grass	**2**	**x**	**2**	**2**
Celandine	**x**	**1**	**1**	**1**
False Solomon's seal	**x**	**1**	**1**	**1**
Wild onion	**1**	**1**	**1**	**1**
Solomon's seal (P. biflorum and pubescens)	**1**	**1**	**1**	**1**
Purplestem Angelica	**x**	**1**	**x**	**x**
False-nettle	**x**	**1**	**1**	**1**
Yellow forest-violet	**x**	**x**	**1**	**1**
Broad-leaved toothwort	**2**	1	0	0
White wood aster	**2**	1	1	x
Field garlic	**2**	1	1	1
Spring beauty (brd. lvd)	**1**	0	0	0
Star-of-Bethlehem	**3**	2	1	0
Common buttercup	**x**	0	0	0
Barren strawberry	**x**	0	0	0
Wild leek	**3**	**3**	2	2
Trout lilly	**3**	**3**	2	2
Blue cohosh	**2**	**2**	1	1
Bloodroot	**2**	**2**	x	1
Sessile-leaved bellwort	**1**	**x**	0	0
Mayapple	**x**	**x**	0	0
Baneberry	**x**	0	**x**	0
Avens	**2**	1	1	**2**
Skunk cabbage	**2**	1	1	**2**
Hispid buttercup	**x**	0	0	**x**
Eastern bluebell	0	**x**	0	0
Wild stonecrop	0	**x**	0	0
Rue anemone	0	**x**	0	0
Cockoo-flower	0	**x**	0	**1**
Round-lobed hepatica	0	**x**	0	**x**
Hooked crowsfoot	0	**x**	0	**x**
Ostrich fern	2	1	**4**	3

(cont.)

Appendix 10.2: Spring Ephemerals by Site

Main Forest Type on Site	Sugar Maple - dominated	Elm - Sugar Maple	Ash - Sycamore - Cottonwood	Green Ash - Silver Maple
number of sites	n=4	n=4	n=3	n=4
Species	average abundance rank 1)			
Dutchman's breeches	2	x	**3**	1
Dame's rocket	2	2	**3**	2
Violet (Common blue or marsh)	2	2	**3**	2
Common Wood-sorrel	1	1	**2**	1
Day lily	1	1	**2**	0
Sensitive fern	1	1	**2**	**2**
Green dragon	0	0	**1**	**1**
True forget-me-not	0	0	**1**	**1**
Wood-nettle	1	1	**2**	**3**
Stinging nettle	x	1	1	**2**
Jack in the pulpit	1	1	1	**2**
Jumpseed	1	1	2	**3**
Jewelweed	2	1	2	**4**
Virginia waterleaf	x	1	1	**2**
False helebore	2	2	2	**3**
Garlic mustard	2	2	2	**3**
Moneywort	1	x	1	**2**
Pennsylvania bittercress	0	0	0	**1**
Herb-robert	0	0	0	**1**
Marsh buttercup	0	0	0	**x**
Canada mayflower	0	0	0	**x**
Nodding trillium	0	0	0	**x**
Gill-over-the-ground, Ground ivy	**0**	1	x	1
Small-flowered crowfoot, Kidney-leaved buttercup	x	x	**0**	1
Wild geranium	2	x	**0**	2
Wood anemone	1	x	**0**	x
Northern blueflag, Iris	1	x	**0**	1
Meadow lily	1	x	**0**	x
Sanicle	1	x	**0**	1
Early meadow rue	2	1	**0**	1
Coltsfoot	x	1	**0**	1
Cut-leaved toothwort	1	1	**0**	1
Red trillium	1	1	**0**	1
Sweet Cicely and Anise Root	1	1	**0**	1
Spring beauty (nar. lvd)	1	1	**0**	1
Wild ginger	x	1	**0**	x
Golden Alexanders	1	1	**0**	x

1) 4=dominant; 3=common; 2=occasional; 1=rare; x=present, abundance not recorded; 0=not observed

Appendix 11: Herbaceous Indicator Species for the four floodplain forest types in Columbia County (*p<0.1; **p<0.05)

	Floodplain Forest Type			
Herbaceous Indicator Species	Sugar Maple - dominated	Elm - Sugar Maple	Ash - Sycamore - Cottonwood	Green Ash - Silver Maple
White Wood Aster	40**	7	1	0
Deer Tongue Grass	19*	0	5	0
Zig-zag Goldenrod	26	19	2	4
White Snakeroot	21	28	2	1
Wild Leek	2	26**	0	0
Blue Cohosh	2	29**	0	1
Virginia Creeper	7	43**	17	9
Violets (V. *sororia* and/or V. *cucullata*)	1	38**	4	19
Honewort	11	38**	3	16
Common Enchanter's Nightshade	6	33*	13	16
Garlic Mustard	15	32	33	16
Yellow Jewelweed	4	21	17	15
Purple Loosestrife	0	0	56**	0
Ditch Stonecrop	0	0	33**	0
Common Water Purslane	0	0	25**	0
Pennsylvania Bittercress	0	0	55**	1
Japanese Stiltgrass	3	3	51**	3
Waterpepper	0	2	37**	7
Fleabane	0	0	26**	2
Stinging Nettle	0	10	27*	3
Ostrich Fern	12	14	33	24
White Grass	9	8	28	32
Sood Sorrel	11	8	27	33
Poison Ivy	0	3	5	68**
Common Woodreed	0	0	8	57**
Jumpseed	1	5	23	55**
Moneywort	0	1	8	52**
Late Goldenrod	4	4	5	47**
Wood-nettle	1	9	8	47**
Clearweed	5	13	34	44**
Sensitive Fern	7	3	1	40**
White Avens	1	1	7	37**
Nodding Fescue	0	1	0	34**
Hog-peanut	1	2	12	30**
Mad-dog Skullcap	0	0	0	20**
Tall Meadow Rue	0	0	0	20**
Virginia Waterleaf	0	0	0	20**
Giant Ragweed	0	0	2	22*
Dame's Rocket	12	6	4	22
Spotted Jewelweed	5	19	16	27
Lady-fern	1	3	0	22*

Appendix 12: Physical and structural characteristics of seven floodplain forest microhabitats

	Microhabitat						
Code	21	1	5	2	17	35	32
Description	closed forest on high terrace	closed forest on levees and low terrace	rel. open forest on very low terrace	fine-textured 2nd channels	closed forest on low-lying sandy soils	shaded gravelly shores and 2nd channels	sunny beaches
n	81	188	47	80	104	54	25
distance from bankfull (ft)	184.17	114.48	68.89	145.15	65.58	5.89	-41.68
elevation relative to bankfull (ft)	2.79	0.35	0.09	-1.66	-0.26	-1.28	-1.57
soil rank	2.36	2.05	2.83	2.06	3.97	6.09	4.84
% canopy cover	82.85	83.91	50.70	72.91	85.88	75.96	16.12
% herbaceous cover	61.19	61.30	82.98	69.50	55.75	47.83	70.40
height herbs (ft)	2.05	2.12	3.17	2.49	1.88	1.65	2.74
% cover bare ground	11.35	17.79	15.15	23.84	39.70	63.80	30.64
% cover fine woody debris	10.89	11.20	7.38	10.88	11.73	9.48	5.52
% cover moss	5.64	6.29	5.53	2.85	2.46	2.59	0.44
% cover leaf litter	32.44	22.04	10.21	11.23	13.88	8.54	10.36
% sites with rocks on surface	0.17	0.12	0.19	0.11	0.36	0.98	0.76
% sites with rocks at 1' depth	0.30	0.23	0.21	0.20	0.29	0.61	0.52
CCA Axis1	-0.68	-0.38	0.37	0.00	0.03	0.70	1.55
CCA Axis2	0.39	-0.09	0.28	-0.32	-0.23	-0.28	0.47
CCA Axis3	0.25	-0.05	-0.15	-0.39	0.29	0.53	-0.17

Appendix 13 p.1: Herbaceous Indicator Species for Floodplain Forest Microhabitats (*p<0.1; **p<0.05)

	Floodplain Forest Microhabitat						
	closed forest on high terrace	**closed forest on levees and low terrace**	**rel. open forest on very low terrace**	**fine-textured 2nd channels**	**closed forest on low-lying soils**	**shaded gravelly shores and 2nd channels**	**sunny beaches**
n=	81	188	47	80	104	54	25
Herbaceous Indicator Species							
White Avens	**7****	0	0	0	0	0	0
Garlic Mustard	**19****	15	12	9	7	2	2
Mayapple	**4****	0	0	0	0	0	0
Blue Cohosh	**5****	1	0	0	0	0	0
Common Enchanter's Nightshade	**9****	4	6	2	4	0	0
Wild Leek	**5***	1	0	0	0	0	0
Osmorhiza sp.	**4***	0	0	0	0	0	0
Zig-zag Goldenrod	**6***	3	0	1	1	0	0
Yellow Forest-violet	**3***	1	0	0	0	0	0
Common Blue Violet	0	**6****	0	1	1	0	0
Nodding Fescue	1	**6***	0	0	1	0	0
Jack-in-the-Pulpit	2	**6***	2	4	0	0	0
Moneywort	0	1	**13****	1	0	0	0
Dame's Rocket	0	3	**15****	1	0	1	0
Common Wood-sorrel	1	5	**18****	6	9	3	3
Yellow Jewelweed	6	3	**14****	3	0	0	1
Whitegrass	0	2	**16****	14	4	7	2
Hedge Bindweed	0	0	**6****	0	0	0	0
Coltsfoot	0	0	**6****	0	0	0	0
Ostrich Fern	3	5	**14****	4	9	1	0
American Germander	0	0	**5****	0	0	0	0
Canada Goldenrod	0	0	**4****	0	0	0	0
Smooth Goldenrod	0	2	**8****	0	2	0	2
False Buckwheat	0	0	**5****	1	1	0	0
Skunk Cabbage	0	2	0	**12****	0	0	0
Spotted Jewelweed	1	2	3	**13****	0	2	0
Clearweed	3	6	15	**18****	5	5	7
Wood-nettle	1	3	2	**9****	2	0	0
Jumpseed	1	2	4	**8****	3	0	0
Ditch Stonecrop	0	0	0	**4****	0	1	0
White Wood Aster	2	1	0	0	**5***	1	0

(cont.)

