Floodplain Forests of Columbia and Dutchess Counties, NY:
Distribution, Biodiversity, Classification, and Conservation

by
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Hawthorne Valley Farmscape Ecology Program
in cooperation with
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Contents

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Executive Summary

Floodplain forests in Dutchess and Columbia counties in New York's Hudson Valley are a rare habitat, which currently covers only 1/3 of the suitable soils along bottomlands of larger streams and some of their (2^{nd} and 3^{rd} order) tributaries in both counties. Ancient floodplain forests, those which have likely never been completely cleared for agriculture (although they may have seen a variety of human activities, including selective logging and garbage dumping), are even rarer. Less than half of the currently forested floodplain areas in Columbia County and less than a third of those in Dutchess County represent ancient floodplain forest. Furthermore, most floodplain forests, and especially the remnants of ancient floodplain forests, occur in small, isolated patches.

Nevertheless, during a two-year study of 31 floodplain forest sites in both counties, we documented a large diversity of plants and animals in these habitats. We recorded 442 species of vascular plants (including 47 regionally rare or uncommon species) and 25 species of mammals (including a land owner's report of the rare Indiana Bat) , 46 species of birds, 4 species of reptiles (including the rare Box and Wood Turtles) and 8 species of amphibians, more than 20 species of butterflies (including the rare Hackberry Emperor and American Snout, and the uncommon Question Mark and Spicebush Swallowtail), and 45 species of dragon- and damselflies (more than 10 of these were new county records, including Brook Snaketail, Spine-Crowned Clubtail, Arrow Clubtail, and Blue-tipped Dancer, all species of greatest conservation need), 59 species of native bees (mostly new county records), and 85 species of ground beetles (35 of which are considered rare or uncommon in our region).

For many of these species, floodplain forests are not the only habitat where they occur. However, we found more than 50 plant species which, in our experience, occur almost exclusively or mostly along streams, at least in Dutchess and Columbia counties. More than half of the documented dragon- and butterfly species were classified as stream or river species, whose aquatic larvae develop in running water. Half of the native bees recorded in the floodplains were not found in adjacent farm fields. More than half of the ground beetle species were classified as associated with water. For other species (many birds and mammals), forested stream corridors provide migration routes and resource-rich areas where they come to feed. Floodplain forests also supply high quality organic detritus to the stream where it creates shelter and serves as the base of the food web for stream organisms. Forested river banks help to minimize soil erosion and filter surface runoff before it reaches the stream, thereby maintaining stream water quality. Floodplain forests might also play a role in diffusing the down-stream intensity of flooding.

The floodplain forests in our study grouped into 5 forest types according to their dominant tree species: 'Sugar Maple Dominated Floodplain Forests' were ancient forests on relatively stable terraces where they might get flooded on average less than once a year. 'Elm – Sugar Maple – Bitternut Floodplain Forests' and 'Elm – Ash – Black Cherry Floodplain Forests' were located lower in the floodplain where, on average, they may receive at least one flood each year, which might last for several days. The latter type occurred in locations where stream activity frequently reshaped the channel. It may represent an earlier successional stage of the former type, which was found in somewhat more stable locations. The Elm – Sugar Maple – Bitternut forests might in turn, over time and with increasing distance from the creek and decreasing disturbance, succeed into a Sugar Maple – dominated forest. 'Black Locust – Sycamore – Cottonwood Floodplain Forests' were recent forests in the most dynamic locations within the floodplain, where they colonized mineral soil that had been deposited in major events of creek bed re-working. 'Green Ash – Silver Maple Floodplain Forests' largely occupied the relatively quiet backwater parts of the floodplain and, barring major re-working of the creek bed, seemed to be quite stable, largely self-perpetuating communities. Each of these forest types had a different set of herbaceous indicator species and somewhat different physical characteristics. Within each of the five forest types, we distinguished seven micro-habitats based on their herbaceous plant indicator species, density of herb cover, elevation within the floodplain, distance from creek, soil texture, and canopy cover. Most of these micro-habitats occurred across all forest types, but differed in their frequency among forest types.

Ancient floodplain forests had a significantly higher diversity of native herbaceous plants than recently reforested floodplains. They also had significantly lower densities of invasive shrubs. We suspect that the lower native herb diversity in the recent floodplain forests resulted from a combination of lack of colonization, competition from invasive shrubs, and, possibly, the impact of deer browsing on vulnerable, newly colonizing plant populations.

We conclude that ancient floodplain forest remnants are ecologically unique and potentially irreplaceable. They deserve high priority for conservation, especially in the few areas where large ancient floodplain forests remain. Nobody knows where the natural succession of recent floodplain forests will lead, but the re-colonization of their native herb communities might be actively promoted by removal of dense invasive shrubs and the introduction of seeds or enrichment planting, especially if deer browsing can be limited.

Introduction

Riparian forests provide important ecological services and can be biological hotspots for species diversity (Naiman et al. 2005, Burton 2006). Three decades ago, it has been estimated that 70% of the natural riparian plant communities in the United States have been destroyed (Brinson et al. 1981).

In 2007/8, the Farmscape Ecology Program (FEP) conducted a study of Columbia County (New York) floodplain forests (Knab-Vispo & Vispo 2009). That study had been designed to map the original and remaining extent of non-tidal floodplain forests in Columbia County, and to document the plants and animals that occur in good-quality examples of this habitat. The study sites for the 2008 field inventories had been selected to largely represent "ancient" floodplain forests. We defined as ancient those forests that had closed and mature forest cover on the earliest available aerial photographs (for Columbia County these were from the 1940s) and likely have been in continuous forest cover (although not necessarily without selective logging and other human or natural disturbance short of complete clearing) for at least 80 -100 years (Flinn & Vellend 2005). This report describes the results from a 2009 follow-up study of the non-tidal floodplain forests (ancient and recently reforested) in Dutchess County (earliest aerial photos from the 1930s) and additional, recently reforested floodplain forest sites in Columbia County.

The goals of the 2009 study were:

(1) To map the original, current, and ancient floodplain forests of Dutchess County, to compare the extent of remaining floodplain forests (both ancient and recently reforested) between Columbia and Dutchess counties, and to highlight areas of large remaining floodplain forests and important riparian corridors in both counties.

(2) To expand the knowledge of the plants in floodplain forests in our region by updating the floristic information derived from the 2008 study of ancient Columbia County floodplain forests with the information from Dutchess County and recently reforested Columbia County floodplain forests.

(3) To update the systematic faunistic observations made during the 2008 study of ancient Columbia County floodplain forests with the more incidental faunistic data collected during 2009 in the study sites in Dutchess County and the recently reforested floodplains of Columbia County.

(4) To explore the classification of ancient and recently reforested floodplain forest types for both counties, and to compare the resulting classification with the four forest types proposed in 2009 for ancient floodplain forests in Columbia County.

(5) To continue the exploration of patterns between species diversity and disturbance begun in the 2009 report, and especially to explore the differences between ancient and recently reforested floodplain forests.

Methodology

Mapping of Floodplain Forests in Columbia and Dutchess Counties

The Columbia County floodplain forests along the main creeks had been mapped remotely by FEP in 2007. The preliminary map that had served as the basis of our field studies was refined and completed in 2010. We used 2004 digital aerial photos to delineate the extent of current floodplain forests and then identified those currently forested floodplain areas that also had forest cover on the 1940s aerial photos. The 1940s aerial photos had to be scanned from prints on file at the Columbia County Soil & Water District office and then geo-referenced to create a digital layer. The floodplain (=alluvial) soils were derived from the Columbia County Soil Survey (Case et al. 1989) and included all areas classified as Limerick (Ln) or Linlithgo (Lo) silt loam, Occum (Om) loam, Carlisle muck (Cc), as well as Fluvaquents-Udifluvents complex (Fn). For Columbia County, we did not systematically map 1940s floodplain forests that were not also forested in 2004.

The Dutchess County floodplain forests were mapped remotely by Hudsonia Ltd. in 2009. Again, the extent of floodplain soils was derived from the Dutchess County Soil Survey (Faber et al. 2001) and included all areas classified as Linlithgo (Ln), Pawling (Pg), or Wayland (Wy) silt loam, Wappinger loam (We), as well as Fluvaquents-Udifluvents complex (Ff). Within the areas of floodplain soil, the areas appearing as forested on the digital 1930's and 2004 aerial photos were delineated.

In both mapping projects, we attempted to exclude swamp forests located on floodplain soils. Alluvial swamp forests are subject to a high water table year-round, although they may be located in a floodplain and also receive occasional flooding from the stream. Their plant community is determined by the almost continuously saturated soil and is more similar to that of non-alluvial swamps than to that of true floodplain forests which are subject to, at the most, a few floods each year and otherwise have non-saturated soil. As a consequence, floodplain forests that occurred within a mosaic of alluvial upland and swamp forest were mapped as isolated floodplain forest patches. Sometimes, the distinction between swamp and floodplain forest was not obvious from the aerial photos, and we might have mapped some floodplain forests that upon field inspection would qualify as swamp forest and, vice versa, might have failed to map some floodplain forests that looked too swampy on the aerial photos.

Field Methods

Site Selection

The floristic data presented here are based on observations at 31 floodplain forest sites in Columbia and Dutchess counties (Fig. 1). They represent:

(1) the 15 Columbia County sites, originally classified as ancient[1] and studied in 2008 (five each in the Kinderhook, Claverack, and Roeliff-Jansen Kill watersheds; Knab-Vispo & Vispo 2009);

(2) five recently reforested Columbia County sites (four of which were adjacent or in close vicinity to ancient forests studied in 2008) representing all three watersheds;

(3) eleven Dutchess County sites: We attempted to get permission for access to 5 ancient and 5 recently reforested floodplain sites within the Hudson River watershed, but were able to get access to only one floodplain forest site that qualified as ancient, seven that were recently reforested, and three that had partial forest cover on the 1930s aerial photos, which we termed "partly ancient"; seven of these sites were in the watershed of the Wappinger Creek, which is the longest creek with the largest watershed in Dutchess County, three sites were in the second-largest Fishkill watershed, and one site was located on Saw Kill, which is one of the smaller creeks draining directly into the Hudson.

Physical Description of the Floodplain Forest Study Sites

In order to characterize the physical environment within the floodplain forests, we established transects perpendicular to the creek and documented the changes in topography as we moved in a straight line from the creek's edge to the end of the floodplain. These topographic cross-sections enabled us to pinpoint the location of our smaller study plots in terms of distance from the stream and their elevation within the floodplain.

At each study site in Columbia County, we established three terrestrial transects located perpendicular to the creek from the water to the upland edge of the floodplain forest. In a few cases of wide but homogeneous floodplains, we limited transects to 300 feet in length. 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

[1] We have since re-interpreted this original classification and now consider one of the 15 sites as recently reforested and four as only partly ancient.

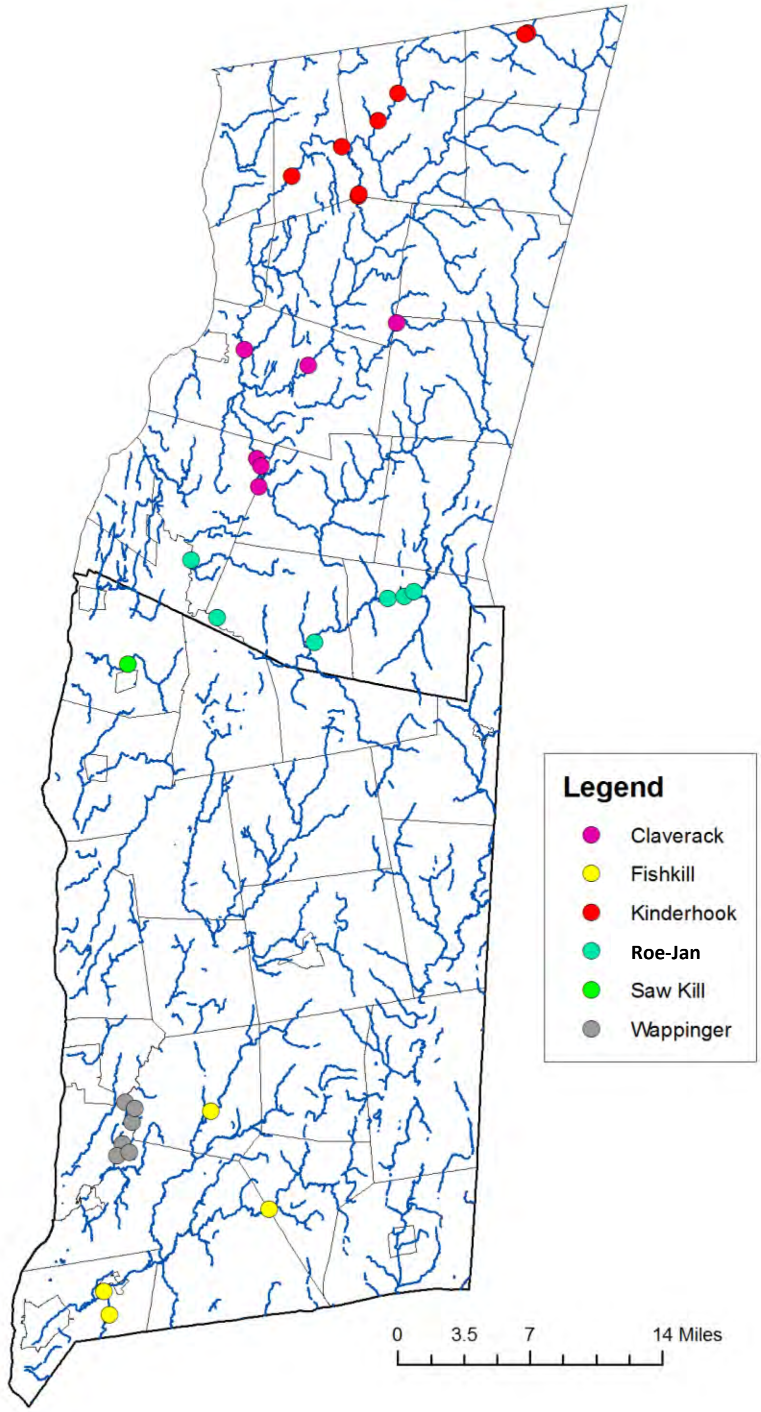

Figure 1: Floodplain Forest Study Sites in Columbia and Dutchess Counties

cases, transects even crossed each other at a certain distance from the creek bank. At each Dutchess County site, we established a single such transect. Along all of the 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 transposed all the height measurements into elevations above/below the bankfull stage.

Along each transect, we marked the obvious changes in topography, soil texture (see paragraph below for definition of soil texture classes used in this study) and moisture, as well as understory vegetation. We then described a number of physical and structural variables at the midpoint of each seemingly homogeneous section along the transect. If the homogeneous sections extended beyond approximately 50 feet in length, we placed additional sampling points spaced 20 to 50 feet, depending on the total length of the homogeneous section.

At each of the 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 sqft frame held overhead at arm's length, second estimate taken after turning 180^{o})
- height of tallest herbaceous plant by mid summer
- % cover[2] (in mid summer) of herbaceous plants, moss, leaf litter, fine woody debris, and bare ground within a 4 sqft 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)

Taken together, the 2008 and 2009 studies resulted in 71 transects with 848 sampling plots.

[2] % cover of the entire herb layer was estimated in the following classes: 0, <1, 1-<10, 10-<25, 25-<50, 50-<75, 75-100

Plant Inventories

Tree Inventories: Along the 71 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 were also noted and, when possible, identified.

Small Woody Plant Inventories: At each of the 848 sampling points along the transects, we recorded the woody plants (dbh<2") in 60 sqft plots placed at random to one side of the transect. For each species present with less 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: <25%, 25-<50%, 50-<75%, 75-100%. 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 848 sampling points along the transects, we recorded % cover[3] (in mid summer) of each herbaceous plant species (plus ground-covering woody species, such as Virginia Creeper and Poison Ivy) within a 4 sqft plot randomly placed three feet from one side or the other of the measuring tape (to avoid sampling of areas that had been impacted when the transect was originally established).

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.

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 and Principal Component Analysis (CCA and PCA) available in PC-ORD (McCune and Mefford 2006). Aaron Ellison of Harvard forest provided important input on the use of these techniques. Sample-based rarefaction was done using the PAST data analysis program (Hammer et al. 2001). STATISTICA was used for regression models.

[3] % cover for each herbaceous species was estimated in the following classes: 0, <1, 1-<10, 10-<25, 25-<50, 50-<75, 75-<100

Results

Distribution of Floodplain Forests in Columbia and Dutchess Counties

In Columbia County, non-tidal floodplain forests occur along the three largest streams (Kinderhook, Claverack, and Roeliff-Jansen Kill), as well as along some of their 3rd and even 2nd order tributaries (Fig. 2). Floodplain soils (green areas in Fig. 2) cover approximately 25,000 acres in Columbia County (Table 1), and this number serves as a proxy for the extent of original floodplain and alluvial swamp forest in the county. Floodplain forest covered 8,700 acres in 2004 and of this area, 4,000 acres (46% of the current floodplain forest area) were also forested in the 1940s and so qualify as ancient floodplain forest (red areas in Fig. 2).

In Dutchess County, floodplain forests occur mostly along the Wappinger and Fishkill Creeks and their tributaries, as well as in smaller areas along many little creeks draining directly into the Hudson and within the watershed of Tenmile River draining east into the Housatonic River (Fig. 3). Floodplain soils cover an area of approximately 26,000 acres in Dutchess County (green areas in Fig. 3). In 1936, there were less than 3,000 acres of floodplain forest in Dutchess County. Since then, floodplain forest has reestablished itself in many places and currently covers 8,600 acres (Table 1). Approximately 400 acres of floodplain forest were lost between 1936 and 2004. As a consequence, approximately 2,600 acres (less than a third of the current floodplain forest area) qualify as ancient floodplain forest in Dutchess County (red areas in Fig. 3), while 6,000 acres (more than 2/3 of the current floodplain forest area) have been recently reforested (yellow areas in Fig. 3).

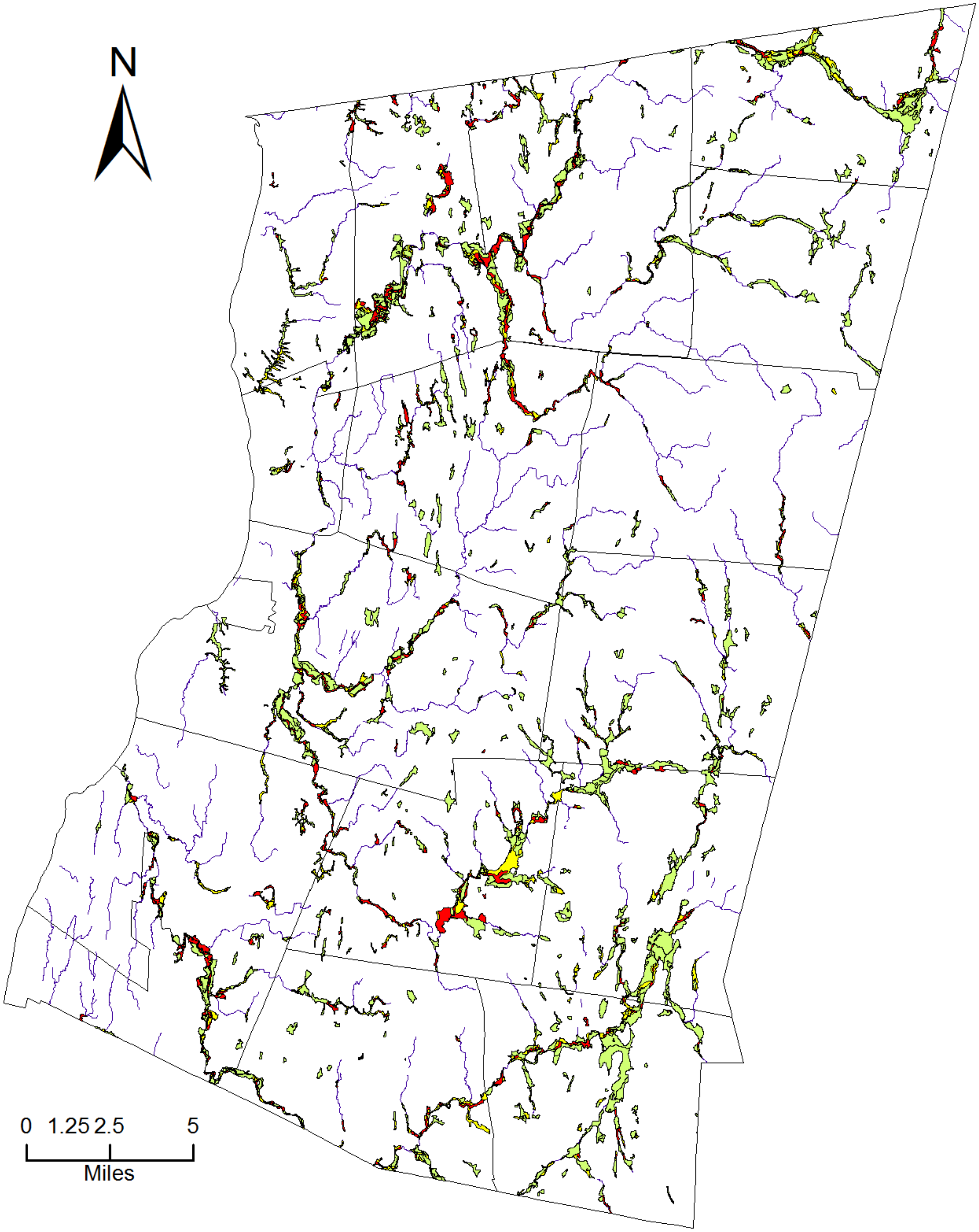

Figure 2: Floodplain soils (green), ancient (red), and recently reforested (yellow) floodplain forest areas in Columbia County

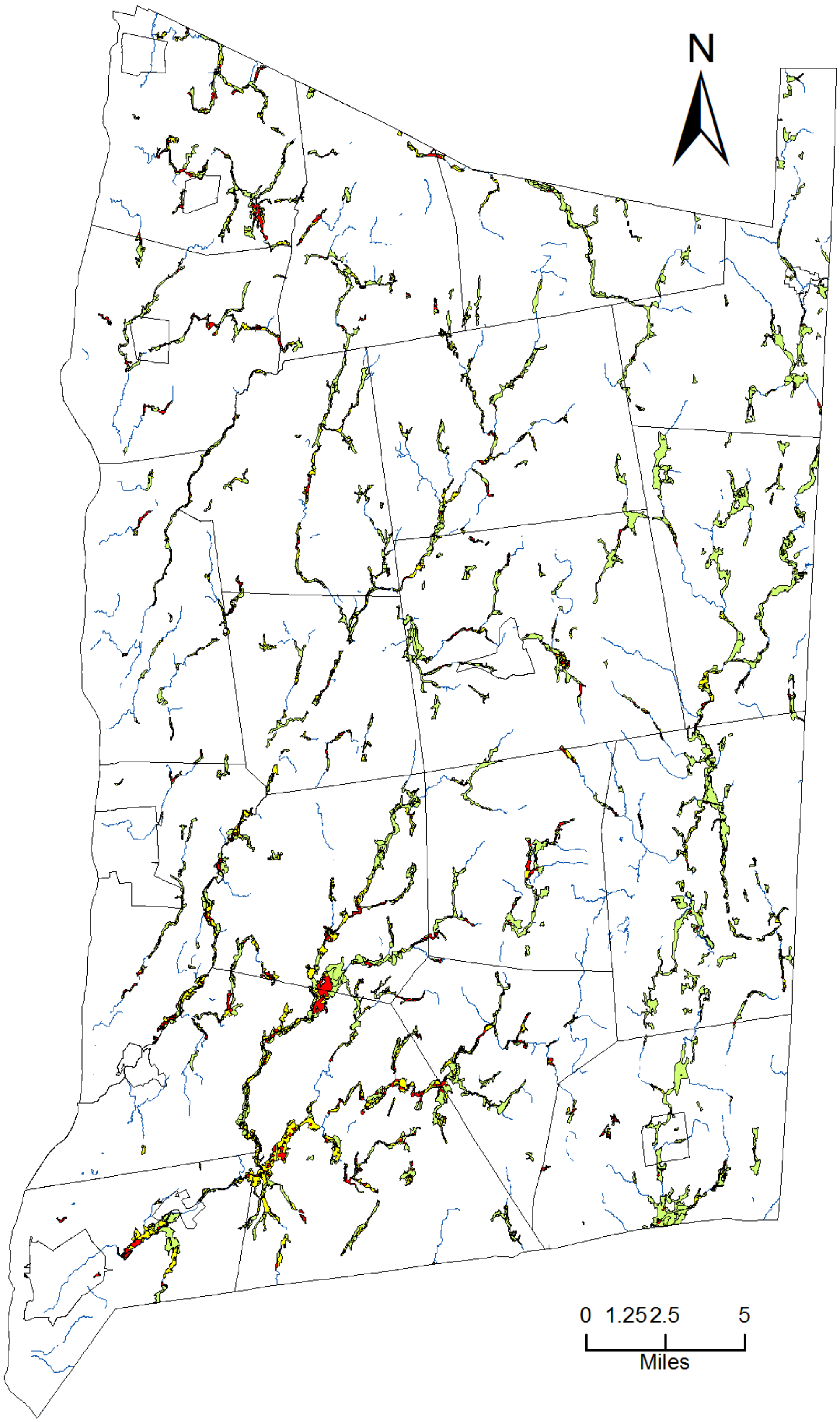

Figure 3: Floodplain soils (green), ancient (red), and recently reforested (yellow) floodplain forest areas in Dutchess County

Table 1: Comparison of the extent of floodplain forests in Columbia and Dutchess counties

	Columbia County (412,000 acres total)	Dutchess County (519,490 acres total)
Floodplain soil (= original non-tidal floodplain and alluvial swamp forest)	24,773 acres (6% of County)	25,998 acres (5% of County)
Current floodplain forest (forested in 2004)	8,700 acres (= 35% of floodplain soil)	8,600 acres (=33% of floodplain soil)
Ancient floodplain forest (forested in 2004 and 1936/40s)	4,000 acres (=16% of floodplain soil) (= 46% of current floodplain forest)	2,600 acres (=10% of floodplain soil) (= 30% of current floodplain forest)

According to the numbers presented in Table 1, Columbia and Dutchess Counties have similar areas of floodplain soil. For the purposes of our study, these areas of floodplain soil are our best estimate for the potential extent of floodplain forest. However, this proxy is not perfect, because the natural vegetation on some floodplains is alluvial swamp, rather than floodplain forest (see p. 2). For example, in Columbia County, much of the currently forested areas on floodplain soil in the New Lebanon and Harlem Valley have not been mapped as floodplain forest because they carried the signature of swamp forests. This pattern was also true for the Harlem Valley in Dutchess County, where large wetland areas along the East Branch Croton River, Swamp River, and other tributaries of Ten Mile River were not mapped as floodplain forest. In addition, the floodplains of many smaller creeks in Dutchess County carried the signature of alluvial swamps on the aerial photos, a pattern that was partially verified in the field during our search for potential study sites.

Based on our analyses of the 2004 aerial photos, Dutchess and Columbia counties have currently almost identical areas of floodplain forest (8,600 and 8,700 acres, respectively), covering approx. 1/3 of the floodplain soils in both counties. However, the amount of ancient floodplain forest that remains in each of the counties is quite different. In Columbia County, almost half of the current floodplain forest area (4,000 acres) is composed of ancient forest, while ancient forest covers only 1/3 of the current floodplain forest area (2,600 acres) in Dutchess County (Table 1). Furthermore, there is a marked difference

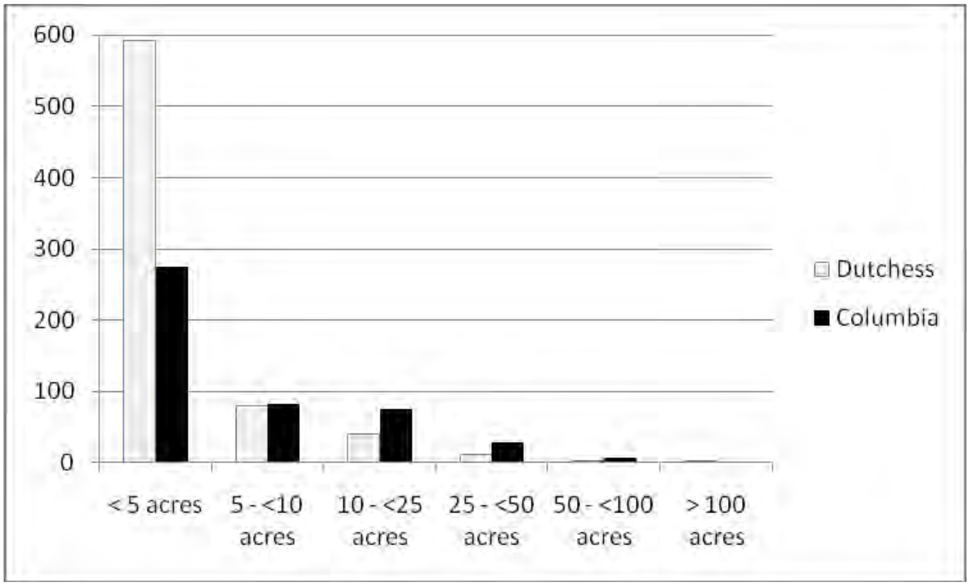

Figure 4: Comparison of the size distribution of remaining ancient floodplain forest patches in Columbia and Dutchess counties

between the two counties in the size distribution of the remaining ancient floodplain forest patches (Figure 4).

In Dutchess County, 82% of the remaining ancient floodplain forest patches were smaller than 5 acres (average patch size 3.6 acres) and only 7% of the remaining patches were at least 10 acres. In contrast, only 59% of the remaining patches of ancient floodplain forest in Columbia County were smaller than 5 acres, the average patch size was 8.5 acres, and 24% of the patches were at least 10 acres.

The largest and most contiguous ancient floodplain forest area in Columbia County extends along the main stem of Kinderhook Creek between Malden Bridge and Valatie and its southern tributary, the Kline Kill, north of Ghent. Large, isolated patches of ancient floodplain forest also occur along Kinderhook Creek south of Kinderhook, and along Valatie Creek north and south of Kinderhook Lake. Another relatively contiguous corridor of ancient floodplain forest extends along Claverack Creek and its southern tributary, the Taghkanic, in the Town of Claverack and the northeast corner of Livingston. Several isolated but large patches are located upriver along Taghkanic Creek around New Forge in the Town of Taghkanic. On Roeliff-Jansen Kill, the largest ancient floodplain forest is found along the town line between Clermont and Livingston south of Blue Stores. Upriver, the ancient floodplain forest becomes more fragmented and the riparian corridor of the Roeliff-Jansen Kill consists of a mosaic of alternating small patches of ancient and recently reforested floodplain forest in the Towns of Gallatin and Ancram. Many of the forested areas along the Roeliff-Jansen Kill and its tributaries in the south-eastern part of the County were not mapped as floodplain forest because, judging from their signature on the aerial photos, they appeared to be swamp forests.

Within Dutchess County, the most extensive floodplain forest areas are found along Fishkill Creek and its tributaries. The largest area of ancient floodplain forest in the County is located along Jackson Creek, in the Town of La Grange, and just downstream, along Sprout Creek in East Fishkill. Along the Fishkill mainstem, the largest floodplain forests are located in the Towns of East Fishkill and Fishkill both north and south of I-84. The floodplain areas of Wappinger Creek and its tributaries tend to be narrower than those of the Fishkill, and most remaining floodplain forests are small and disconnected, but the sheer length of Wappinger Creek makes it a potential ecological corridor crossing much of the county, and every bit of ancient or recently reforested floodplain forest currently present in this corridor might be particularly valuable because of its role in facilitating the connectedness of a large area. Floodplain forest areas are also present along some of the smaller creeks draining directly into the Hudson. Noteworthy are floodplain forests along Saw Kill and its tributaries in Red Hook and along Landsman Kill east of Rhinebeck.

The largest and most connected ancient floodplain forest remnants deserve priority for the conservation of their unique flora and fauna (see details below). If at all possible, the removal of any of the remaining ancient floodplain forests should be avoided. Overall, we expect their conservation value to increase with increasing amounts of recently reforested areas that serve as connectors between ancient forest sites. Although this report highlights the importance and uniqueness of ancient floodplain forests, it is important to note that every small patch of floodplain that is currently forested (independent of its age and species composition) can play an important role in supporting the in-stream food web and microhabitats, limiting surface runoff into the stream and providing corridors for some wildlife. This is especially important in intensively farmed areas, such as the Harlem Valley, where even small and disconnected floodplain forest patches can contribute to limiting agricultural runoff into the streams. The fact that isolated floodplain forest patches in the Harlem Valley are often adjacent to alluvial swamps improves their value for certain wildlife and likely enhances their role in runoff control. Small and isolated patches of floodplain forest in densely populated areas can contribute to filter storm water runoff from impervious surfaces before it enters the streams, but also serve as depositional areas for silt-laden streams during high-water events, thereby contributing to a faster clearing of the stream water. Every remnant of floodplain forest will contribute during high water events to reduce the amount of downstream flooding by allowing the floodwater to spread over a larger area and to slow down before returning into the streambed. Floodplain forests also serve as areas where debris gets deposited by high water, thereby reducing the danger of downstream damming of the stream-bed with flood debris.

Finally, it shall be re-emphasized that only 1/3 of the floodplain soils in Dutchess and Columbia County are currently covered by floodplain forest. Even if one takes into account that alluvial swamps cover some of these soils (probably more so in Dutchess than in Columbia County), most of the remaining non-forested floodplain areas are in agriculture. We encourage any measure that limits soil erosion from these agricultural areas. Conversion of tilled fields in the floodplain into well-managed permanent pasture/hayfields might go a long way towards keeping the soil in place and are probably the most sustainable agricultural use of floodplains. Corn fields, even if they are no-till, likely leave the soil much more prone to erosion during a flooding event than a well-established, perennial sward of grasses and legumes.