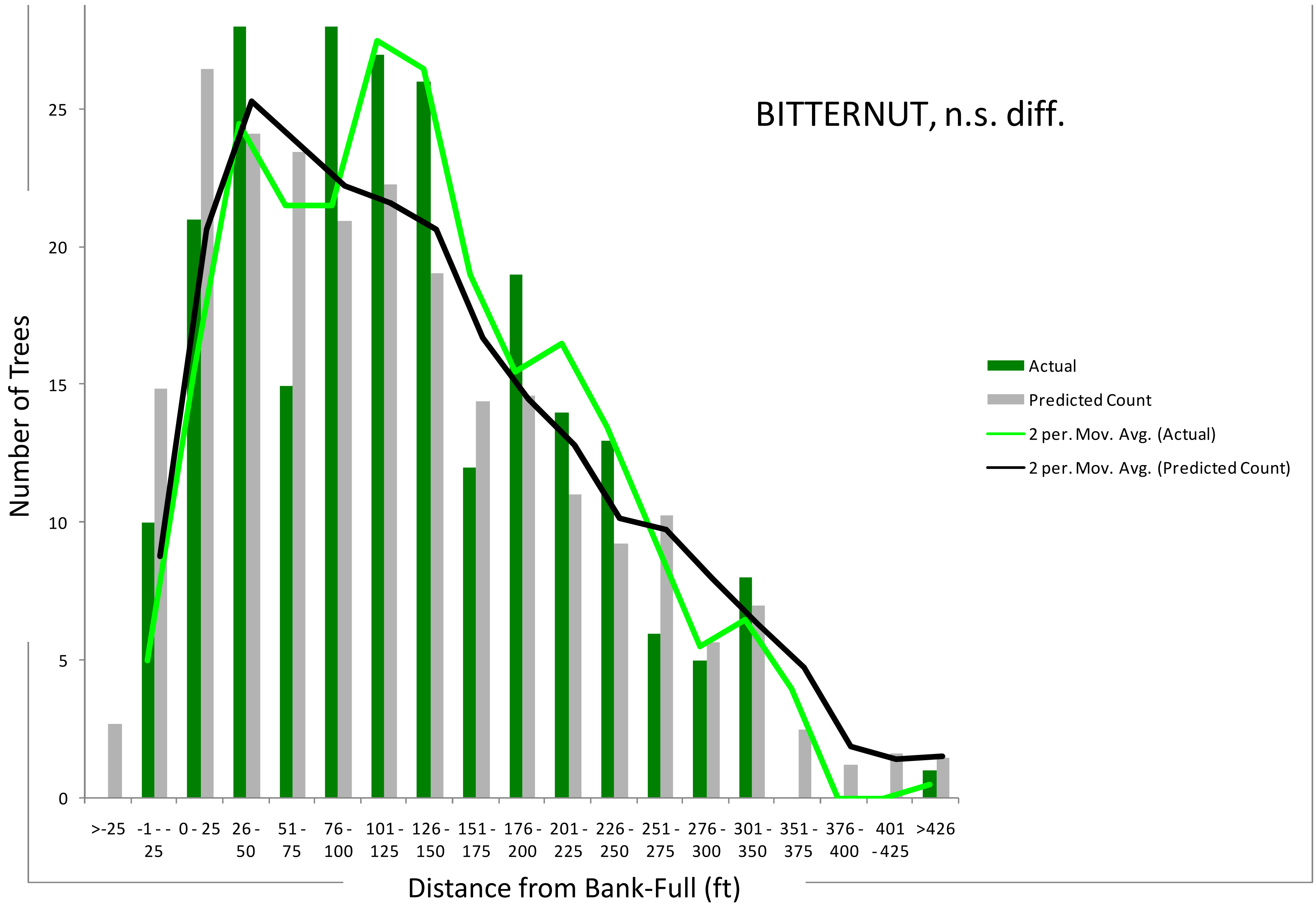
Appendix 13 p.2: Herbaceous Indicator Species for Floodplain Forest Microhabitats (*p<0.1; **p<0.05)

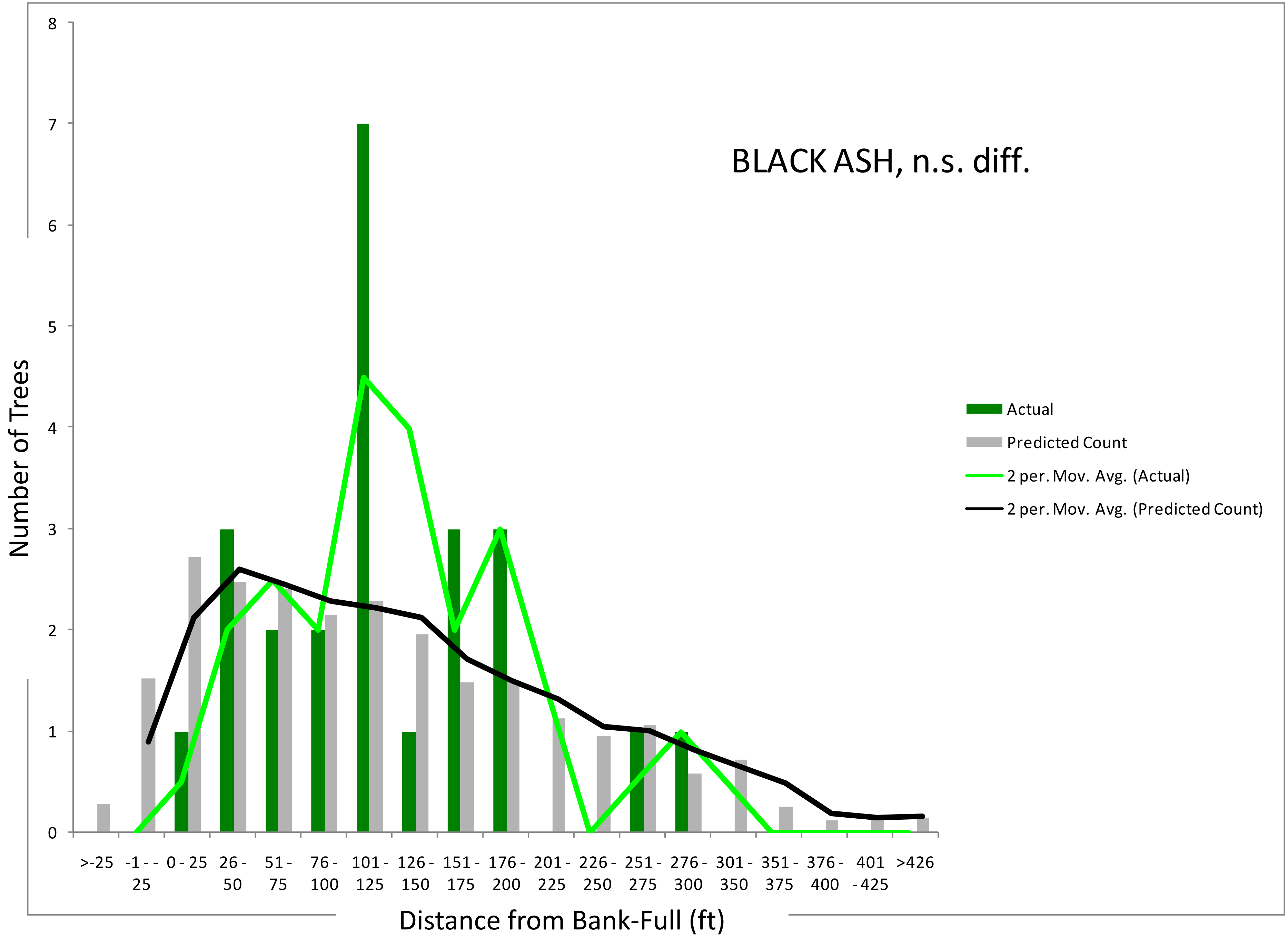
	Floodplain Forest Microhabitat						
	closed forest on high terrace	closed forest on levees and low terrace	rel. open forest on very low terrace	fine-textured 2nd channels	closed forest on low-lying soils	shaded gravelly shores and 2nd channels	sunny beaches
n=	81	188	47	80	104	54	25
Herbaceous Indicator Species (cont.)							
Barnyard Grass	0	0	0	0	0	**7****	0
Dwarf St. Johns-Wort	0	0	0	0	0	**4****	0
Knotroot Foxtail	0	0	0	0	0	**4****	0
White Vervain	0	0	0	0	0	**5****	1
Common Horsetail	0	0	0	0	0	**4****	0
Common Plantain	0	0	0	1	0	**4****	3
Three-seeded Mercury	0	0	0	0	0	**4****	1
Long-bristled Smartweed	0	1	3	3	2	**6****	0
Streambank Wild Rye	0	0	0	0	0	**3***	0
Yellow Foxtail	0	0	0	0	0	**3***	1
Forest-Muhly	0	0	0	0	1	**3***	0
Giant Foxtail	0	0	0	0	0	0	**12****
Water Speedwell	0	0	0	0	0	0	**12****
Common Lamb's Quarters	0	0	0	0	0	0	**9****
Reed Canary-Grass	0	0	0	0	0	0	**13****
Giant Chickweed	0	0	2	0	0	3	**12****
Common Chickweed	0	0	0	1	1	2	**18****
Purple Loosestrife	0	0	0	0	0	0	**24****
Waterpepper	0	0	1	2	0	1	**18****
Lady's Thumb	0	1	7	1	2	4	**22****
White Clover	0	0	0	0	0	0	**8****
Dandelion	0	0	0	0	0	4	**7****
Boneset	0	0	0	0	0	0	**7****
Wild Madder	0	0	0	0	0	0	**6****
Common Burdock	0	0	0	0	0	0	**6****
Deer Tongue Grass	0	0	0	0	0	0	**5****
Common Ragweed	0	0	0	0	0	0	**5****
Dotted Smartweed	0	0	0	1	0	0	**5****
Arrow-leaved Smartweed	0	0	4	0	0	2	**6****
Hempnettle	0	0	1	0	0	0	**4****
Broad-leaved Dock	0	0	1	0	0	2	**5****
Japanese Knotweed	0	0	1	0	0	2	**5****
White Snakeroot	0	1	2	0	1	3	**6****
Giant Ragweed	0	0	4	0	0	0	**5****
Crab-grass	0	0	0	0	0	0	**4****
English Plantain	0	0	0	0	0	0	**4****
Sptted Knapweed	0	0	0	0	0	0	**4****
Soapwort	0	0	0	0	0	0	**4***
Knotweed	0	0	0	0	0	1	**3***