Plants of Floodplain Forests in Columbia and Dutchess Counties

During the 2009 field season, we documented an additional 80 plant species in floodplain forests of Columbia and Dutchess counties, bringing the total number of plant species found in floodplain forests in both counties to 442. Most of the additional species were relatively common native plants or wide-spread weeds not specifically associated with floodplain habitat. Two native herbs associated with calcareous soils and found uncommonly in Columbia County, the Great Lobelia and Horse-gentian, occurred in two Dutchess County floodplain sites. Great Lobelia is a plant of calcareous wet meadows and seeps and can't be considered a floodplain specialist. Horse-gentian tends to be associated with calcareous forests and thickets (McVaugh 1958). Blackhaw and Wild Yam are native species with southern distributions that may not reach Columbia County and were only found in floodplain forests in Dutchess County. Two hawthorn species (cf. *C. punctata* and *C. coccinea*) that we had never noticed before, were common at some recently reforested Columbia County sites, but we don't yet know if these species have a particular affinity to floodplains. Chinese Tree Lilac occurred at two recently reforested floodplain sites in Columbia County, and based on a personal communication with invasive plant specialist Troy Weldy (NYNHP), we suspect this escaped ornamental to be a potential floodplain-specific invasive in our region. Toringo Crab, which occurred at one recently reforested floodplain site in Columbia County, is behaving like an invasive species in a variety of habitats in the county. False Bromegrass, a potential invasive just recently reported for the first time from New York State (Daniel & Werier 2010), occurred at two floodplain forest sites in Dutchess County. Additional invasive species observed in floodplain forests during the 2009 field season were Narrow-leaved Bittercress and Autumn Olive in Dutchess County. Both of these species are not considered floodplain-specific invasives.

Autumn Olive is already wide-spread in Columbia County and Narrow-leaved Bittercress seems to be invading from the south and has been found along an old railbed in the southern part of the county. The invasive Japanese Spiraea occurred in one of the recently reforested floodplain sites in Columbia County. Several new sedge species were found during the 2009 study, but these additions are likely due to improved field identification skills and do not necessarily represent ecological or geographic differences.

Appendix 1 is an updated annotated list of the plants found in Columbia and Dutchess County floodplain forests and provides information about their origin (native vs. introduced), invasiveness, and rarity. It also highlights those species closely associated with the floodplain forest habitat. The list indicates how frequently each species was observed across the 31 sites inventoried in 2008 and 2009. The species' frequencies in the 15 sites inventoried in 2008 were also included in this appendix to allow for a quick scanning of the newly found species. The following is a summary description of information that can be gleaned from Appendix 1. Please refer to the appendix for scientific nomenclature (Gleason & Cronquist 1991) corresponding to the common names mentioned in the text.

Three quarters (74%) of the species documented in the 31 floodplain forest sites were plants considered native to our region. Most of the introduced species were herbs, but we also found eleven tree, fourteen shrub and six 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 maintained by the New York Natural Heritage Program (Young 2010). Another 45 species found in the study sites are considered rare or scarce in the Hudson Valley (Kiviat and Stevens 2001, Stevens, pers. com.), in Columbia County (Knab-Vispo pers. obs.) or Dutchess County (Stevens pers. obs.). Below, we highlight those rare and uncommon species that seem to have a strong habitat preference for floodplain forests (Tables 2-5).

Thirty-five invasive species were documented in the floodplain forests. The most frequently encountered invasive plants were Garlic Mustard and Multiflora Rose (present at all study sites), and Dame's Rocket, Japanese Stiltgrass, Reed Canary Grass and Moneywort (present at more than 75% of study sites). More than half of the study sites also had Japanese Barberry, Tartarian (and possibly other species of non-native) Honeysuckle, Oriental Bittersweet, Black Locust, Long-bristled Smartweed, Purple Loosestrife, and Ground Ivy.

We categorized the plant species we found based on the strength of their association with floodplain forests (Tables 2-5). Eighteen native species occurred ***almost exclusively*** along streams, 38 species (including 4 invasives), occurred ***mostly*** along streams, but are also found elsewhere in wetlands and along roadsides, and 26 species were generally ***associated with rich mesic forests***, be they in a floodplain or in upland forest. 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, occasionally flooded secondary channels) and under the canopy gaps created by the dynamics of the stream.

Table 2: Updated list of 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 31 sample sites studied in 2008 and 2009)
[1)] Kiviat and Stevens 2001; [2)] Knab-Vispo, pers. obs.; [3)] Stevens (pers. com.); [4)] Stevens (pers. com.) did not find these species particularly associated with floodplains in other parts of the Hudson Valley, but see discussion in text

Almost exclusively floodplain:			
55%	Silver Maple	*Acer saccharinum*	
52%	Boxelder	*Acer negundo*	
3%	Marsh Pea	*Lathyrus palustris*	rare in Hudson Valley[1)]
Mostly floodplain:			
84%	Sycamore	*Platanus occidentalis*	
84%	Green Ash[4)]	*Fraxinus pensylvanica*	
68%	Cottonwood	*Populus deltoides*	
55%	Slippery Elm[4)]	*Ulmus rubra*	
35%	Butternut[4)]	*Juglans cinerea*	uncommon in Columbia County[2)], NYS exploitably vulnerable
26%	Hackberry	*Celtis occidentalis*	uncommon throughout the Hudson Valley[3)]
16%	Wild Cucumber	*Echinocystis lobata*	
13%	Black Walnut	*Juglans nigra*	
10%	Crack Willow	*Salix fragilis*	
10%	Black Willow	*Salix nigra*	
6%	Bur-cucumber	*Sicyos angulatus*	
6%	Japanese Hop	*Humulus japonicus*	INVASIVE!

Trees, Shrubs, and Vines: American Elm and Bitternut were present in every single floodplain forest site we visited. Almost ubiquitous were Basswood (present at 97% of the sites), Sugar Maple, Green Ash, Sycamore and Wild Black Cherry (present at more than 80% of the sites). Of all the tree species documented, Boxelder and Silver Maple occur in our region ***almost exclusively*** in floodplain forests, while Green Ash, Sycamore, Cottonwood, Slippery Elm, Black Walnut, Black Willow, Crack Willow, as well as Butternut and Hackberry seem to be ***mostly*** associated with floodplain forests. Butternut is an uncommon species in Columbia County and Hackberry is uncommon throughout the Hudson Valley. Red Mulberry is a tree species that is rare or scarce in the Hudson Valley and was documented in one floodplain forest site, 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 and Dutchess counties might show that floodplain forests are only one but not necessarily the main habitat for these species. On the other hand, Weatherbee (1996) describes the habitat affinity of these species from neighboring western Massachusetts to be very similar to what we observed in our study. 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) similarly observed that "southern" species come into Columbia County along the Hudson, but they do not reach into the higher, eastern part of the county.

Black Locust and Norway Maple, which occurred at 55 and 40% of the study sites, were considered amongst the worst invasive species in NYS by the Invasive Plant Council[4]. Tree-of-Heaven and Russian Olive are listed in the Invasive Plant Atlas of New England[5]. Chinese Tree Lilac (*S. pekinensis*) is locally very common and seems to act like an invasive plant in some floodplain forests of the Kinderhook Creek. 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 all 31 study sites, and reached up to 25-50% cover in some of the recently reforested sites (9% on average), while it occurred only at low densities in the ancient floodplain forests (usually well below 10% cover; 3% on average). Other invasive shrubs present in many study sites (68% of the sites) were Japanese Barberry, which never was common, and Tartarian Honeysuckle, which reached more than 50% cover in some recently reforested areas (<10% on average), but rarely reached 10% cover in ancient floodplain forests (1% average). Less frequent were European Buckthorn, Common Privet, Winged Burning Bush, and Autumn Olive. 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 23% of the study sites.

[4] seen in 2008 on the now discontinued web-page (www.nysgextension.org/glhabitat/epacd/pages/plants/invasives.htm)
[5] http://nbii-nin.ciesin.columbia.edu/ipane/icat/catalogOfSpecies.do

The native vine Virginia Creeper was present at all study sites. Poison Ivy and Grape occurred in most sites. The invasive Oriental Bittersweet was found at 60% of the sites, somewhat more frequently in recently reforested areas, but nowhere very dense. The invasive Japanese Hops, which was ***mostly*** found in floodplain forests, occurred in two of our study sites. The native Marshpea, which is rare in the Hudson Valley is found ***exclusively*** in floodplain forests, the more common Wild cucumber and Bur-cucumber were ***mostly*** found in this habitat. 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 native Common Enchanter's Nightshade and the non-native, highly invasive Garlic Mustard. Most sites (at least 90%) also had Clearweed, Jumpseed, Spotted Jewelweed, Common Wood-sorrel, Whitegrass, and Woodnettle. Jack-in-the-Pulpit, Wild Leek and the non-native, invasive Dame's Rocket occurred at 87% of the sites.

Table 3 lists the herbaceous species that seem to occur in Columbia County, Dutchess 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 31 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 3: Updated list of herbaceous plant species that almost exclusively occur in floodplain forests in our region (listed in order of their frequency of occurrence in the 31 sample sites in Columbia and Dutchess County) [1)] Kiviat and Stevens 2001; [2)] Knab-Vispo, pers. obs.; [3)] Stevens, pers.com.; [4)] Young 2008

81%	Ostrich Fern	*Matteuccia struthiopteris*	
65%	False Mermaid Weed	*Floerkea proserpinacoides*	rare in Hudson Valley[1)]
35%	Giant Ragweed	*Ambrosia trifida*	scarce in Hudson Valley[1)]
32%	Green Dragon	*Arisaema dracontium*	rare in Hudson Valley[1)]
32%	Wild Rye	*Elymus virginicus*	
32%	Davis's Sedge	*Carex davisii*	NYS-threatened[4)]
26%	Sedge	*Carex grisea*	
23%	Hairy Wild-rye	*Elymus villosus*	
19%	Canada Brome	*Bromus altissimus*	
19%	American Germander	*Teucrium canadense*	rare in Columbia County[2)] and Dutchess County[3)]
16%	Anise Root	*Osmorhiza longistylis*	uncommon in Columbia County County[2)] and Dutchess County[3)]
10%	Winged Monkeyflower	*Mimulus alata*	NYNHP Watch List[4)]
10%	Hedge-nettle	*Stachys tenuifolia var. hispida*	uncommon in Columbia County[2)]
6%	Sprengel's Sedge	*Carex sprengelii*	potentially rare in Hudson Valley[1)]

Table 4 lists herbaceous species documented at the 31 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. However, Stevens (pers.com.) finds it generally associated with moist soils in semi-shade further south in the Hudson Valley, and it has to be expected to eventually also spread into other habitats in Columbia County.

Table 4: Updated list of herbaceous plant species that mostly occur in floodplain forests in our region (listed in order of their frequency of occurrence in the 31 sample sites) [1] Kiviat and Stevens 2001; [2] Knab-Vispo, pers. obs.; [3] Stevens, pers.obs.; [4] according to Stevens (pers.obs.), this species is generally associated with moist soils in semi-shade further south in the Hudson Valley, see text

94%	Whitegrass	*Leersia virginica*	
90%	Wood-nettle	*Laportea canadensis*	
87%	Dame's Rocket	*Hesperis matronalis*	INVASIVE!
77%	Japanese Stiltgrass[4]	*Microstegium vimineum*	INVASIVE!
65%	Trout Lily	*Erythronium americanum*	
58%	Wild Onion	*Allium canadense*	
48%	Streambank Wild Rye	*Elymus riparius*	
42%	Meadow Lily	*Lilium canadense*	scarce in Hudson Valley[1], NYS exploitably vulnerable
39%	Forest Sunflower	*Helianthus decapetalus*	
39%	Japanese Knotweed	*Polygonum cuspidatum*	INVASIVE!
39%	Narrow-leaved Spring Beauty	*Claytonia virginica*	uncommon in Columbia County[2] and Dutchess County[3], potentially scarce in Hudson Valley[1]
32%	Zig-zag Aster	*Aster prenanthoides*	uncommon in Columbia County[2]
29%	Forest-muhly	*Muhlenbergia sylvatica*	
29%	Gray's Sedge	*Carex grayi*	
26%	Figwort	*Scrophularia marilandica*	rare in Columbia County[2] and Dutchess County[3]
19%	Wild Rye	*Elymus canadensis*	
19%	Lopseed	*Phryma leptostachya*	rare in Hudson Valley[1]
19%	Hairy-fruited Sedge	*Carex trichocarpa*	occurrence in Hudson Valley uncertain[1]
13%	Cardinal Flower	*Lobelia cardinalis*	rare in Columbia County[2], NYS exploitably vulnerable
10%	Green-headed Coneflower	*Rudbeckia laciniata*	scarce in Hudson Valley[1]
10%	Yellow Water-cress	*Rorippa palustris var. fernaldiana*	
10%	Common Sneezeweed	*Helenium autumnale*	
6%	Twisted Sedge	*Carex torta*	
6%	Eastern Bluebell	*Mertensia virginica*	rare in Columbia County[2] and Dutchess County[3], NYS exploitably vulnerable
3%	False Pimpernel	*Lindernia dubia var. dubia*	
3%	Nodding Trillium	*Trillium cernuum*	rare in Columbia County[2] and Dutchess County[3], NYS exploitably vulnerable

Table 5: Updated list of herbaceous plant species associated with rich mesic forests in our region (listed in order of their frequency of occurrence in the 31 floodplain forest sample sites)
[1)] Kiviat and Stevens 2001; [2)] Knab-Vispo, pers. obs.; [3)]Stevens, pers. comm.

87%	Jack-in-the-pulpit	*Arisaema triphyllum*	
87%	Wild Leek	*Allium tricoccum*	
84%	Honewort	*Cryptotaenia canadensis*	
77%	Bloodroot	*Sanguinaria canadensis*	NYS exploitably vulnerable
71%	Zig-zag Goldenrod	*Solidago flexicaulis*	
71%	Wild Geranium	*Geranium maculatum*	
55%	Blue Cohosh	*Caulophyllum thalictroides*	scarce in Hudson Valley[1)]
55%	Bottlebrush Grass	*Elymus hystrix*	
48%	Wild Ginger	*Asarum canadense*	uncommon in Columbia County[2)]
45%	Pubescent Sedge	*Carex hirtifolia*	
39%	Dutchman's Breeches	*Dicentra cucullaria*	scarce in Hudson Valley[1)]
35%	Cut-leaved Toothwort	*Dentaria laciniata*	
32%	Virginia Waterleaf	*Hydrophyllum virginianum*	
32%	Eastern Woodland Sedge	*Carex blanda*	
29%	Early Meadow Rue	*Thalictrum dioicum*	
26%	Toothwort	*Dentaria diphylla*	
26%	Sweet Cicely	*Osmorhiza claytonii*	uncommon in Columbia County[2)]
19%	Small-flowered Crowfoot	*Ranunculus abortivus*	
16%	Herb-Robert	*Geranium robertianum*	
13%	Mayapple	*Podophyllum peltatum*	uncommon in Hudson Valley[3)]
13%	Clustered Snakeroot	*Sanicula canadensis*	
10%	Horse-balm	*Collinsonia canadensis*	
6%	White Baneberry	*Actaea alba*	NYS exploitably vulnerable
6%	Foam Flower	*Tiarella cordifolia*	
6%	Large-flowered Bellwort	*Uvularia grandiflora*	potentially scarce in Hudson Valley[1)]
3%	Black Cohosh	*Cimifuga racemosa*	rare in Columbia County[2)] and Dutchess County[3)]
3%	Red Baneberry	*Actaea rubra*	scarce in Hudson Valley[1)], NYS exploitably vulnerable
3%	Maidenhair Fern	*Adiantum pedatum*	uncommon in Columbia County[2)], NYS exploitably vulnerable
3%	Rue Anemone	*Anemonella thalictroides*	
3%	Maple-leaved Waterleaf	*Hydrophyllum canadense*	rare in Columbia County[2)]
3%	Barren Strawberry	*Waldsteinia fragarioides*	

Finally, Table 5 lists those native herbaceous plants documented from the 31 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.).

For a number of rare or uncommon plants associated with rich mesic forest, certain 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 of Floodplain Forests in Columbia and Dutchess County

Most of the information on the occurrence of animals in floodplain forests had been collected during the first year of study and was reported in detail in Knab-Vispo & Vispo (2009). Here, we summarize those earlier findings and add incidental observations from the second year.

Mammals: In the systematic mammal surveys of 15 Columbia County study sites in 2008, we had reported the following twelve species: White-tailed Deer (100% of sites), Raccoon (80%), Grey, Red or Flying Squirrel (73%), Eastern Chipmunk (67%), Muskrat (60%), Mink and Beaver (47%), Star-nosed (?) Mole (27%), Opossum and Red or Grey Fox (13%), as well as Striped Skunk and House Cat (7%). In addition, we had found tracks and sign of River Otter and Cottontail at several sites during winter tracking, live-trapped Short-tailed Shrew and Deer Mouse at some of the sites, caught a Masked Shrew in an insect pit at one site, and observed a Woodland Jumping Mouse. Anabat recordings of bat sonar documented Little Brown Bat, Northern Myotis, and probably Big Brown Bat as common, Eastern Red Bat and Eastern Small-footed Bat as occasional, and Eastern Pipestrelle as common at only one site. These bats were hunting in the floodplain forest or over the stream, but we did not gather information about bat roosts. We did not observe any additional mammal species during the 2009 season, but we were informed by the owner of one of the Dutchess County study sites that a radio-collared Indiana Bat had been tracked to his property and found to spend some days under the bark of a tree in the floodplain forest (Suter pers. com).

None of these mammals is known to exclusively inhabit floodplain forests, but several species find them obviously quite suitable. We were surprised at the high frequency of Muskrat in the floodplain forest areas, as this species has declined significantly at least during the last 20 years in many habitats. There is the hope that Muskrat populations in floodplain forests are somewhat protected from whatever factor (possibly the spread of Common Reed and subsequent decline of Cattails) is causing their decline elsewhere. Deer were not only omnipresent, there were also signs of deer browsing at every study site and certain plant species were clearly preferred over others (Knab-Vispo & Vispo 2009). As we discuss below, deer likely have a significant impact on the vegetation of floodplain forests.

Birds: During 2008, forty-six bird species were documented during the breeding season in the floodplain forests of Columbia County (Knab-Vispo & Vispo 2009). These birds belonged to three ecological groups: forest species, edge or openland species, and those that occur always near water. Again, probably no bird species relies exclusively on floodplain forests, but many species use these habitats for breeding and food. While it is obvious that one would observe the water-dependent birds mostly near the water and one could expect edge/openland species to be more common along the shoreline than in the interior of the floodplain forest, it was interesting that even amongst the forest species, some were observed more commonly within 50 feet of the stream than others. Pileated Woodpecker, Warbling Vireo, Blue-headed Vireo, and Downy Woodpecker tended to occur near the stream, while Red-bellied Woodpecker, Wood Thrush, and Ovenbird seemed to favor areas farther from the water. During the 2009 season, we also observed Chestnut-sided Warbler, Turkey, Red Tailed and Broad-winged Hawks in floodplain forests.

Amphibians and Reptiles: During 2008, we documented the following 12 herp species (in order of decreasing frequency) in floodplain forests (Knab-Vispo & Vispo 2009). American Toad (67% of sites), Green Frog (53%), Two-lined Salamander (47%), Red-backed Salamander (33%), Wood Frog (27%), Pickerel Frog and Wood Turtle (20%), Garter Snake (13%), and Northern Leopard Frog, Spring Peeper, Ambystoma (probably Spotted) Salamander, and Snapping Turtle (7%). Most of these species are not particularly dependent on floodplain forest and some of them are much more common in other habitats. The great exception is the uncommon Wood Turtle, which is classified as a species of special concern in New York State. Its core habitats are in and near flowing water, preferably shallow clear streams with heavily vegetated banks. While our observations of this species in 2008 were based on shells and tracks only, during 2009, we found two live individuals at a recently reforested floodplain forest site along the Wappinger Creek in Dutchess County. We also found tracks of a Box Turtle in a recently reforested site along Clove Creek in the very southern part of Dutchess County.

Butterflies: During 2008, we documented more than 20 species of butterflies in floodplain forests (Knab-Vispo & Vispo 2009), but in general, butterflies were neither especially abundant nor diverse in floodplain forests. However, six of the observed butterfly species had a tight association with floodplain forests. The most common, Eastern Comma, was nearly ubiquitous in the floodplain forests. Its caterpillars reportedly feed on Elm and Nettles, two plants found in most floodplain forest sites. Red Admiral, whose caterpillars feed mostly on Nettles, was also quite common, although the abundance of this migratory species varied radically from 2007 to 2008. The Hackberry Emperor (seen at two floodplain forest sites) and American Snout (seen once) are two rare butterfly species whose caterpillars feed on Hackberry, which in turn is an uncommon plant in Columbia and Dutchess counties and occurs mostly in floodplain forests. Question Mark and Spicebush Swallowtail are not considered as rare as the last two, but are seen only occasionally in Columbia County. They were found at one floodplain forest site each, and their association to floodplains is again through the host plants for their caterpillars, which is Elm for the Question Mark and Spicebush for the Spicebush Swallowtail. During 2009, we did not observe any additional butterfly species, but saw Spicebush Swallowtail at three of the Dutchess County floodplain forest sites.

Dragonflies & Damselflies: During 2008, we observed 44 species of dragon- and damselflies (=odonates) in the 15 floodplain forest sites (Knab-Vispo & Vispo 2009). More than half of these species can be classified as stream or river odonates, whose aquatic larvae develop in running water. Streams and floodplain forests are clearly an important habitat for many odonate species. Three of the species found in Columbia County (Brook Snaketail, Spine-Crowned Clubtail, and Arrow Clubtail) are listed as species of greatest conservation need in New York State (White et al. 2010). Approximately a quarter of the species we found were new records for Columbia County and have been included in the recently published New York Dragonfly and Damselfly Survey (White et al. 2010). Floodplain forests are still a little-studied habitat and, at least in certain species groups, harbor many surprises. During 2009, we documented an additional dragonfly species, the Blue-tipped Dancer, at a floodplain forest site along the Wappinger Creek in Dutchess County. The Blue-tipped Dancer is a species of greatest conservation need and ours was the first record of this species from east of the Hudson River. Although we had attempted to continue the systematic collection of odonate exuvia (larval skins left behind by the emerging adults) along the shores of the floodplain forest study sites in 2009, the wet summer and consequent frequent flooding and high water tables, had resulted in very few additional specimens.

Native Bees: During 2008, Martin Holdrege conducted a study of native bees in floodplain forests and on farms (Holdrege 2009). He sampled bees in bee bowls in five of our Columbia County floodplain forest sites during the time when spring ephemerals were flowering. He collected 59 species of native bees in the floodplain forests, more than half of these species were not found in adjacent farm fields during spring or later in the season (Knab-Vispo & Vispo 2009). Of these, especially the *Andrena* species, who have a very short flight season, might well complete their entire life cycle in the floodplain forest. Other native bee species with a longer flight season occurred in the floodplain forest in spring but were found pollinating agricultural crops on farm fields later in the season. For these economically important species, natural areas rich in spring flowers, such as floodplain forests, provide pollen and nectar resources early in the season.

Ground Beetles: During 2008 we captured and identified 990 specimens and 62 species using a standardized methodology of pit trapping described in our last report (Knab-Vispo & Vispo 2009). That report also outlines aspects of ground beetles distribution across the floodplain. During 2009, we only used hand collecting but collected 341 beetles and an additional 23 species. Seven of the 85 species are introduced. Table 8 lists the species recorded during the two years, together with information on the percent of captures that each species accounted for in each forest type. Comments on abundance and/or conservation status are also provided.

In keeping with the botanical analysis this year, we have separated those captures into species caught in ancient and recent forests. The species recorded at each site are listed in Table 8. Please realize that because our collecting methods varied between years and because the average age of our forests varied between years, any apparent differences between the beetle communities of differently aged forests might be confounded by differences in collecting methods. The ground beetles themselves were classified as dwellers of wetland/river, forests, or disturbed areas based on existing literature on their ecology (Larochelle and Lariviere 2003; Bousquet 2010). Ground beetles are known to have relatively distinct communities associated with different cover types. Certain species, for example, seem to be favored by flooding; others by disturbance (be that natural or human-caused); and still others are rarely found outside of mature forests.

The captures in ancient forests were dominated by beetles associated with the margins of rivers or other wetlands, whereas those of recent forests were about equally divided between beetles with disturbed land affinities and those with wetland affinities (Table 6). Forest beetles were slightly more common in recent than ancient forests. Thirty one beetles species (15 wetland species, 11 disturbed land species, and 5 forest species) were unique to the recent forests; nine species were unique to the ancient forests (7 wetland species, 1 disturbed, and 1 forest species).

Table 6: Habitat affinity of ground beetles captured at ancient and recently reforested floodplain forest sites expressed as percent of the total beetle captures in the forests of each age group.

		Forest Age	
		Ancient N=716	Recent N=612
Ground Beetle Habitat Preference	Disturbed	25.98%	41.66%
	Forest	3.77%	10.78%
	Wetland	70.25%	46.90%

Given that the recently reforested floodplain forests were so-called because they were more recently disturbed (by humans and/or nature), it is not surprising that the beetle communities of such forests might have a larger proportion of disturbance-adapted species. However, it may also be that the afore-mentioned differences in collection technique resulted in these differences in species composition.

Aside from Tiger Beetles (a group that we did not include in this component of our study), there is little information available on the relative rarity of ground beetles in our region. We do not have a detailed knowledge of ground beetle distribution and status in New York, and the information for surrounding areas is patchy. For the most part, knowledge is limited to species lists for select areas. Bousquet (2010 and unpublished) has compiled occurrence lists at the level of state or province for much of the Northeast, including New York State. The only statewide New York list of which we are aware is Howard Notman's list in Leonard (1928). More modern and detailed information exists for the neighboring states of Pennsylvania (Davidson unpublished) and Connecticut (Krinsky and Oliver 2001). Official recognition of conservation status for ground beetles varies widely and seems to be more a product of local knowledge levels than of actual ecological variation. Vermont, for example, has the most detailed listing and, probably not coincidentally, is the home state of Ross Bell, noted northeastern ground beetle specialist. In Table 8, we summarized what information we could find on regional abundances and conservation status. It is important to caution, however, that the attempt to pool regional data, to come up with overall assessments of rarity based on the literature, can be confounded by range boundaries within the region and by researcher-specific collection tendencies and identification issues.

In an effort to see if there were differences in species' rarity status between the communities of beetles in forests of different ages, we used data from Bousquet (2010) to assign each species a rareness value. Bousquet (2010) assigns most species two forms of abundance ranking – a 'site frequency', denoting how often it occurs across sites; and an 'at-site relative abundance', denoting the average abundance at sites where it does occur. In both cases, the scales are 1 to 4 with 4 being most abundant. Table 7 suggests that there was little difference in average ground beetle rarity between the forest types. This table hints at a greater abundance of non-native species in the recent forests, however, this difference was entirely due to the much greater abundance of one exotic species (*Bembidion tetracolum*) in the recent forests; when that species was excluded, there was no appreciable difference between the sites. This general result was corroborated by a similar assessment we made using data provided in Krinsky and Oliver (2001). Species classified as "Rare" by that publication accounted for about 12% of the individuals captured in the ancient forests and about 15% of those captured in the recent forests.

Table 7: Occurrence and origin information for the ground beetles captured during this study. The site-frequency and at-site abundance data were derived from Bousquet's work (2010), and reflect his judgment regarding species occurrence in "Northeastern North America" which he defines as including the neighboring lands of Vermont and Ontario, but not New York State itself. See text.

	Forest Age	
	Ancient	Recent
Weighted Average Site Frequency*	3.45 (N=716)	3.44 (N=599)
Weighted Average At-site Abudance*	2.71 (N=627)	2.93 (N=509)
% of Individuals of Exotic Species	6% (N=716)	19% (N=612)

Table 8: List of ground beetles species captured during two years of floodplain forest inventories in Columbia and Dutchess counties. Species shaded in blue are described in the literature (Larochelle and Lariviere 2003, Bousquet 2010) as being associated with water, those in yellow are associated with disturbance, while those in green are described as associated with closed forest. The percentages indicate the percent of the total captures in each forest age class. Comments were gleaned from the literature and other sources (Davidson unpublished, Krinsky and Oliver 2001, and state rare species listings). Standard state abbreviations are used for the Northeast. "NE" stands for Northeastern North America as defined by Bousquet (2010); it includes the states of VT, NH, and ME plus the provinces of Quebec and Ontario. GCN stands for "Greatest Conservation Need" and SC is "special concern".

SPECIES	FOREST AGE ANCIENT	RECENT	STATUS
Agonum extensicolle	6.98%	7.52%	
Agonum ferreum	0.28%	0.49%	unusual NE
Agonum melanarium	6.28%	3.10%	
Agonum muelleri	0.28%	0.98%	introduced
Agonum palustre	0.98%	1.47%	
Agonum sp?	0.00%	0.49%	
Amara aenea	0.28%	0.00%	introduced
Amara exarata	0.00%	0.98%	unusual NE
Amara littoralis	0.00%	0.16%	"rare" CT
Amara musculis	0.00%	0.33%	
Amara turbata	0.00%	0.16%	unusual NE / unusual PA / not recorded
Amphasia interstitialis	2.51%	1.14%	
Anisodactylus discoideus	0.14%	0.16%	"rare" CT
Anisodactylus harrisii	0.00%	0.16%	
Anisodactylus nigrita	0.00%	0.16%	"rare" CT
Anisodactylus sanctaecrucis	0.00%	1.31%	
Anisodactylus verticalis	0.00%	0.65%	
Apristus subsulcatus	3.07%	0.49%	"rare" CT
Asaphidion curtum	1.26%	0.98%	introduced
Bembidion castor	0.42%	2.29%	
Bembidion chalceum	0.42%	0.00%	
Bembidion frontale	1.68%	0.49%	
Bembidion inequale	0.14%	0.33%	"rare" CT
Bembidion nigrum	0.42%	2.45%	
Bembidion quadrimaculatum oppositum	0.84%	3.76%	
Bembidion rufotinctum	0.00%	0.16%	unusual NE / VT GCN / unusual PA
Bembidion salebratum	0.00%	0.49%	
Bembidion semistriatum	0.00%	0.82%	
Bembidion sp.	0.00%	0.82%	
Bembidion tetracolum	2.09%	15.85%	introduced
Brachinus cordicollis	0.28%	0.00%	rare CT
Brachinus cyanipennis	5.03%	1.31%	CT SC
Brachinus fumans	0.14%	0.00%	CT SC / "rare" CT
Brachinus janthinipennis	4.05%	0.33%	rare CT
Brachinus ovipennis	0.00%	0.16%	unusual NE / CT SC / "rare" CT
Bradycellus atrimedeus	0.00%	0.16%	not recorded CT
Bradycellus rupestris	0.42%	0.49%	
Carabus nemoralis	0.00%	0.33%	introduced
Chlaenius aestivus	6.42%	2.78%	unusual NE
Chlaenius brevilabris	3.63%	0.49%	unusual NE
Chlaenius cordicollis	1.96%	0.16%	

SPECIES	FOREST AGE		STATUS
	ANCIENT	RECENT	
Chlaenius emarginatus	0.28%	0.00%	rare CT
Chlaenius impunctifrons	4.47%	0.49%	
Chlaenius lithophilus lithophilus	0.14%	0.16%	rare CT
Chlaenius pennsylvanicus pennsylvanicus	0.14%	0.00%	
Chlaenius sericeus sericeus	2.23%	0.98%	
Chlaenius tricolor	2.79%	2.12%	
Clivina impressifons	0.00%	0.16%	
Dyschirius pilosus	0.28%	1.14%	unusual NE / "rare" CT
Dyschirius sphaericollis	0.00%	0.16%	rare CT
Elaphropus anceps	0.00%	1.14%	not reported CT
Elaphropus incurvus	0.42%	0.49%	unusual PA
Elaphropus tripunctatus	0.14%	0.00%	not reported CT
Elaphropus vivax	0.00%	0.16%	
Elaphrus californicus	0.14%	0.65%	rare CT
Elaphrus ruscarius	0.00%	1.31%	
Harpalus fulgens	0.00%	0.16%	rare CT
Harpalus longicollis	0.00%	0.33%	rare CT
Harpalus pensylvanicus	0.70%	0.65%	
Harpalus rufipes	0.00%	0.16%	introduced
Lachnocrepis parallela	0.00%	0.16%	
Lophoglossus scrutator	0.00%	0.16%	VT GCN
Loricera pilicornis	0.00%	0.65%	
Nebria lacustris lacustris	0.42%	0.33%	CT SC / "rare" CT
Nebria pallipes	4.75%	5.07%	
Notiophilus aeneus	0.00%	0.33%	rare CT
Omophron americanum	3.49%	0.98%	
Oxypselaphus pusillus	1.12%	1.14%	
Paratachys scitulus	0.14%	0.00%	
Patrobus longicornis	1.54%	0.33%	
Platynus hypolithos	0.70%	7.03%	unusual NE / not reported CT
Platynus tenuicollis	0.00%	0.16%	
Poecilus lucublandus	2.09%	2.94%	
Pterostychus caudicalis	0.84%	0.16%	rare CT
Pterostychus coracinus	0.14%	0.16%	
Pterostychus corvinus	0.42%	0.16%	
Pterostychus luctuosus	0.70%	0.16%	
Pterostychus melanurius	2.09%	0.49%	introduced
Pterostychus mutus	5.87%	6.05%	
Pterostychus stygicus	12.57%	5.72%	
Schizogenius lineolatus	1.26%	0.00%	rare CT
Sphaeroderus stenosomus	0.14%	0.49%	
Stenolophus lecontei	0.00%	0.33%	unusual NE / "rare" CT
Stenolophus ochropezus	0.00%	1.47%	
Stenolophus sp.	0.00%	0.16%	
Trichotichnus vulpeculus	0.00%	0.65%	rare CT

Classification of Ancient and Recently Reforested Floodplain Forests in Columbia and Dutchess Counties

The 71 study transects were subjected to a hierarchical cluster analysis (PC-Ord) that grouped them by similarity in their species composition of trees and woody lianas (≥2" dbh). Five floodplain forest types could be described that differed in the relative abundance[6] and relative frequency[7] of certain woody species. The indicator value[8] of each species in each of the floodplain forest types was calculated and a Monte Carlo simulation was performed to help select those woody species with indicator values that were significantly higher in one of the forest types than expected by chance (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.