Appendix 14: Indicator values for those woody seedlings that showed a statistically significant difference in their distribution between the seven microhabitats of the floodplain forests (* $p < 0.1$; ** $p < 0.05$)

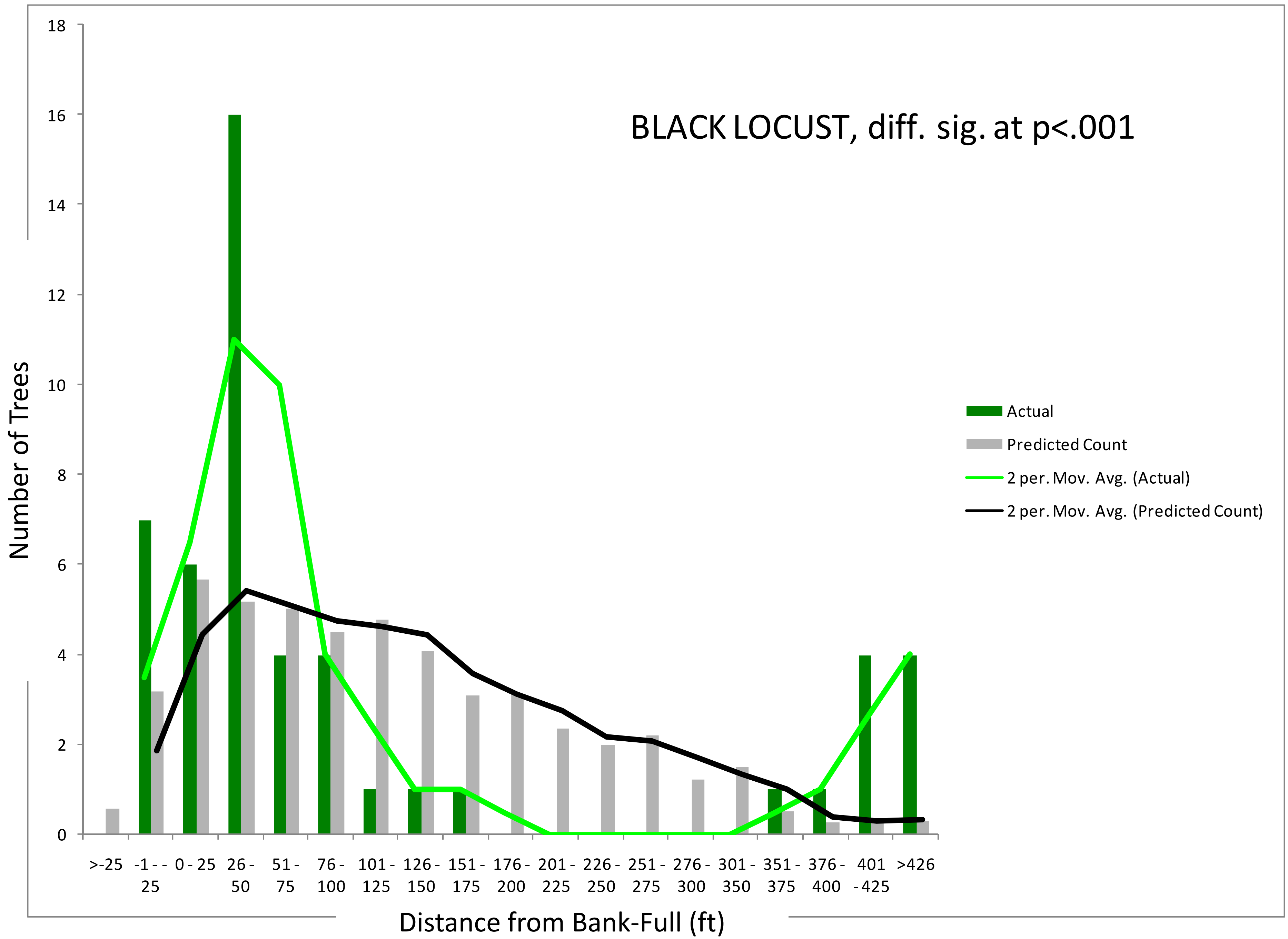
	Microhabitat						
Code	21	1	5	2	17	35	32
Description	closed forest on high terrace	closed forest on levees and low terrace	rel. open forest on very low terrace	fine-textured 2nd channels	closed forest on low-lying sandy soils	shaded gravelly shores and 2nd channels	sunny beaches
Nannyberry	4*	0	0	0	0	0	0
White Ash	1	9**	0	0	0	0	0
Honeysuckle	0	0	12**	0	1	1	0
Multiflora Rose	1	3	10*	5	6	1	0
Poison Ivy	10	6	10*	2	2	0	1
Grape	0	1	8**	0	0	0	1
Silver Maple	0	0	5*	0	1	0	0
Hickory	0	0	0	4*	0	0	0
Sycamore	0	0	1	0	0	3	18**
Elm (*Ulmus* sp.)	1	1	3	1	2	11	15**
Cottonwood	0	0	1	0	0	1	9**
Red Maple	0	0	0	0	0	0	7**
Pignut	0	0	0	0	0	0	5*
Honey Locust	0	0	0	0	0	0	5**
Blackberry	0	0	0	0	0	0	4*

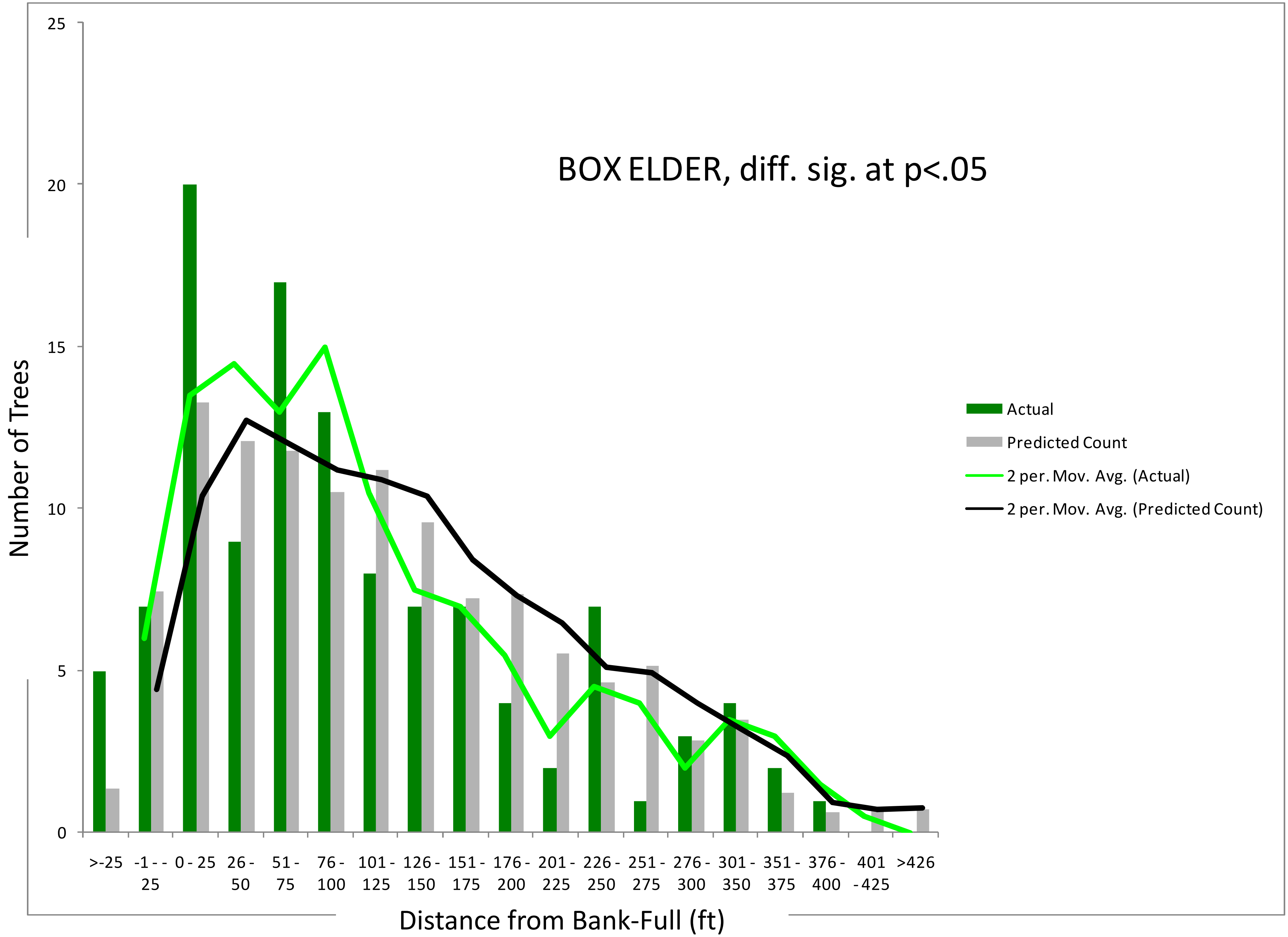
Appendix 15: The distribution of floodplain trees relative to bankfull. Predicated count is corrected for the distribution of total tree counts, we had fewer trees distant from water because we had fewer transects that were so long. Chi-square was used to test for significant differences.