Based on their tree indicator species, the following five forest types can be distinguished in Columbia and Dutchess County floodplain forests:

- **Sugar Maple-dominated Floodplain Forest**
- **Elm – Sugar Maple - Bitternut Floodplain Forest**
- **Elm – Ash – Black Cherry Floodplain Forest**
- **Black Locust - Sycamore – Cottonwood Floodplain Forest**
- **Green Ash – Silver Maple Floodplain Forest**

Table 9 below shows the tree and woody liana species that are significantly associated with each of these five floodplain forest types.

Please note that not all of these indicators are exclusive to a single floodplain forest type: American Elm, Bitternut, Cottonwood, Black Cherry, Sycamore, Grape, and Ash[9] 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 - Bitternut** forest. Other common woody species occurred across all five floodplain forest types without statistically significant differences. Of these, Norway Maple tended to be more common in **Elm - Sugar Maple – Bitternut** forests, while Musclewood tended to be more common in **Elm- Ash – Black Cherry** forests. Red Oak

[6] 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
[7] percentage of transects in a given group where a given species is present
[8] product of relative abundance and relative frequency
[9] 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".

and large individuals of Poison Ivy occurred here and there throughout the forest types. Appendix 2 lists all the tree species documented in the standardized inventories and shows for each species the percentage of trees (dbh ≥ 2”) it contributes to each forest type.

Table 9: Indicator values of woody species (dbh ≥2”) associated with the five floodplain forest types identified in 71 floodplain forest transects in Columbia and Dutchess County (* p<0.1; ** p<0.05). The indicator value for each species in each forest type was calculated as the product of the species’ proportional abundance in each forest type relative to the abundance of that species in all forest types and its proportional frequency (the proportion of transects in each forest type that contained the species). The indicator values could range from 0 (no indication) to 100 (perfect indication). Perfect indication means that the presence of a species points to a particular forest type without error, at least within the data set at hand (McCune & Grace 2002).

	Floodplain Forest Type				
	Sugar Maple - dominated	Elm - Sugar M. - Bitternut	Elm - Ash - Black Cherry	Black Locust - Sycamore - Cottonwood	Green Ash - Silver Maple
	n=11	*n=10*	*n=23*	*n=8*	*n=19*
Sugar Maple	63**	27	4	3	0
Ironwood	32**	0	3	0	1
Bitternut	15	46**	17	0	8
Slippery Elm	0	59**	14	3	0
Basswood	8	39**	14	0	9
American Elm	8	25	40**	8	17
Black Cherry	1	4	45**	10	2
Ash	3	19	38**	1	9
Honeysuckle	0	0	31**	6	0
Grape	1	15	29*	1	9
Black Locust	0	0	0	81**	0
Sycamore	9	7	12	56**	1
Cottonwood	2	1	6	50**	2
Boxelder	0	0	7	49**	8
Toringo Crab	0	0	0	38**	0
Oriental Bittersweet	0	0	0	36**	0
Willow	0	0	0	38**	0
Green Ash	0	6	7	5	70**
Silver Maple	0	1	0	3	80**
Nannyberry	0	2	3	0	26**
Spicebush	4	0	1	0	25**
Swamp White Oak	0	0	1	0	15*

Table 10 compares some variables describing the physical environment and structural characteristics of the five floodplain forest types. The values are averages for transects belonging to each forest type. The table also indicates differences in the disturbance history of those transects that were grouped within each forest type.

Table 10: Physical Environment, Structural Characteristics, and Disturbance History of the five floodplain forest types found in Columbia and Dutchess County (*) these % cover values should be read as "average maximum % cover", because the values had been estimated in the field in 7 classes, i.e., 0, <1, 1-<10, 10-<25, 25-<50, 50-<75, and 75-100 and averages were calculated by averaging the upper limit of the respective classes; **) in contrast, % canopy cover was estimated to a single percentage value in the field and the averages were calculated directly from these original estimates)

	Floodplain Forest Type				
	Sugar Maple - dominated *n=11*	Elm - Sugar M. - Bitternut *n=10*	Elm - Ash - Black Cherry *n=23*	Black Locust - Sycamore - Cottonwood *n=8*	Green Ash - Silver Maple *n=19*
elev. relative to bankfull (ft)	0.5	-0.6	-0.4	0.1	-0.2
% herb cover*)	38.3	44.5	66.9	49.4	74.1
height herbs (ft)	1.2	1.6	2.4	2.9	2.8
% cover bare ground*)	38.5	35.0	24.1	31.4	22.0
% cover leaf litter*)	27.3	25.3	28.8	18.7	22.3
% cover small woody debris*)	10.7	10.0	14.5	12.6	12.9
% cover moss*)	1.8	1.8	3.8	0.2	10.5
topsoil rank	3.4	3.0	2.8	3.1	2.1
% canopy cover**)	85.2	83.5	75.0	68.7	75.2
% cover small woody plants*) (<2")	14	20	40	40	24
# trees (≥2")/acre	275	291	263	294	198
# trees (≥10")/acre	75	76	68	68	64
% big trees (≥10")	29	27	27	27	36
avg dbh all trees (≥2")	8	7	7	7	9
avg. dbh of five biggest trees	23	21	22	19	25
# of dead trees/acre	6	8	7	12	7
density of fallen coarse woody debris (≥3")/acre	20	23	32	36	16
% ancient transects	100%	70%	35%	13%	37%

Sugar Maple – Dominated Floodplain Forests were found only in Columbia County along the middle reaches of the Kinderhook and Claverack creeks and their tributaries at elevations of at least 200 feet above sea level and a distance of at least 17 creek-miles from the Hudson. Only ancient forest sites clustered together in this group. On average, this forest type is located on the highest ground, secondary channels located in these forests provide for quick drainage of floodwater back into the main channel. Most 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 above bankfull stage was 0.5 feet, 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 due to the presence of sandy depressions and gravelly secondary channels within the matrix of mostly loamy and sandy-loam soils (App. 3). Sugar Maple – dominated floodplain forests had an intermediate overall tree density, but, like the Elm – Sugar Maple – Bitternut forests, they had a high density of big trees (≥10”) (Table 10).

The Sugar Maple – dominated forest was on average composed of 70% of Sugar Maple (App. 2 & 11); this species was well represented in all size classes. More than 60% of the biggest trees in this forest type were Sugar Maple[10] and seedlings of this species were most common here and in the Elm – Sugar Maple – Bitternut forest (App. 4 & 12). Bitternut, American Elm, Sycamore, Basswood, Cottonwood and Ash co-occurred in low densities and all but the last were observed amongst the biggest trees in this forest type. Musclewood, Ironwood, and Spicebush were present in small numbers in the understory; Ironwood was almost exclusively found in this floodplain forest type. See Appendix 2 for other woody plants (≥ 2” dbh) found in this forest type. It was characterized by the lowest density of dead standing trees and a low density of fallen coarse woody debris. Overall, these forests seem quite stable in terms of external physical disturbance and in terms of intrinsic dynamics.

The spring flora of the Sugar Maple – dominated forest was diverse. Among the many spring ephemerals present, Wild Leek, Bloodroot, False Mermaid Weed, Early Meadow Rue, Broad-leaved Toothwort, and Trout Lily were evident at every site within this forest type. Blue Cohosh, Cut-leaved Toothwort, Dutchman's Breeches, False Hellebore, and Wild Geranium occurred at 80% of the sites. Furthermore, Broad-leaved Spring Beauty and Red Baneberry, two uncommon plants of our region, were observed only in this floodplain forest type. During the summer, the canopy was closed, and herbaceous plant cover was relatively sparse (Table 10). The most common herbaceous plants in summer were Ostrich Fern, White Wood Aster and the invasive Garlic Mustard (App. 5). White Wood

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

Aster was the only significant herbaceous indicator for this forest type, but Zig-zag Goldenrod was almost as tightly associated with it as with the Elm – Sugar Maple – Bitternut forest (App. 6). Tree seedlings were relatively common, most of them being Sugar Maple, Elm, White Ash, and Bitternut (App. 7 & 12). This forest type had overall the lowest density of small (dbh <2") woody plants, including shrubs (Table 10). The most common shrub was Tartarian Honeysuckle (2%), but Multiflora Rose was also present in low densities (App. 7).

Judging from the composition of tree seedlings in this forest type, we don't expect a drastic shift in the future canopy composition (App. 11 & 12). Given the dense canopy cover (Table 13), the shade-tolerant Sugar Maple is likely to maintain its dominant role while fewer of the less shade-tolerant Elm, White Ash, and Bitternut seedlings will survive the dense shade long enough to become part of the canopy (Fowells 1965).

Elm – Sugar Maple - Bitternut Floodplain Forests were found in Columbia County along all three tributaries, at similar elevations and distances from the Hudson as the Sugar Maple – dominated forests, sometimes even at the same site. In addition, one recently reforested transect (located adjacent to a Sugar Maple –dominated site) in Columbia County and two recently reforested transects along the Wappinger Creek in Dutchess County classified as this forest type. However, 70% of the transects in this group were already forested in the 1930/40s. The average elevation of all these transects was below 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 10). The matrix of mostly loamy soils was punctuated by both, fine-textured and gravelly secondary channels (App. 3). Together with the Black Locust – Sycamore – Cottonwood forests, these forests had the highest overall tree density. Like the Sugar Maple – dominated forests, they had a high number of larger (≥10") trees, but the biggest trees were on average somewhat smaller (Table 10).

The most common tree in the Elm – Sugar Maple - Bitternut forest was Sugar Maple (30%), but Elms (both American and Slippery Elm) and Bitternut co-occurred in significant numbers (>15%). This was also the forest type with the highest concentration of the invasive Norway Maple (5%). Ash, Basswood, Sycamore, and Cottonwood were the most common other trees in this forest type (2-7%, each; App. 2 & 11). Bitternut, Slippery Elm and Basswood were significantly more common in this forest type (Table 9). The biggest trees in this forest type were mostly Sugar Maple, Sycamore, Bitternut, Basswood, and Cottonwood. The spring flora was characterized by a diversity of rich mesic forest species. During the summer, the canopy was quite closed, but the herbaceous plant cover was somewhat denser than in the Sugar Maple – dominated forest (Table 10). The most common herbs were Ostrich Fern and the invasive

Garlic Mustard (App. 5), but Bloodroot, Wild Ginger, Sanicles, Hairy Wild Rye, Blue Cohosh, Skunk Cabbage, Wild Leek, Blue Violets (*V. sororia* and/or *V. cucullata*), and Honewort were significant indicators for this floodplain forest type (App. 6). Zig-zag Goldenrod was associated with this forest type and with the Sugar Maple – dominated forest. Many other herbaceous species also occurred at low densities (App. 5). Sugar Maple, as well as Elm seedlings, were as common here as in the Sugar Maple – dominated forest, and Bitternut seedlings were significantly more common in this forest type than anywhere else (App. 7 & 12). This forest type had a relatively low density of small (dbh <2") woody plants, including shrubs (Table 10). Most common in that category was Virginia Creeper and less so Multiflora Rose and Spicebush. Tartarian Honeysuckle (App. 7) as well as Japanese Barberry were present in small numbers.

Comparing the composition of canopy trees and tree seedlings in this forest type (App. 11 & 12), we do expect a shift in the future canopy composition towards increasing dominance of Sugar Maple. Given the dense canopy cover in this forest type (Table 13), the shade-tolerant Sugar Maple seedlings are likely to survive longer than the less shade-tolerant Elm and Bitternut seedlings, and have a higher chance to eventually become part of the canopy (Fowells 1965).

Elm – Ash – Black Cherry Floodplain Forests were represented in all three watersheds in Columbia County (including ancient and recently reforested transects) as well as two recently reforested transects along the Wappinger Creek and one along the Saw Kill in Dutchess County. Sixty-five percent of the transects that grouped in this forest type were recently reforested. On average, they were located somewhat below bankfull. Their soil texture was very similar to that of the Elm – Sugar Maple – Bitternut forests, with a matrix of mostly loamy soils punctuated by both, fine-textured and gravelly secondary channels (App. 3). The canopy cover was more open, and the herb layer much better developed than in the preceding forest types. The density of coarse woody debris was high, but the density of dead standing trees was comparatively low (Table 10).

The Elm – Ash – Black Cherry forests were dominated by Elm (18% American and 3% Slippery) and Ash (5% Green Ash, 2% White Ash, 14% not distinguished between White and Green), which were accompanied by Sugar Maple, Sycamore, and Bitternut (6% each), and Black Cherry and Musclewood (5% each) (App. 2 & 11). American Elm, Ash, and Black Cherry were all significant indicators for this forest type. It was also associated with large grape vines and large individuals of Tartarian Honeysuckle (Table 9). The biggest trees in this forest type were mostly Sycamore, Cottonwood and Ash, with an occasional Sugar Maple, Elm or Basswood. The suite of spring ephemerals was overall quite similar to that of the Elm – Sugar Maple – Bitternut forest. In summer, the canopy was markedly more open than in the above-discussed forest types, and herb cover was, on average, slightly greater and the herbs tended to be taller (Table 10). The most common herbs were Ostrich Fern, Yellow Jewelweed, and the invasive Garlic Mustard (App. 5). The invasive Japanese Stiltgrass was a significant indicator for this forest type, as were the native Ditch Stonecrop, Pennsylvania Bittercress, and Virgin's Bower (App. 6). Many other herbaceous species occurred in this forest type (see App. 5 for the most common herbs). There were a few tree seedlings of Sugar Maple, Elm and Sycamore (App. 7 & 12), but the dense layer of small (dbh <2") woody plants (Table 10) was dominated by Multiflora Rose and Tartarian Honeysuckle. Virginia Creeper, Poison Ivy, Raspberry (*Rubus* sp.), and Spicebush were also quite common (App. 7). Tartarian Honeysuckle and Raspberry (*Rubus* sp.) were significant indicators for this forest type (App. 4). The uncommon hybrid vervain (*Verbena x engelmanii*) and Red Mulberry were found exclusively in this forest type during our study.

This forest type had a slightly more open canopy that the preceding forest types (Table 13). Judging from the composition of canopy trees and tree seedlings in this forest type (App. 11 & 12) and the differential shade-tolerance of these seedlings (Fowells 1965), we suspect that Sugar Maple will become more common in densely shaded areas, while the present Elm, Ash, and Bitternut seedlings might only be able to grow into trees in less-shaded micro-habitats. Overall, the future canopy composition in this forest type might well be moving towards a composition typical of the Elm – Sugar Maple – Bitternut Floodplain Forest.

Black Locust – Sycamore – Cottonwood Floodplain Forests were mostly found on sites with a high frequency and intensity of flooding disturbance. Most of them were recently reforested areas on stream deposits of islands or the inner curve of a meander. The very high number of dead standing trees and the highest density of coarse woody debris attest to the dynamic character of these sites. They had the most open canopy, and although the herbs present tended to be tall, the overall herb cover was not very dense. The average soil rank was relatively high, but App. 3 shows that, although sandy soils were the most common in this forest type, there was also a high variation in soil texture, with patches of silt, loam, sandy loam, as well as significant areas covered by pebbles or gravel.

Black Locust – Sycamore – Cottonwood forests were the only forests with any significant amount of Black Locust (24%). It was accompanied by Sycamore and Cottonwood (18% each) and Boxelder (10%) (App. 2). All four of these tree species, as well as willow trees (1%), were significant indicators for this forest type. Significantly associated with this forest type were also the invasive Oriental Bittersweet and the potentially invasive Toringo Crab (Table 9). American Elm, Sugar Maple, Green Ash, and Silver Maple were present in low densities (App. 2 & 11). Half of the largest trees were

Cottonwood, a third Sycamore, and occasionally there was a large Willow, Boxelder and Red Maple. The occurrence of spring ephemerals seemed a bit more patchy than in the preceding forest types. Wild Leek was the only spring ephemeral found at all sites in this forest type. Several species were not found here at all, such as Red Trillium, Yellow Forest Violet, and Virginia Waterleaf. Some species that frequently occurred in the aforementioned forest types were only occasionally present in this forest type, for example Wood Anemone, Wild Geranium, Trout Lily, Toothwort, Spring Beauty, Golden Alexander, False Hellebore, and Blue Cohosh. In the summer, Yellow Jewelweed and Ostrich Fern were the most common herbs, and the invasive Garlic Mustard was also quite common (App. 5). The herbaceous indicators of this forest type included a number of native and introduced “weedy” species, but also the uncommon American Germander (App. 6). Boxelder and Sycamore seedlings were significant indicators amongst the small woody plants in this forest type (App. 4). Small woody plants were dense (Table 10) and dominated by Multiflora Rose, Toringo Crab, Oriental Bittersweet (which all were significantly indicators for this forest type; App. 4), as well as Virginia Creeper, Tartarian Honeysuckle, and Poison Ivy (which were even more common in other forest types; App. 7). Tree seedlings were fewer than in any of the preceding forest types, with a marked absence of Sugar Maple and Bitternut (App. 12).

The open canopy (Table 13) and the presence of Sycamore, Cottonwood, and Black Locust seedlings (App. 12) suggest that these light-loving, early successional species might continue to dominate this forest type for a while to come.

Green Ash – Silver Maple Floodplain Forests occurred in Columbia and Dutchess counties, both on sites that had been completely cleared of their forest cover in the 1930/40’s and on sites with ancient forest. The average elevation of these transects was slightly below bankfull stage. This was the floodplain forest type with the lowest overall tree density, but the trees were on average bigger than in the other floodplain forests (Table 10). The soils were mostly loamy, with little variation, and had on average the finest texture of all forest types (App. 3).