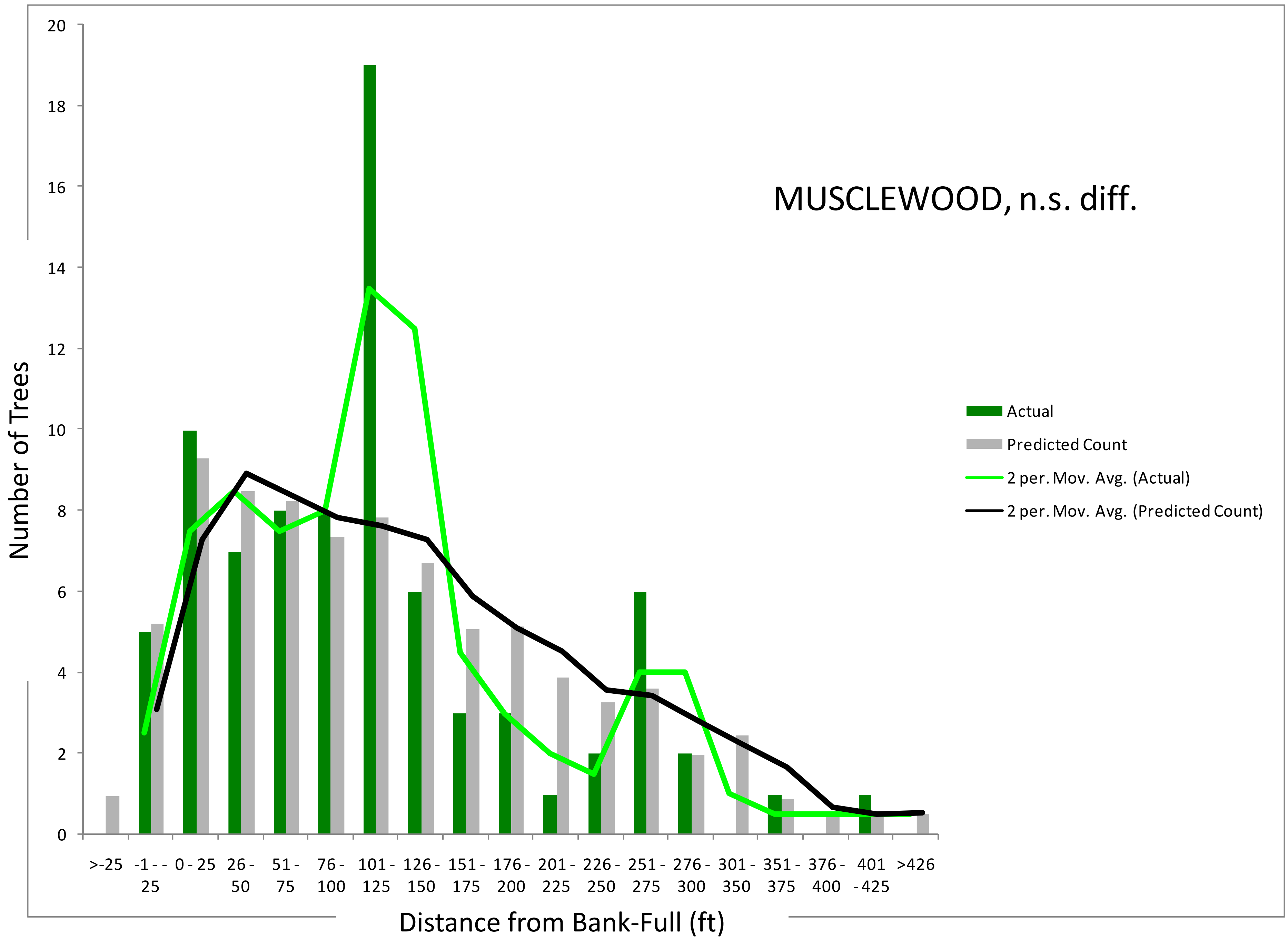


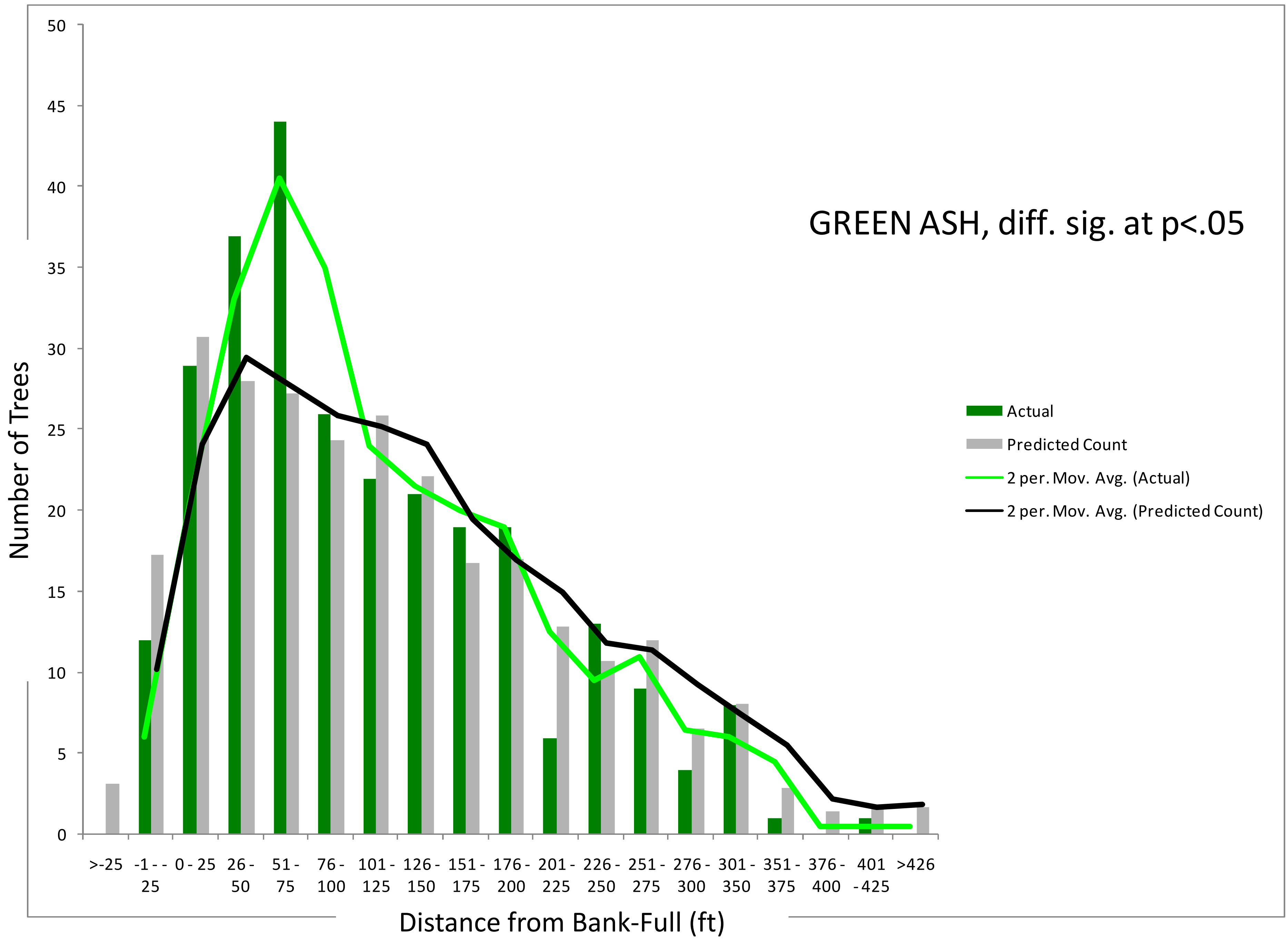


BLACK ASH, n.s. diff.
Number of Trees
8
7
6
5
4
3
2
1
0
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)