The trees in the Green Ash – Silver Maple forest were composed mostly of Silver Maple and Green Ash (28 and 27%), with significant amounts of American Elm (9%), and some Ash, Bitternut (both 5%), Boxelder (4%) and Cottonwood (3%) (App. 2 & 11). Silver Maple and Green Ash, together with Spicebush, Nannyberry, and Swamp White Oak, were significant indicators for this forest type (Table 9). In the spring, these forests had a very open understory, with plenty of bare ground, but also a good diversity of spring flowers. In the summer, a dense and tall herb layer covered the ground. The predominant herbaceous species were Woodnettle, Ostrich Fern, Clearweed, Sensitive Fern, Spotted and

Yellow Jewelweed, Garlic Mustard, Japanese Stiltgrass, Whitegrass, and Jumpseed (App. 5). Significant herbaceous indicators were Woodnettle, Moneywort, Common Woodreed, Clearweed, Sensitive Fern, Jumpseed, Avens (mostly *G. canadense*, but we cannot exclude the possibility that some sterile individuals might have been a different *Geum* species), and False Nettle (App. 6). Large individuals of Poison Ivy and Silver Maple seedlings were significant indicators in the category of small woody plants (App. 4). The density of small woody plants (including shrubs) was intermediate (Table 10), the most prominent species were Poison Ivy, Multiflora Rose, and Spicebush (App. 7). A number of regionally rare or protected plant species, such as Nodding Trillium, Winterberry, New York Fern, Cinnamon Fern, Biennial Gaura, and Squarrose Sedge, were observed exclusively in this forest type during our study.

The Green Ash – Silver Maple forest had a lower density of tree seedlings than any other floodplain forest type. The species distribution of tree seedlings (App. 12) gives no evident direction for the likely succession of this forest type towards any of the other forest types described here. We suspect that, as long as the flooding intensity stays high, forests of this type will regenerate themselves. Because of their low shade-tolerance (Fowells 1965), Green Ash and Silver Maple seedlings don't persist under the canopy of a mature Green Ash – Silver Maple forest. Nevertheless, both species are prolific seed producers and their flood-tolerant seedlings seem to out-compete less flood-tolerant species on moist alluvial soil, as long as there is enough light.

Comparison of Floodplain Forest Classifications

These five floodplain forest types confirm and refine the typology proposed in Knab-Vispo & Vispo (2009). Within the 2008 transects, there was 100% correspondence in the groups of transects that clustered together in the Sugar Maple – dominated and the Green Ash – Silver Maple forest categories. No 2009 transects were added to the Sugar Maple –dominated group. A number of 2009 Columbia and Dutchess county transects, mostly recently reforested, but also the only ancient forest we were able to study in Dutchess County, were added into the Green Ash – Silver Maple category. The newly defined Elm – Sugar Maple – Bitternut forest corresponds quite closely with the former Elm – Sugar Maple forest and most of the 2008 transects that had originally clustered in this group are still included. However, a few of the 2008 transects that had originally been classified as Elm – Sugar Maple forest were split of and fit better into the newly created Elm – Ash – Black Cherry type. Three 2009 transects clustered into the newly defined Elm – Sugar Maple – Bitternut forest type. The largest modification happened to the former Ash – Sycamore – Cottonwood type, which basically got split in half. Most of its former transects were joined with former transects from the Elm – Sugar Maple type to create the new Elm – Ash – Black Cherry forest type, into which also a large number of the recently reforested 2009 transects clustered. A small number of its former transects clustered with a few recently reforested 2009 transects to form the newly defined Black Locust – Sycamore – Cottonwood forest type.

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 five 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[11]. No state-wide classification of floodplain forest types in New York has yet been published. We had discussed in some detail the correspondence of our initial floodplain forest classification with classifications from neighboring states (Knab-Vispo & Vispo 2009) and concluded that, although there seem to be certain similarities, the specific patterns of species co-occurrence vary somewhat between regions in the Northeast.

Floodplain Forest Types and Disturbance

It is our understanding that the **Sugar Maple – Dominated Floodplain Forests** represent the most mature floodplain forests, located at relatively stable terraces that have neither been cleared by people in recent history, nor received significant disturbance from flooding or re-channeling of the creek bed. When they get flooded (we estimate that this happens on average less than once a year), the water moves through quickly, scouring the soil, removing fine particles from the soil surface and depositing somewhat coarser sediment in turn (Fig. 5).

The two Elm floodplain forest types seem to be located in physically very similar locations, low in the floodplain, presumably receiving on average at least one flood a year, which might last several days. The somewhat finer texture of the surface soil might be due to slower-flowing water. **Elm – Ash – Black Cherry Floodplain Forest** tends to occur in more dynamic locations along the streams, where the channel is being reshaped quite frequently (Fig. 6).

It may represent an earlier successional state of the **Elm – Sugar Maple – Bitternut Floodplain Forest**, which tends to be found in somewhat more stable locations (Fig. 7) and, in turn, might over time and with increasing distance from the creek and decreasing disturbance frequency become a Sugar Maple – dominated forest. The presence of Sugar Maple and Bitternut seedlings in the Elm – Ash – Black Cherry forest and the high density of Sugar Maple seedlings in the Elm – Sugar Maple – Bitternut forest support this suggested successional sequence (App. 11 & 12).

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

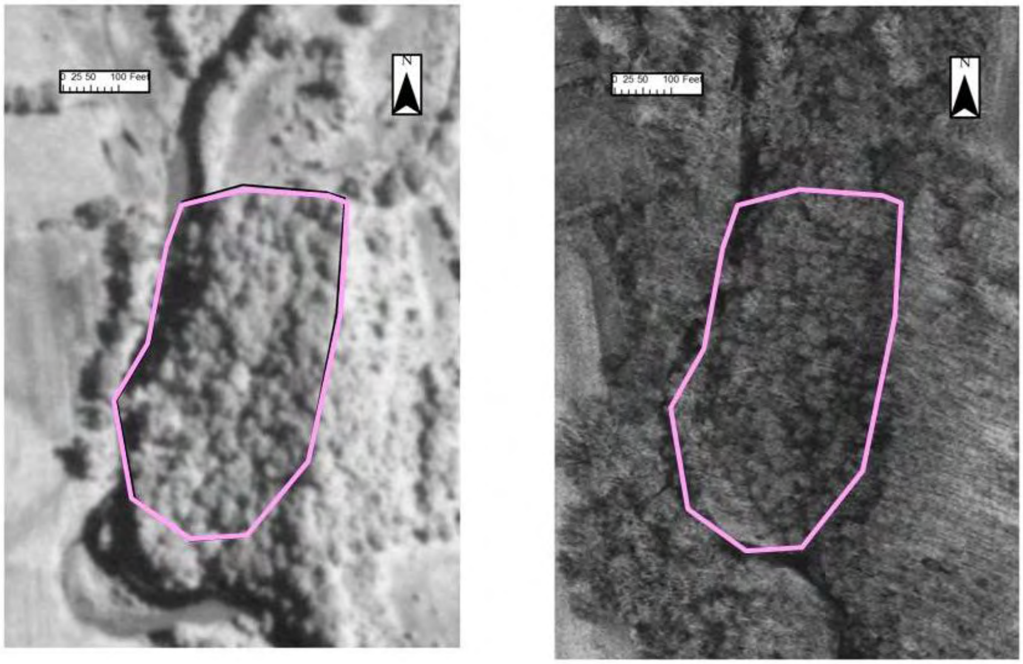

Figure 5: *Example of a historical (1940s; left) and current (2004; right) aerial photo of a patch of ancient* ***Sugar Maple – Dominated Floodplain Forest*** *along Kline Kill in Columbia County. Note the relative stability of the terrace indicated by very small changes in the location of the channel.*

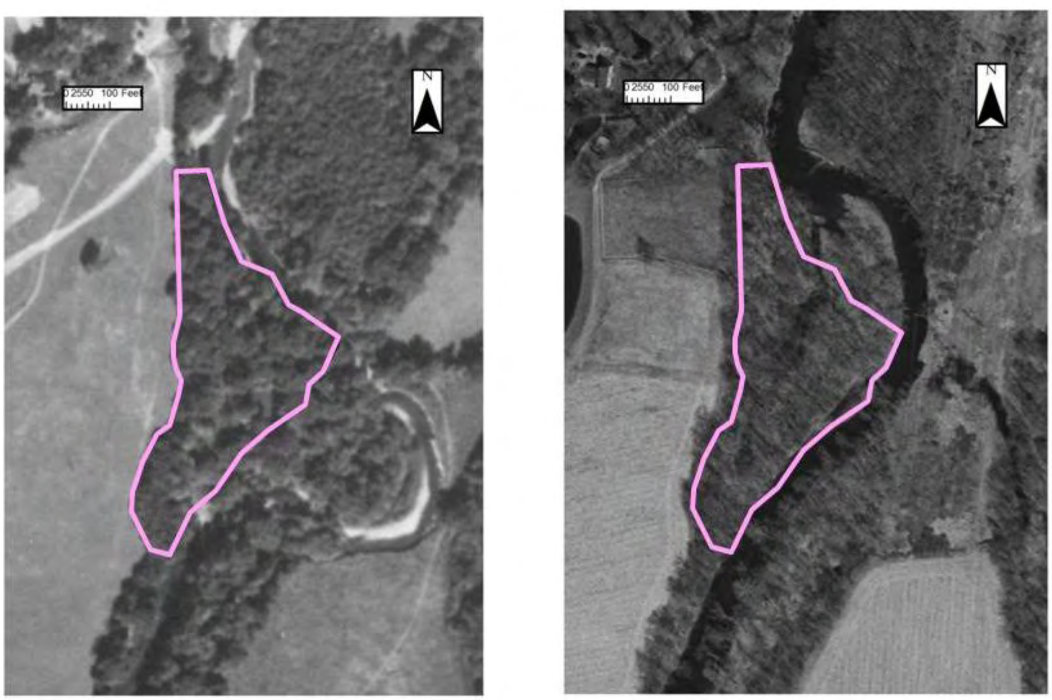

Figure 6: *Example of a historical (1940s; left) and current (2004; right) aerial photo of an ancient* ***Elm - Ash – Black Cherry Floodplain Forest*** *along Roeliff-Jansen Kill in Columbia County. Note the significant shift in location of the channel.*

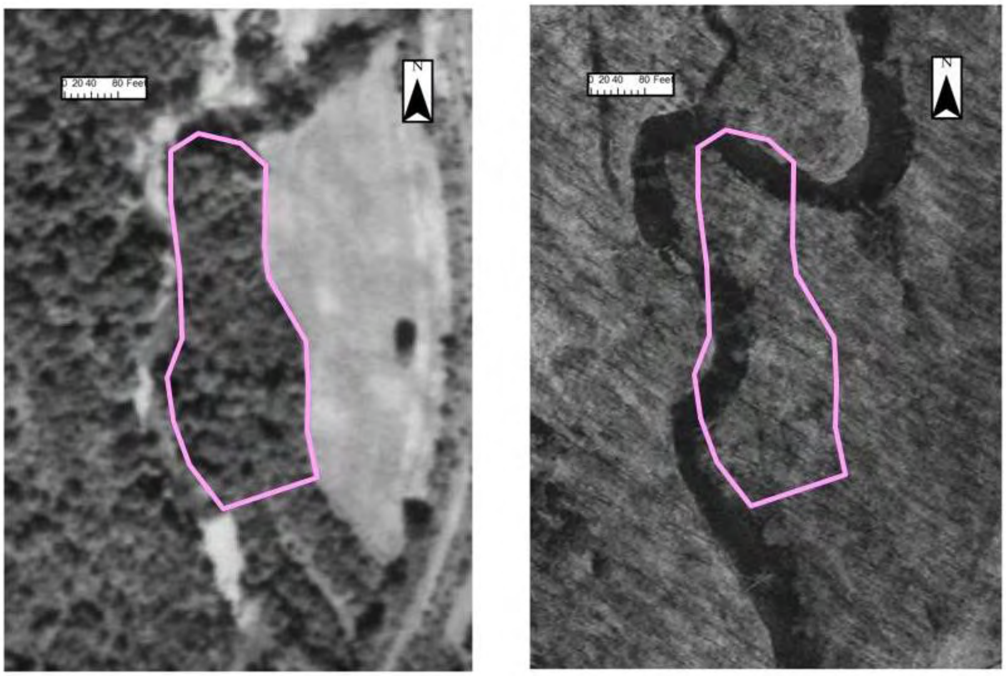

Figure 7: *Example of a historical (1940s; left) and current (2004; right) aerial photo of an ancient corridor of* ***Elm - Sugar Maple – Bitternut Floodplain Forest*** *along Roeliff-Jansen Kill in Columbia County. Note the relative stability of the creek bed.*

The examples of **Black Locust – Sycamore – Cottonwood Floodplain Forest** are young forests that occupy the most dynamic locations within the floodplain, where they colonize mineral soil that had been deposited in major events of creek bed re-working (Fig. 8). There might be places in the floodplain where these forests persist for a long time due to repeated severe flooding disturbances that set the successional clock back again and again. Although we found few seedlings of Elm, Bitternut and Sugar Maple in these forests, we do suspect that, with reduced flooding intensity and barring any human disturbance, these forests would slowly go through the above suggested succession via the Elm-dominated forest types and eventually become Sugar Maple – dominated.

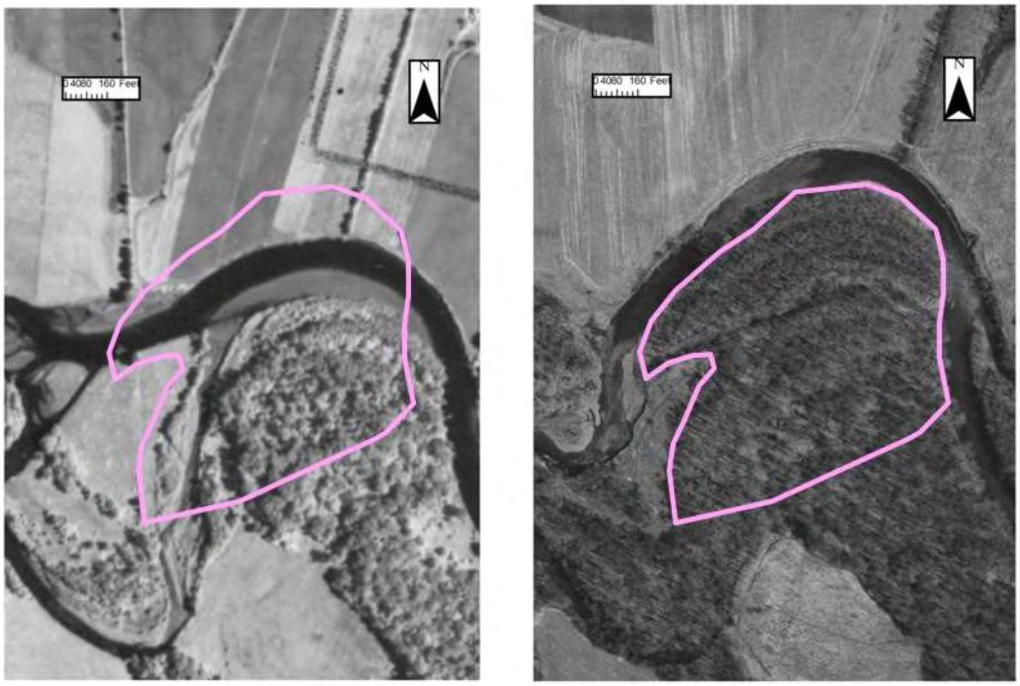

Figure 8: *Example of a historical (1940s; left) and current (2004; right) aerial photo of an only partly ancient* ***Black Locust – Sycamore – Cottonwood Floodplain Forest*** *along Kinderhook Creek in Columbia County. Note the significant shift in channel location and subsequent reforestation of the former creek bed and fields.*

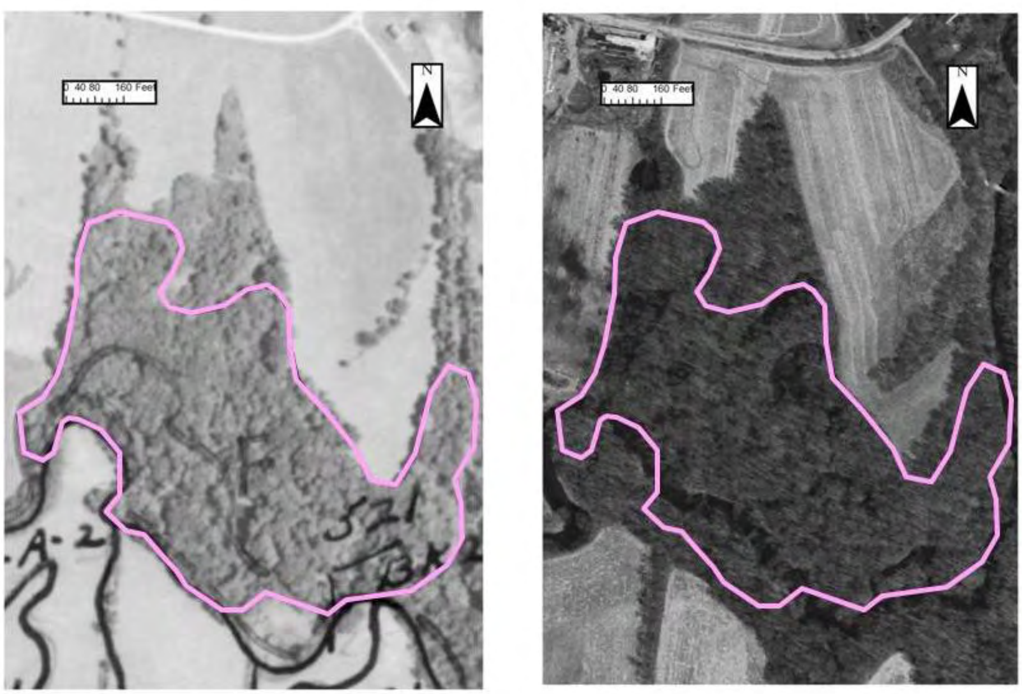

Figure 9: *Example of a historical (1940s; left) and current (2004; right) aerial photo of an* <u>*ancient*</u> ***Green Ash – Silver Maple Floodplain Forest*** *along Roeliff-Jansen Kill in Columbia County. Note the extensive backwater areas in this type of floodplain forest.*

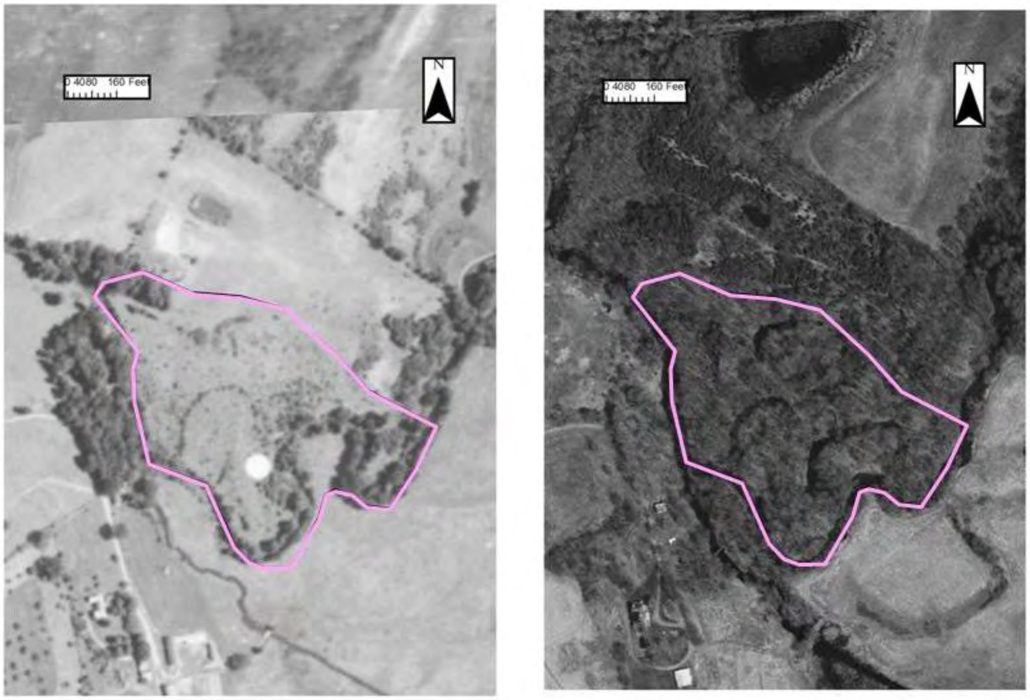

Figure 10: *Example of a historical (1940s; left) and current (2004; right) aerial photo of a* *<u>recently reforested</u>* ***Green Ash – Silver Maple Floodplain Forest*** *along Roeliff-Jansen Kill in Columbia County, just up-river from the site depicted in Figure 9. Cleared floodplains with the right characteristics seem to regenerate quickly to Green Ash – Silver Maple Forests, seemingly without any intermediate successional stages*

Finally, the **Green Ash – Silver Maple Floodplain Forest** largely occupies the relatively quiet backwater parts of the floodplain (Figures 9 and 10). Unless the creek moves its bed, these forests seem to be quite stable, largely self-perpetuating communities dominated by the flood-resistant Green Ash and Silver Maple trees. Green Ash seedlings were the most prominent component of the generally scarce tree seedling community in this forest type. However, the reproductive strategy of Silver Maple (Fowells 1965) seems to allow for rapid colonization of possible canopy gaps, as long as competing, less flood-tolerant species are kept in check by flooding. After complete forest removal, these forests seem to regenerate quickly with the same set of wind (and somewhat water) dispersed, flood-tolerant tree species. Their fine-textured surface soils suggest flooding with relatively slow-flowing water. In fact, in many of these sites, flood water seems to get trapped in backwater areas and cannot freely drain back into the creek, but has to percolate or evaporate, which leads to extended periods and areas of moist soils. When the creek moves its bed and a Green Ash – Silver Maple forest gets "stranded" on less frequently flooded ground, Silver Maple does not regenerate, most likely due to increased competition from less flood-tolerant species. The old trees eventually die and the conversion to another forest type gets initiated. An example of such a Green Ash – Silver Maple forest in transition is found on the west bank of the Fishkill just north of the I-84 bridge, but we did not study its composition in any detail.

Micro-habitat Variation and Plant Distribution within the Floodplain Forests

It is important to note that, within the forest types (represented by transects perpendicular to the creek bed), tree species were not always evenly distributed. For example, several of the Sugar Maple – dominated forests had a small stand of Ash – Sycamore – Cottonwood at their creek-facing edge. As we showed in Knab-Vispo & Vispo (2009), Sycamore, Cottonwood, Green Ash, Boxelder and Black Locust tended to be more common near the creek than expected at random, 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. This serves as an indication that within each forest type there might be different microhabitats occupied by different sets of species.

The variation of microhabitats within the floodplain forests was explored with a Canonical Correspondence Analysis of the 848 sample plots. The clustering of plots according to similar physical characteristics and similarities in their plant species composition resulted in the distinction of seven microhabitats.

Table 11 compares and summarizes some key physical characteristics of the seven microhabitats. Appendix 8 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 Figures 11 and 12.

Table 11: Physical characteristics of the seven microhabitats distinguished in floodplain forests in Columbia and Dutchess counties.

CCA Group Code		Microhabitat	Physical Characteristics				
	n	Description	elevation relative to bankfull	distance from creek	soil texture	canopy	herb cover
2	101	very closed forest on high terrace	above	intermediate	fine	most closed	little
14	74	closed forest on high terrace	well above	intermediate	finest	closed	intermediate
1	320	closed forest on low ground	slightly below	intermediate	medium	closed	intermediate
9	78	fine-textured 2nd channels, backwaters	far below	farthest	finest	closed	dense
10	141	open forest on low terrace	slightly below	intermediate	medium	rel. open	densest
8	99	shaded shores	below	nearest	coarse	rel. open	intermediate
43	35	sunny beaches	far below	in creek bed	pebbles	very sunny	intermediate

Appendix 9 and 10 compare the indicator values of herbaceous and small woody plants in the seven microhabitats and show, which of these values are significantly higher than expected at random. Plants without an affinity for one of the microhabitats were not included in these appendices. Table 12 shows the distribution of microhabitats across the five floodplain forest types.

The **very closed forests on high terraces** were microhabitats located well above bankfull at intermediate distances from the creek and under a dense tree canopy. They had mostly loamy soils and were the habitats with the most leaf litter and the least herbaceous cover. Significant indicator species were a group of native forest plants, such as White Wood Aster, Zig-zag Goldenrod, Wild Leek, and False Hellebore (App. 9). The invasive Garlic Mustard (which was common in a number of different microhabitats) was the most common herb in this microhabitat. The seedlings of Bitternut, Sugar Maple, Cherry, Musclewood, Bladder-nut, and Ironwood were all significant indicators for this microhabitat (App. 10). Multiflora Rose, Virginia Creeper, Tartarian Honeysuckle, and Poison Ivy also occurred here in relatively high densities. Very closed forests on high terraces were mostly found in Sugar Maple –dominated and Elm – Sugar Maple –Bitternut forests (Table 12).

The **closed forests on high terraces** were also located well above bankfull at intermediate distances from the creek on mostly loamy soil. Their tree canopy was slightly more open, the herbaceous cover much denser and taller. Herbaceous indicators were Wrinkle-leaved Goldenrod, Eastern Woodland Sedge, Jack-in-the-Pulpit, Lady Fern, Blue Cohosh, Gill-over-the-ground, Mayapple, *Osmorrhiza* sp., and False Solomon's Seal (App. 9). Small individuals of Virginia Creeper and the invasive Garlic Mustard were significantly more common here than in any other microhabitat. Ostrich Fern and Yellow Jewelweed occurred in high densities, but were even more common in open forests on low terraces. Chokecherry, Raspberry (*Rubus* sp.), White Ash seedlings, and seedlings of Toringo Crab were significant small woody plant indicators (App. 10), but Multiflora Rose, Virginia Creeper, Tartarian Honeysuckle, and Spicebush also occurred here in relatively high densities. Closed forests on high terraces occurred in small areas in all five floodplain forest types (Table 12).

The **closed forests on low ground** was the most common microhabitat, located on average slightly below bankfull, at intermediate distances from the creek, with mostly sandy loam soil. The density of the tree canopy and extent of herb cover were comparable to that of the closed forests on high terraces. The most common herbs were Ostrich Fern, Garlic Mustard, Japanese Stiltgrass, Clearweed, Woodnettle, Spotted and Yellow Jewelweed, and Whitegrass. The most common small woody plants were Multiflora Rose, Poison Ivy, and Spicebush. No herbs or small woody plants qualified as significant indicators of this microhabitat (App. 9 & 10). Closed forests on low ground commonly occurred in all floodplain forest types with the exception of Black Locust – Sycamore – Cottonwood Forest (Table 12).

The **fine-textured secondary channels** and backwater areas were located well below bankfull and far from the creek under a closed tree canopy. A large number of herbaceous species reached their highest densities here and qualified as significant indicators for this microhabitat with its fine-textured soil. Wood-Nettle was the most common herb here as well as in the open forests on low terraces. Wood-Nettle, Long-bristled Smartweed, Clearweed, Sensitive Fern, Whitegrass, Common Woodreed, Skunk Cabbage, but also the invasive Narrow-leaved Bittercress were among the herbaceous indicator species (App. 9). Japanese Stiltgrass, Ostrich Fern, Whitegrass, and Spotted Jewelweed, which also occurred in high densities in other microhabitats, were common here, as well. Grey-twig dogwood was the only significant small woody indicator species (App. 10), but the ubiquitous Tartarian Honeysuckle, Poison Ivy and Spicebush were also quite common. Fine-textured secondary channels were mostly found in Green Ash – Silver Maple Forest (Table 12).

The **open forests on low terraces** were common microhabitats located in similar locations within the floodplain as the closed forests on low ground, with mostly sandy loam soil. They had a much more open tree canopy and the densest and tallest herb cover of all microhabitats. Smooth Goldenrod, Ostrich Fern, Yellow Jewelweed, Dame’s Rocket, Wood-nettle, Common Enchanter’s Nightshade and Moneywort were significant herbaceous indicators (App. 9). The ubiquitous Garlic Mustard and Japanese Stiltgrass were also quite common. Multiflora Rose was a significant small woody indicator (App. 10), but the ubiquitous Tartarian Honeysuckle, Poison Ivy, and Virginia Creeper were also common. Open forests on low terraces were mostly found in the Black Locust – Sycamore –

Cottonwood Forest, but also quite common in Elm – Ash – Black Cherry and Green Ash – Silver Maple forests (Table 12).

The **shaded shores** had coarser soil texture than the preceding microhabitats. A tree canopy was present, but relatively open. The herb cover was only moderately developed, and the most common plants were Japanese Stiltgrass, Clearweed, Ostrich Fern, Whitegrass, Yellow Jewelweed, and Garlic Mustard. Significant indicators, which occurred here exclusively or more than in other microhabitats, were such weedy plants as Eastern Lined Aster, Barnyard Grass, Cocklebur, Dock-leaved Smartweed, Common Wood-sorrel, Thyme-leaved Speedwell, and Beggar-ticks (App. 9). Next to Multiflora Rose, Tartarian Honeysuckle, and Virginia Creeper, Oriental Bittersweet was also common among the small woody plants, but none of these species was significantly associated with only this microhabitat (App. 10). Shaded shores were mostly found in Black Locust – Sycamore – Cottonwood Forest, as well as in Sugar Maple –dominated and Elm – Sugar Maple – Bitternut forests. It hardly was ever found in Green Ash – Silver Maple Forest.

Finally, the **sunny beaches** had a multitude of herbaceous plants that seemed to thrive best or even exclusively in the exposed, coarse-textured soil and intense light of this microhabitat of the riparian corridor. Less than half of the 48 plants that occurred in significantly higher densities on sunny beaches are native to our area and all of these also occur in non-riparian habitats. 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 (App. 9). Sycamore, Elm, Cottonwood, Trembling Aspen, Willow, and Honey Locust seedlings were found significantly more frequently here than in other microhabitats (App. 10). Sunny beaches were most common in Black Locust – Sycamore – Cottonwood, Sugar Maple – dominated, and Elm – Ash – Black Cherry forests (Table 12).

Table 12: Distribution of seven microhabitats (% of plots in each forest type) across the five floodplain forest types distinguished in Columbia and Dutchess counties

		Floodplain Forest Type				
CCA Group*)	**Microhabitat**	Sugar Maple - dominated	Elm - Sugar M. - Bitternut	Elm - Ash - Black Cherry	Black Locust - Sycamore - Cottonwood	Green Ash - Silver Maple
2	**very closed forest on high terrace**	**24%**	**25%**	9%	6%	*3%*
14	**closed forest on high terrace**	*6%*	7%	**11%**	**12%**	8%
1	**closed forest on low ground**	**44%**	**38%**	**34%**	***24%***	**43%**
9	**fine-textured 2nd channels, backwaters**	*1%*	7%	7%	*0%*	**21%**
10	**open forest on low terrace**	*2%*	*6%*	20%	**32%**	22%
8	**shaded shores**	**17%**	**15%**	13%	**18%**	*3%*
43	**sunny beaches**	**6%**	2%	**6%**	**8%**	*1%*
	all microhabitats	100%	100%	100%	100%	100%

Almost all microhabitats did occur, at least occasionally, in each of the forest types (Table 12). Sugar Maple – dominated and Elm – Sugar Maple – Bitternut forests were both mostly composed of closed forest on low ground, very closed forest on high terrace and shaded shores. Elm – Ash – Black Cherry forests were mostly composed of closed forest on low ground and open forest on low terrace. Black Locust – Sycamore – Cottonwood forests were mostly composed of open forest on low terrace, and, to a lesser degree, of closed forest on low ground and shaded shores. Green Ash – Silver Maple forests were mostly composed of closed forest on low ground and open forest on low terrace.

Figures 11 and 12 illustrate the grouping of the 848 sample plots into similar microhabitats along the axes derived from a Principal Component Analysis. Please consult Table 11 above for a description of the microhabitats corresponding to the code numbers (CCA grouping) used in Figures 11 and 12.