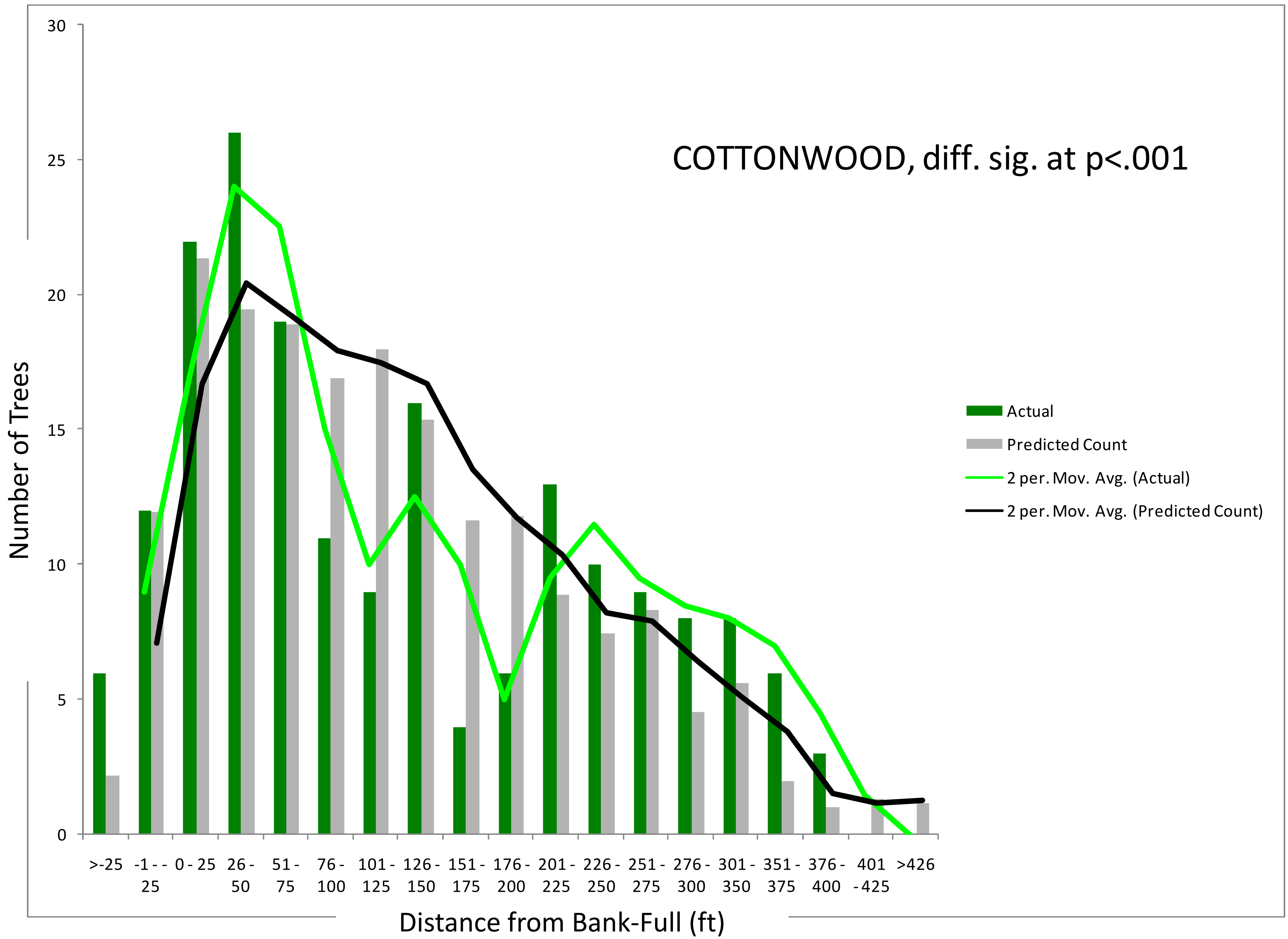

BLACK LOCUST, diff. sig. at p<.001
Number of Trees
18
16
14
12
10
8
6
4
2
0
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)

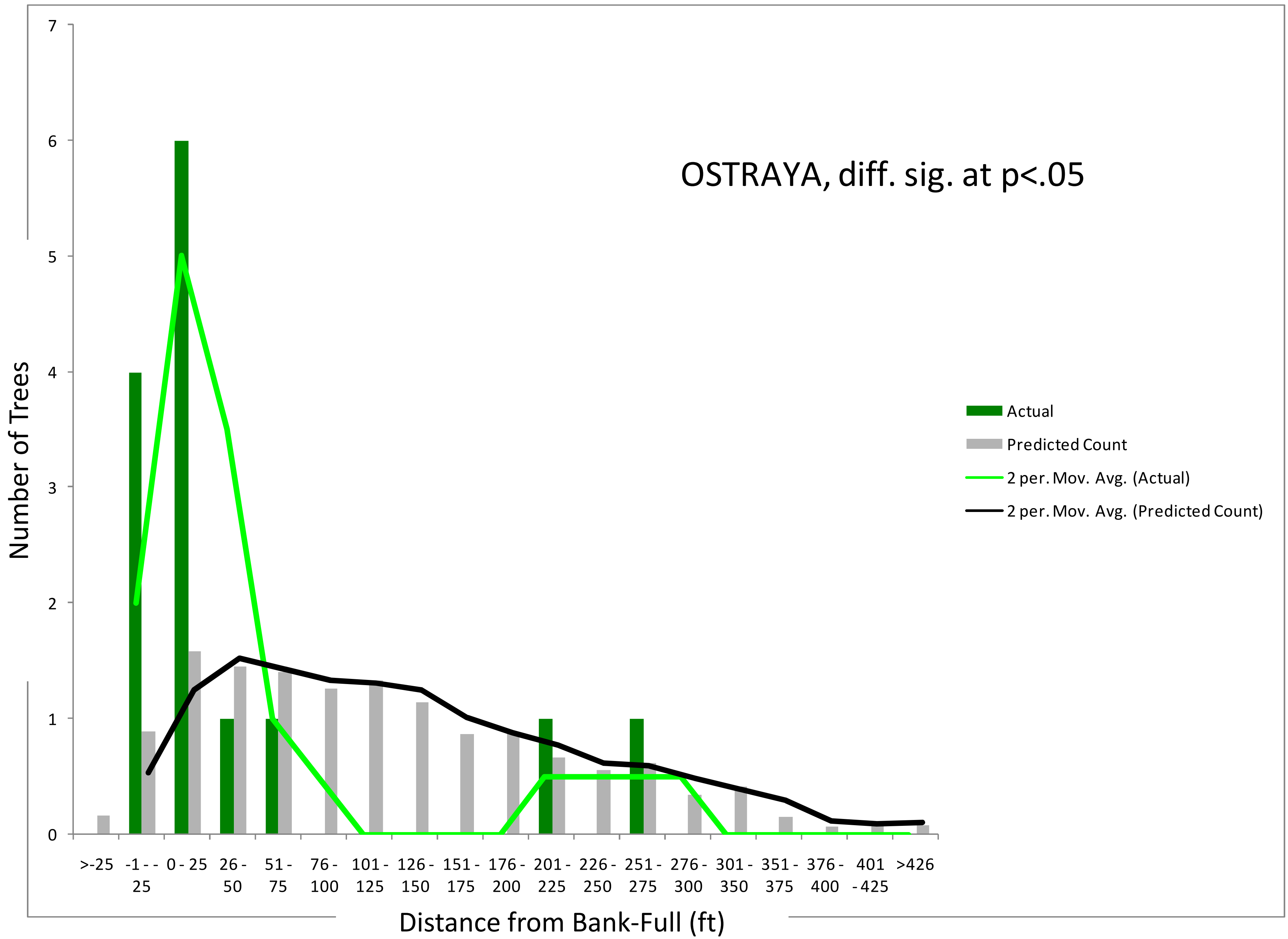

BOX ELDER, diff. sig. at p<.05
Number of Trees
Distance from Bank-Full (ft)
25
20
15
10
5
0
>-25
-1 - -25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)


MUSCLEWOOD, n.s. diff.
Number of Trees
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)
0
2
4
6
8
10
12
14
16
18
20
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426

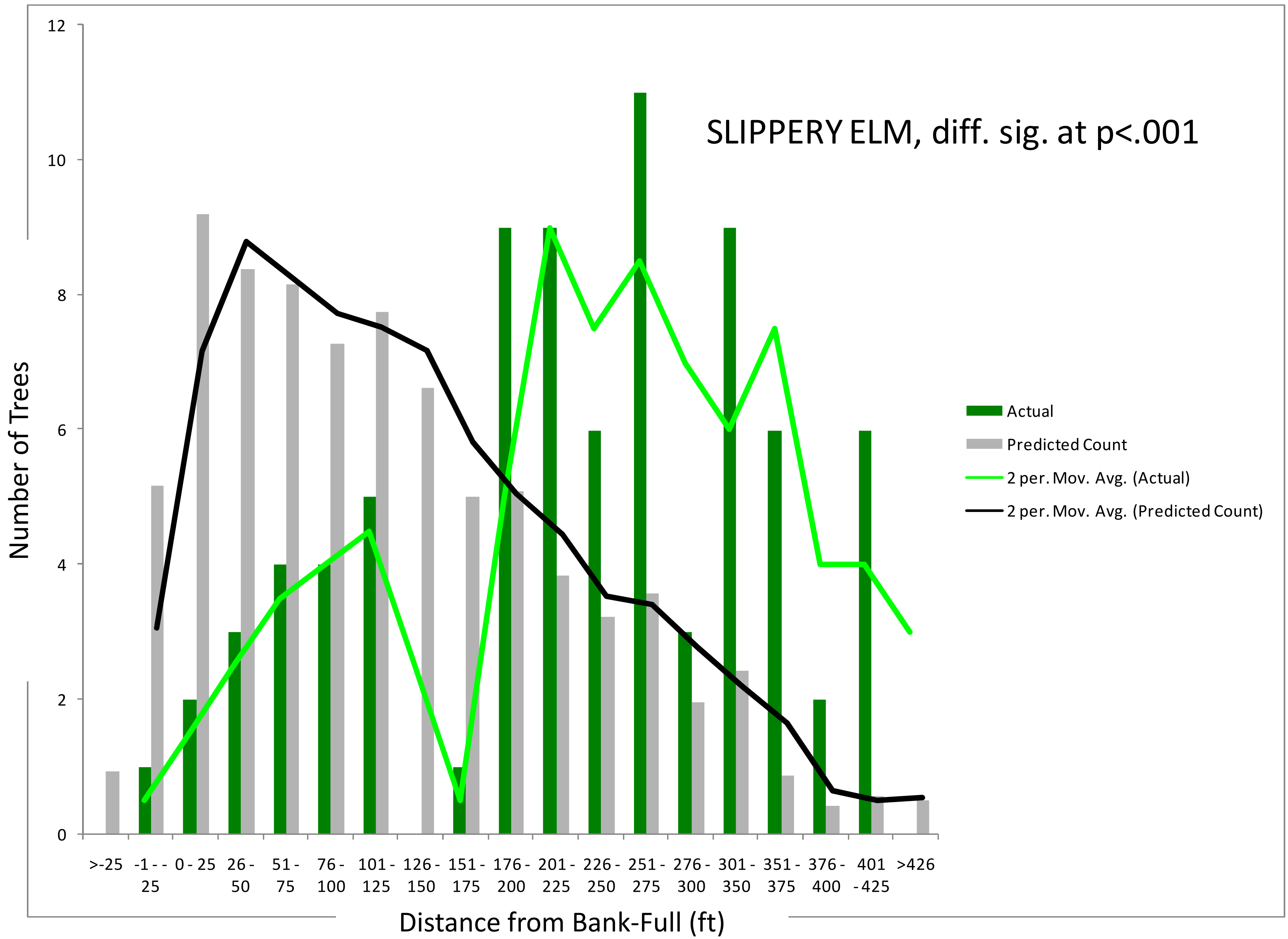


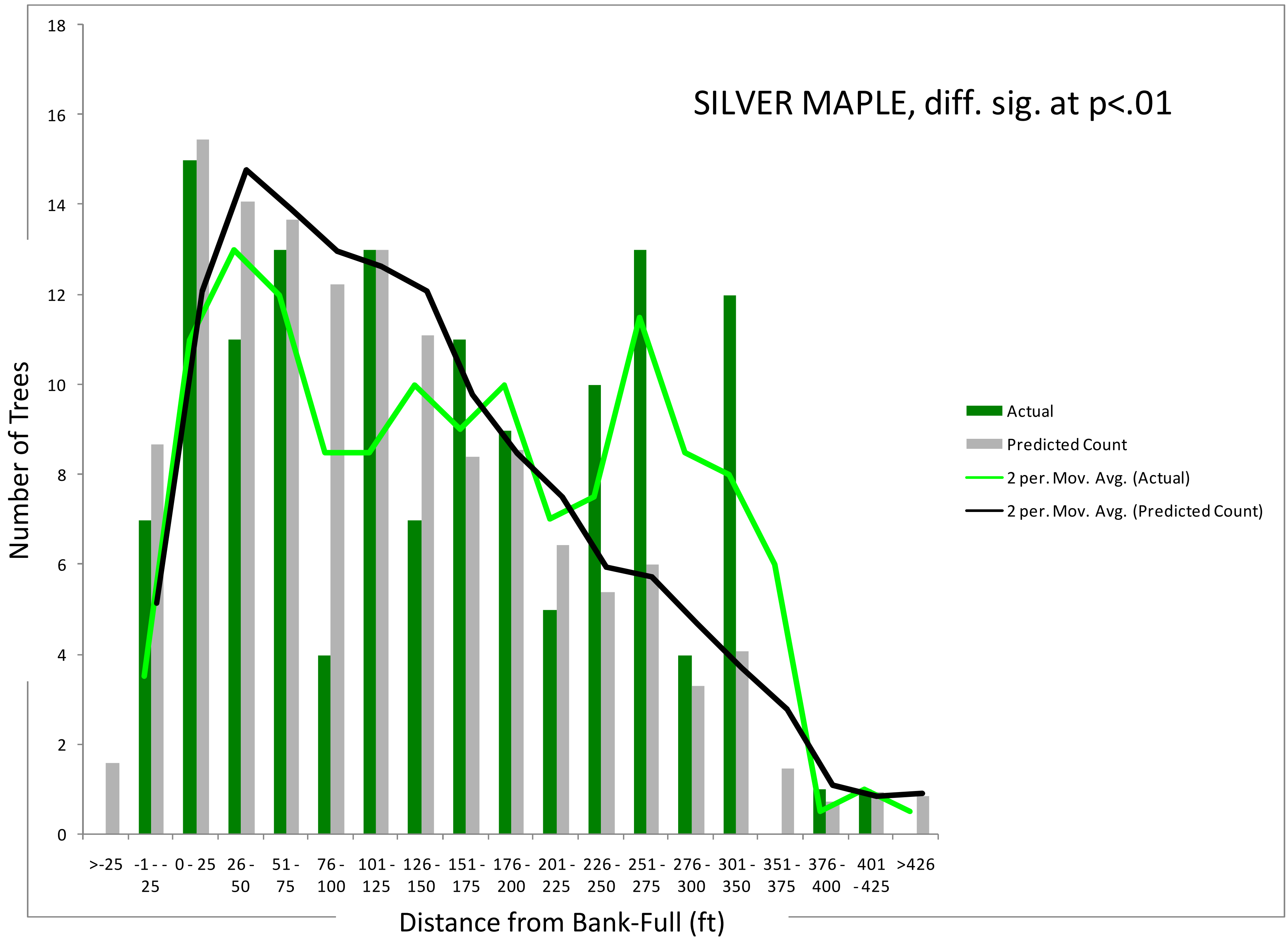
GREEN ASH, diff. sig. at p<.05
Number of Trees
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)
0
5
10
15
20
25
30
35
40
45
50
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426


COTTONWOOD, diff. sig. at p<.001
Number of Trees
Distance from Bank-Full (ft)
30
25
20
15
10
5
0
>-25
-1 - -25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)

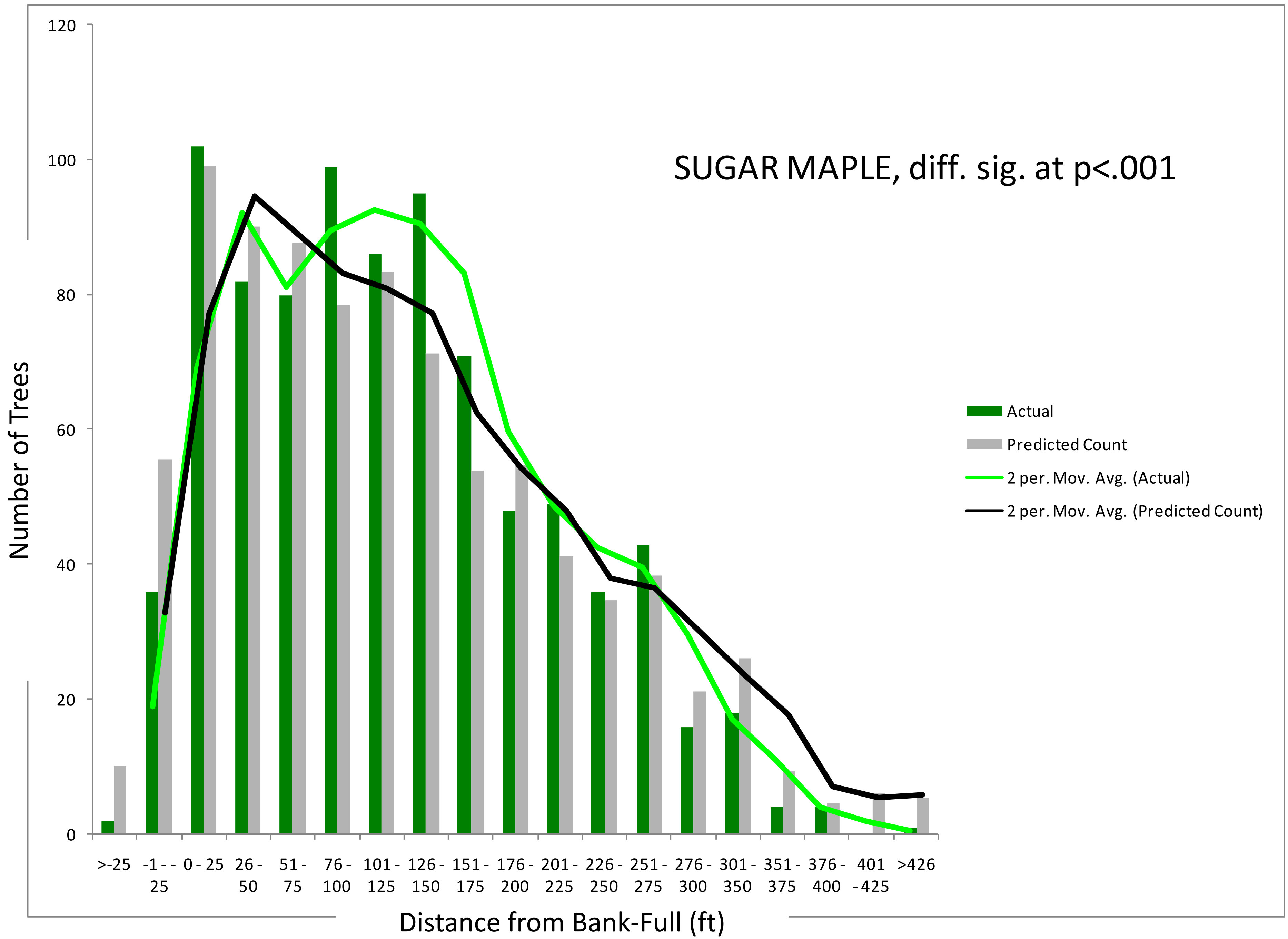


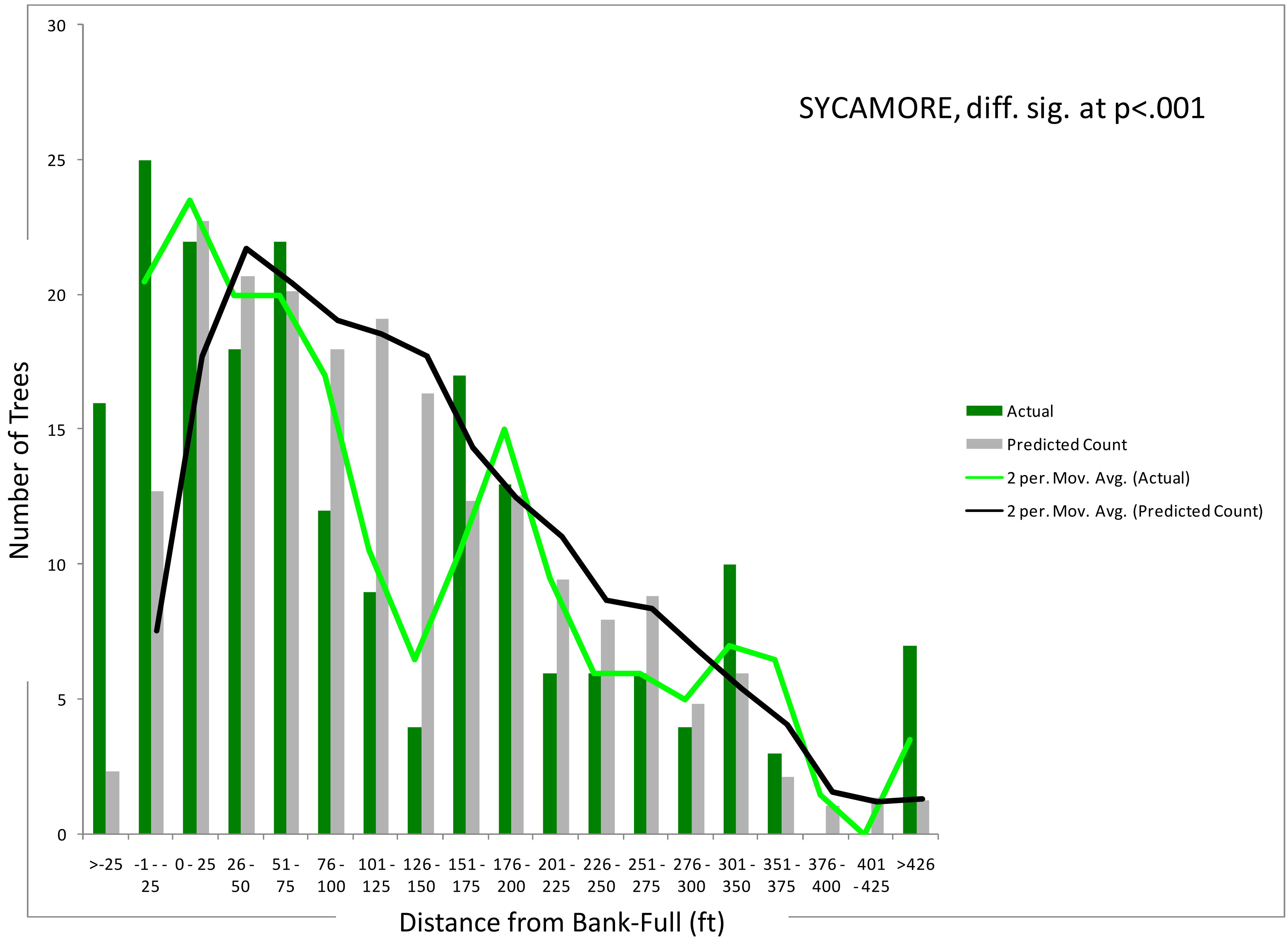
OSTRAYA, diff. sig. at p<.05
Number of Trees
Distance from Bank-Full (ft)
0
1
2
3
4
5
6
7
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)

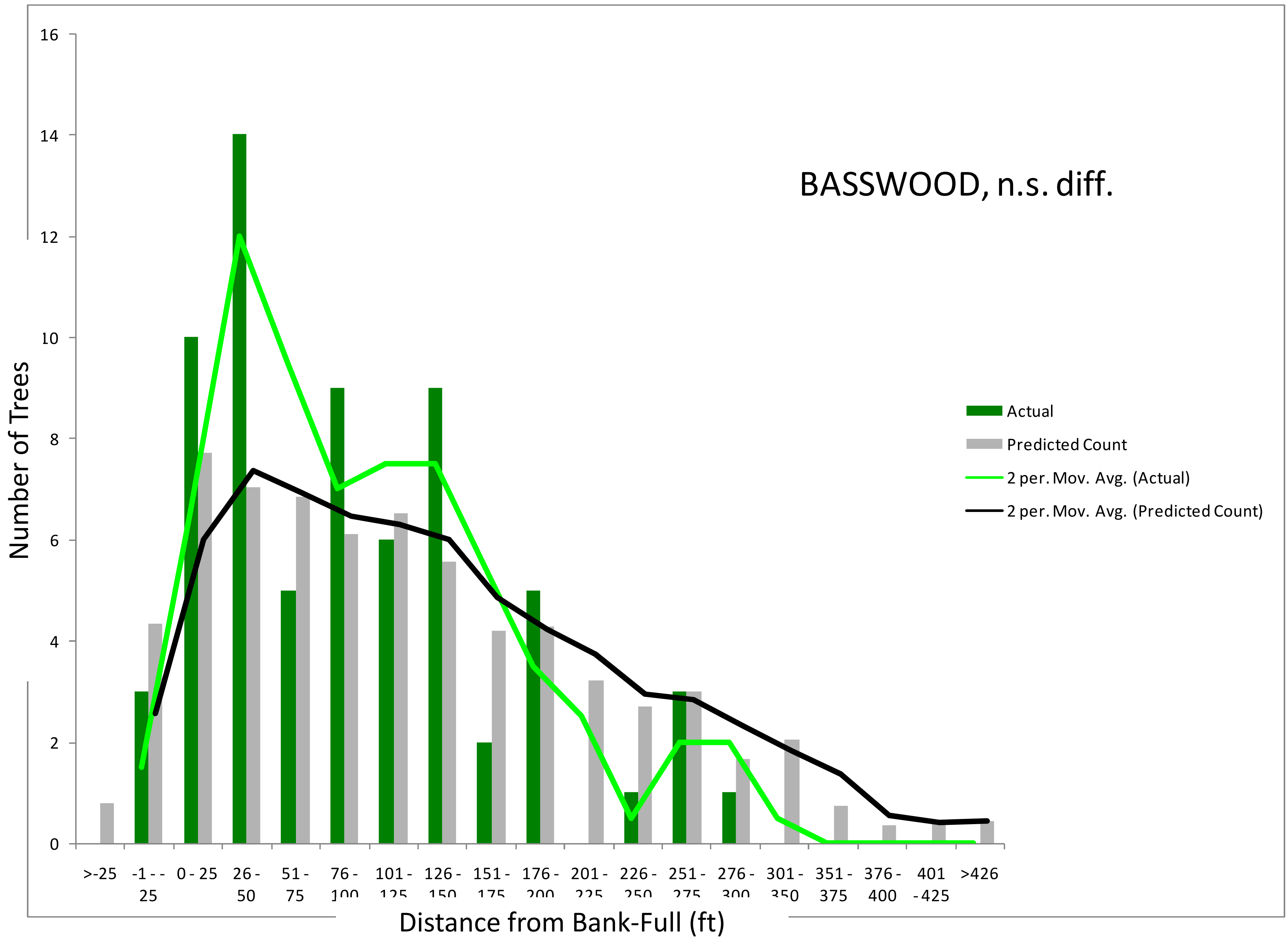

SLIPPERY ELM, diff. sig. at p<.001
Number of Trees
0
2
4
6
8
10
12
>-25
-1 - -25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)

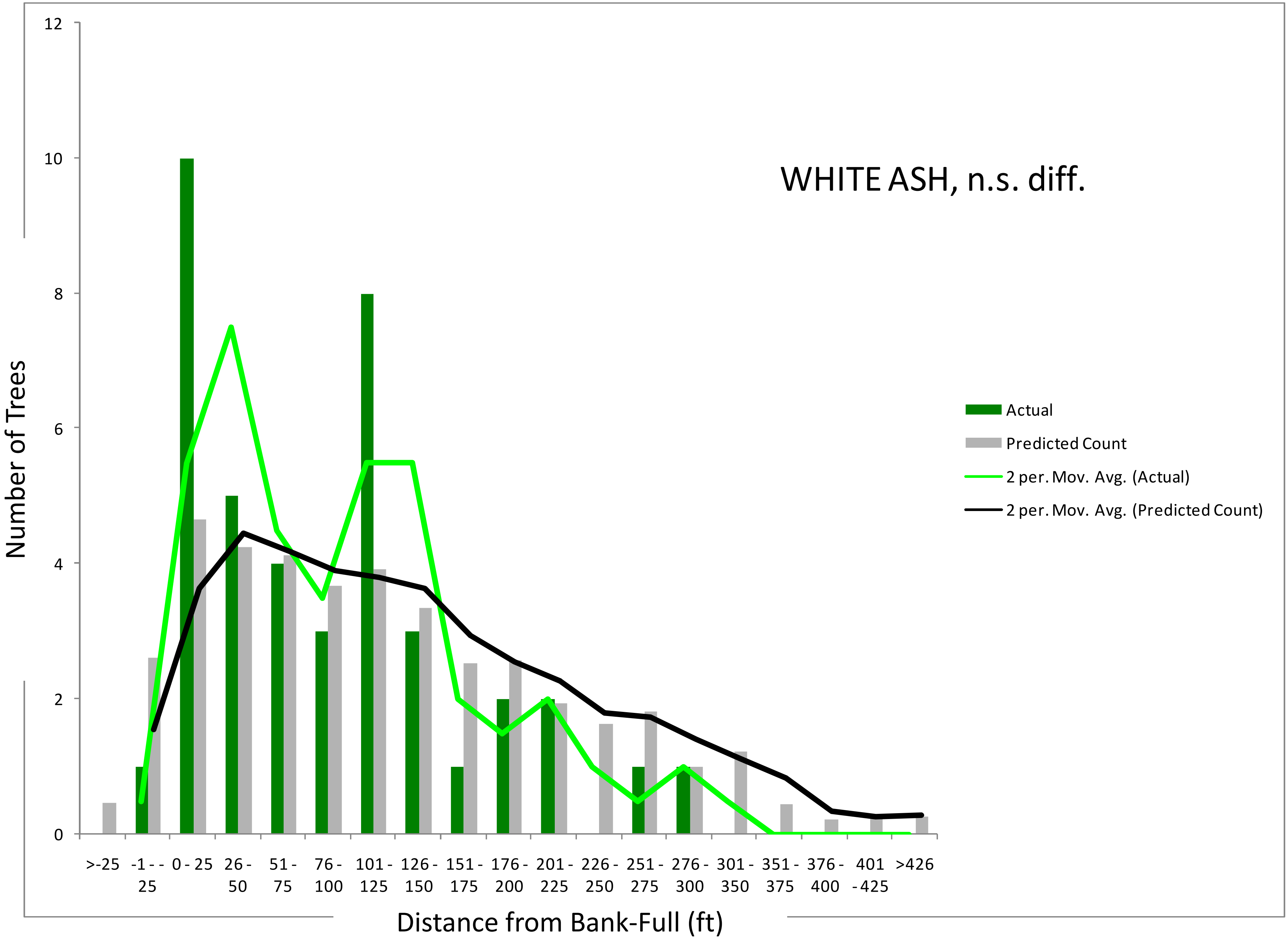


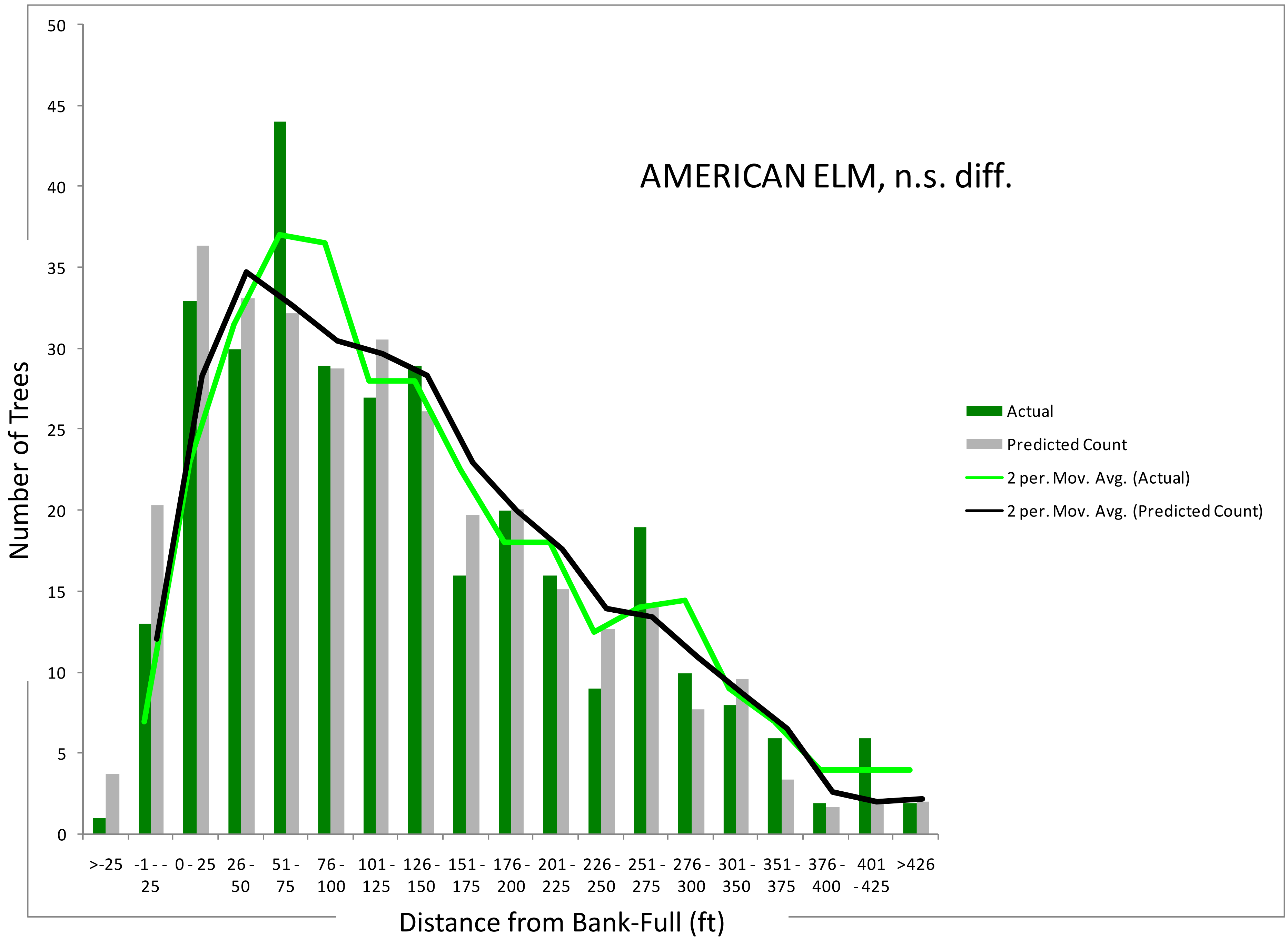
SILVER MAPLE, diff. sig. at p<.01
Number of Trees
18
16
14
12
10
8
6
4
2
0
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)


SUGAR MAPLE, diff. sig. at p<.001
Number of Trees
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)
0
20
40
60
80
100
120
>-25
-1 - -25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426


SYCAMORE, diff. sig. at p<.001
Number of Trees
30
25
20
15
10
5
0
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)


BASSWOOD, n.s. diff.
Number of Trees
Distance from Bank-Full (ft)
0
2
4
6
8
10
12
14
16
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
376 - 400
401 - 425
>426
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)


WHITE ASH, n.s. diff.
Number of Trees
0
2
4
6
8
10
12
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)


AMERICAN ELM, n.s. diff.
Number of Trees
50
45
40
35
30
25
20
15
10
5
0
>-25
-1 - - 25
0 - 25
26 - 50
51 - 75
76 - 100
101 - 125
126 - 150
151 - 175
176 - 200
201 - 225
226 - 250
251 - 275
276 - 300
301 - 350
351 - 375
376 - 400
401 - 425
>426
Distance from Bank-Full (ft)
Actual
Predicted Count
2 per. Mov. Avg. (Actual)
2 per. Mov. Avg. (Predicted Count)