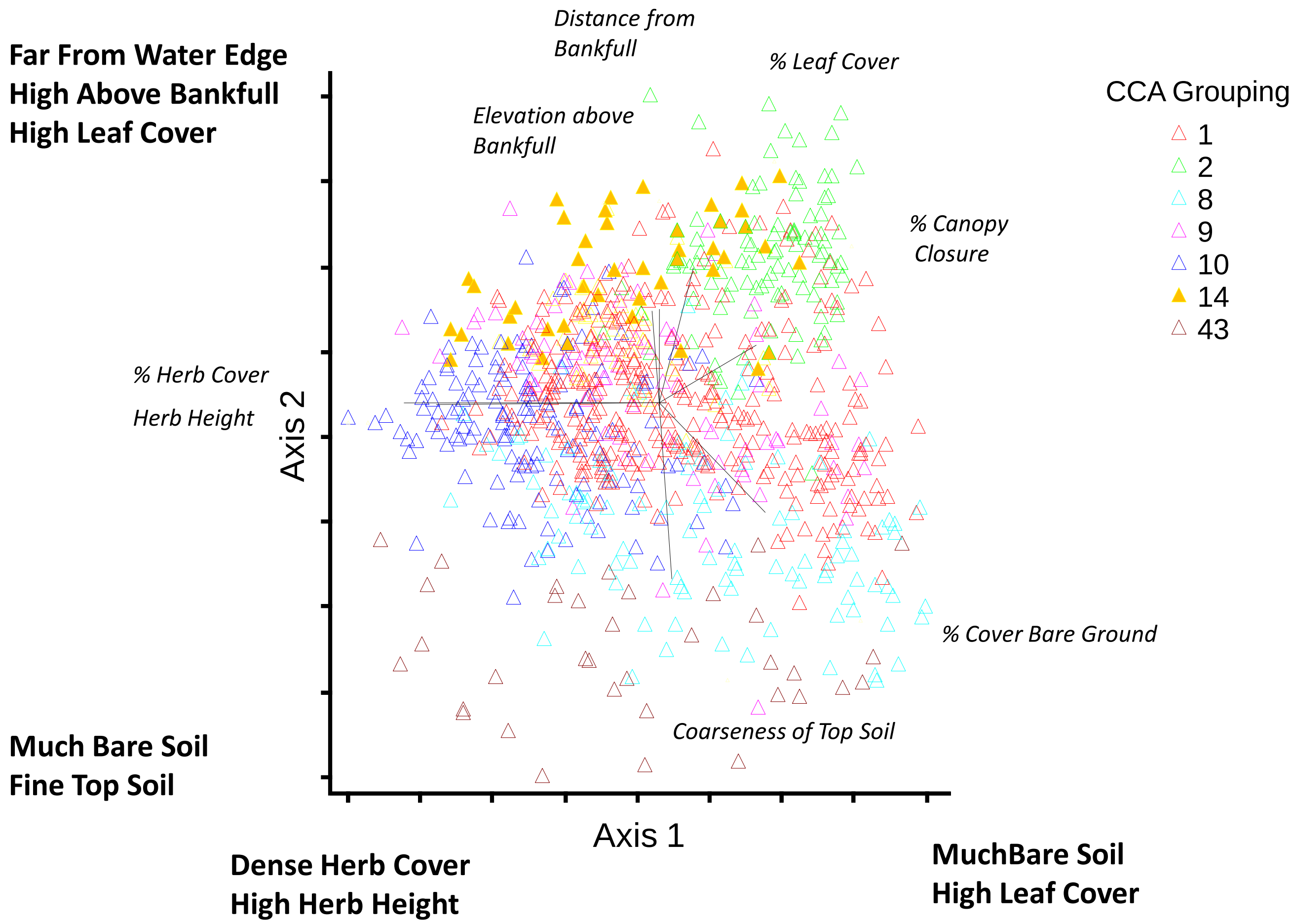

Figure 11: Distribution of the 848 study plots along the first two axes of a principal component analysis. *Plots are color-coded based on their CCA-identified microhabitats.*

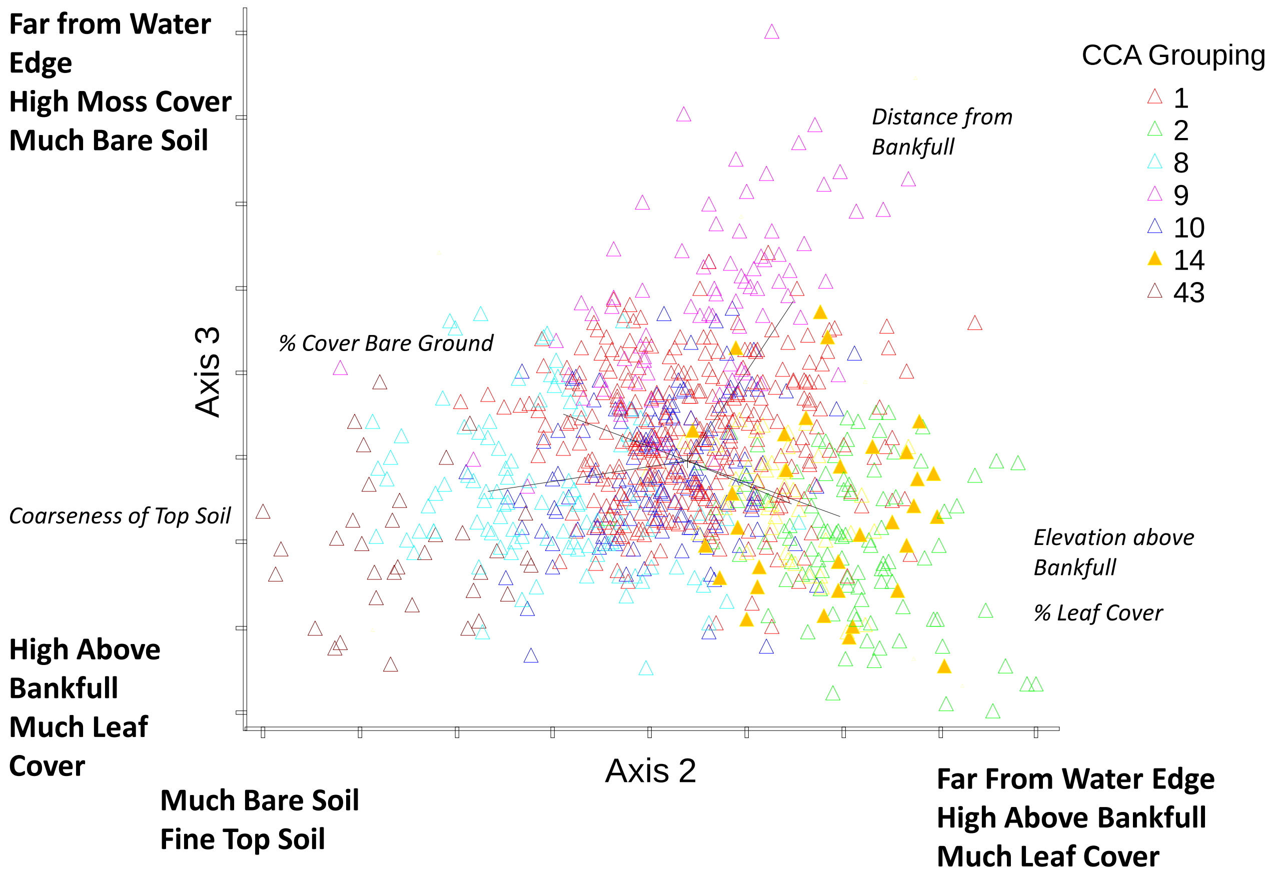

Figure 12: Distribution of the 848 study plots along axis 2 and 3 of a principal component analysis. *Plots are color-coded based on their CCA-identified microhabitats.*

Axis 1 in Figure 11 is positively correlated with the amount of bare soil and leaf litter, and negatively correlated with the density and height of herbaceous vegetation. Axis 2 is positively correlated with distance from creek, elevation above bankfull and amount of leaf litter, and negatively with the amount of bare soil. Soil texture tends to get coarser with increasing values along axis 2. Axis 3 in Figure 12 is positively correlated with distance from creek, as well as moss cover and amount of bare soil. It is negatively correlated with elevation above bankfull and amount of leaf litter.

Patterns of Plant Diversity in Relation to Disturbance in Floodplain Forests

This section starts with a comparison of the presence of rare and uncommon plants in ancient vs. recently reforested floodplain forest sites. We then explore the apparent differences in overall native plant diversity between ancient and recently reforested transects in the different **forest types**. No statistical analysis of the differences between forest types was conducted because not all forest ages were represented in all forest types. Finally, we present a statistical analysis of forest age and other factors potentially associated with native plant diversity at the scale of study **sites** and **plots**. This section closes with a discussion of what we think we learned from this analysis and which questions remain unanswered.

Distribution of rare plants in floodplain forests of different age:

Of the rare or protected plants found during our floodplain forest studies, only two species, Horse Gentian and the sedge *Carex sprengelii* were exclusively found at recently reforested sites. Butternut, Great Lobelia, Royal Fern, Maple-leaved Waterleaf, Biennial Gaura, and Squarrose Sedge were only found at recently reforested or partly ancient sites. More than half of the rare or protected plants did not seem to show a clear preference for ancient or recently reforested sites in our study. Finally, about 1/3 of the rare or protected species seemed to be associated exclusively with ancient floodplain forest. Black Cohosh, Nodding Trillium, Groundnut, Broad-leaved Spring Beauty, Red Baneberry, Maidenhair Fern, Fragile Fern, and the hybrid vervain (*Verbena x engelmanii*) occurred exclusively in ancient floodplain forests, while Cardinal Flower, Lopseed, Aniseroot, Sweet Cicely, Mayapple, Turtlehead, Eastern Bluebell, White Baneberry, Figwort, Christmas Fern, Red Trillium, Moonseed, Blue Cohosh, Meadow Lily, Zig-zag Aster and the state-listed Winged Monkeyflower occurred mostly in ancient floodplain forests. In addition, forty-six more common native plants were also exclusively observed in ancient floodplain forest sites. For the interpretation of this information, however, it is important to remember that some of the rare plants were observed only very few times and therefore these distribution patterns should be taken as very preliminary suggestions.

Overall native plant diversity in transects of different forest types:

The diversity of native herbaceous plants[12] varied between transects in the five floodplain forest types distinguished in Columbia and Dutchess County (Table 13). Transects in Elm – Sugar Maple – Bitternut

[12] We compared rarefied numbers of native herbaceous species to be expected in six sample plots within each transect

forests had on average the highest number of native herbaceous plant species. This forest type was to a large degree composed of transects located in ancient floodplain forest. Green Ash – Silver Maple and Elm – Ash – Black Cherry forests also had on average a high number of native herbaceous plant species, although less than half of their transects were located in ancient forest. The lowest native herb species richness was in the Black Locust – Sycamore – Cottonwood forest transects, which were all recently reforested or only partly ancient. Surprisingly, native herbaceous plant diversity was also low in the Sugar Maple – dominated forest transects, although they were all located in ancient forest.

Table 13: Comparison of native herbaceous plant diversity across transects in the five floodplain forest types.

	Floodplain Forest Type				
	Sugar Maple - dominated *n=11*	Elm - Sugar M. - Bitternut *n=10*	Elm - Ash - Black Cherry *n=23*	Black Locust - Sycamore - Cottonwood *n=8*	Green Ash - Silver Maple *n=19*
% canopy cover	85.2	83.5	75.0	68.7	75.2
native herb diversity (rarefied number of species to be expected in 6 sampling plots)	13.0	18.0	16.0	12.0	17.0
% ancient transects	100%	70%	35%	0%	37%

Although there seemed to be a tendency for ancient floodplain forest transects to harbor a higher diversity of native plant species, forest age clearly did not seem to be the only determining factor of diversity. We suspected the low native plant diversity in the Sugar Maple – dominated forests to be related to the high canopy cover. However, canopy cover alone could hardly be exclusively responsible for low species diversity, because the diverse Elm – Sugar Maple – Bitternut forests had on average almost the same canopy cover as the Sugar Maple – dominated forests. Table 14 compares some additional factors between the five forest types and, most importantly, between the ancient and the recently reforested/partly ancient transects within each forest type.

For the forest types that were represented by both ancient and recently reforested/partly ancient transects, the rarefied number of native herbaceous species was clearly higher in the ancient transects in Elm – Sugar Maple – Bitternut and Green Ash – Silver Maple forests, but only slightly higher in Elm – Ash – Black Cherry forests (Figure 13). The result from the Black Locust – Sycamore – Cottonwood transects matched the apparent pattern of lower native species diversity in recently reforested floodplains. However, the low native species diversity in the all-ancient Sugar Maple – dominated transects did not suggest a straight-forward positive association between native herbaceous plant diversity and forest age. Shading from the dense canopy in the ancient Sugar Maple – dominated transects might limit the diversity of native herbs. However, as shown in Figure 14, average % canopy cover was just as high in ancient as in recently reforested Elm – Sugar Maple – Bitternut transects, and within that forest type did not seem to have any correlation with native plant diversity. On the other hand, recently recovered Green Ash – Silver Maple transects had on average a slightly more closed canopy as well as drastically lower native herb diversity than the ancient transects in this forest type.

Table 14: Comparison of native plant diversity and related factors between ancient and recently reforested/partly ancient transects in the five floodplain forest types. (*) These percentages were calculated by adding the upper limits of ranges, such as 25 for 10-25% and 50 for 25-50% for all species present in a particular plot and therefore can sum to >100%. These values are not comparable with values presented in Table 10, which were derived from the averages of a single estimate for the combined % cover of all herb species in a plot.)

Forest Type	age	*n*	canopy cover	% cover*) invasive shrubs	% cover*) native herbaceous species	native herbaceous diversity	non-native herbaceous species
Sugar Maple - dominated	ancient	*11*	85	5	51	13	7
Elm - Sugar Maple - Bitternut	ancient	*7*	83	3	80	19	6
	recent/part. ancient	*3*	85	7	48	13	4
Elm - Ash - Black Cherry	ancient	*8*	75	6	88	17	9
	recent/part. ancient	*15*	76	27	78	16	7
Black Locust - Sycamore - Cottonwood	recent/part. ancient	*8*	69	21	59	12	8
Green Ash - Silver Maple	ancient	*7*	73	1	136	21	5
	recent/part. ancient	*12*	77	10	86	14	6

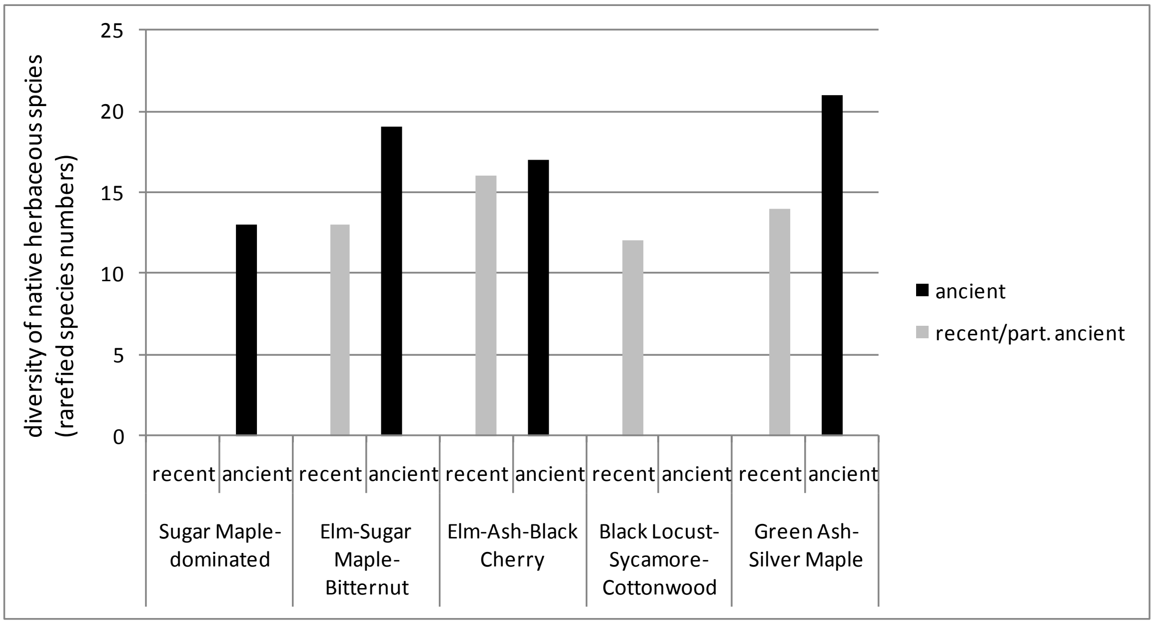

Figure 13: Comparison of rarefied numbers of native herbaceous species between recently reforested/partly ancient and ancient transects within the five floodplain forest types

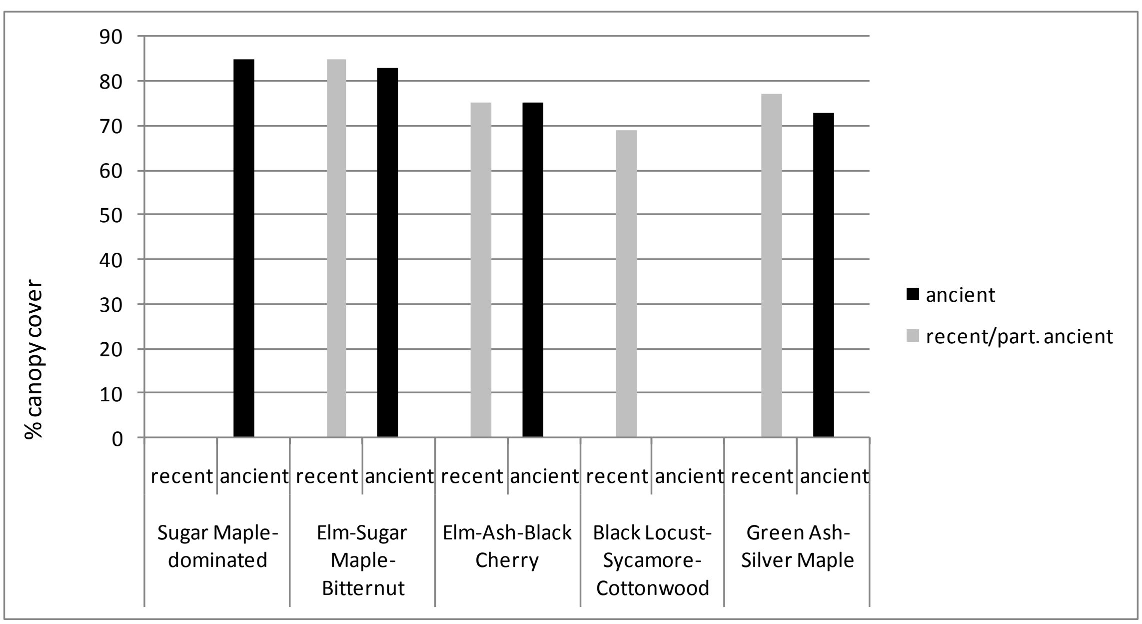

Figure 14: Comparison of % canopy cover between recently reforested/partly ancient and ancient transects within the five floodplain forest types

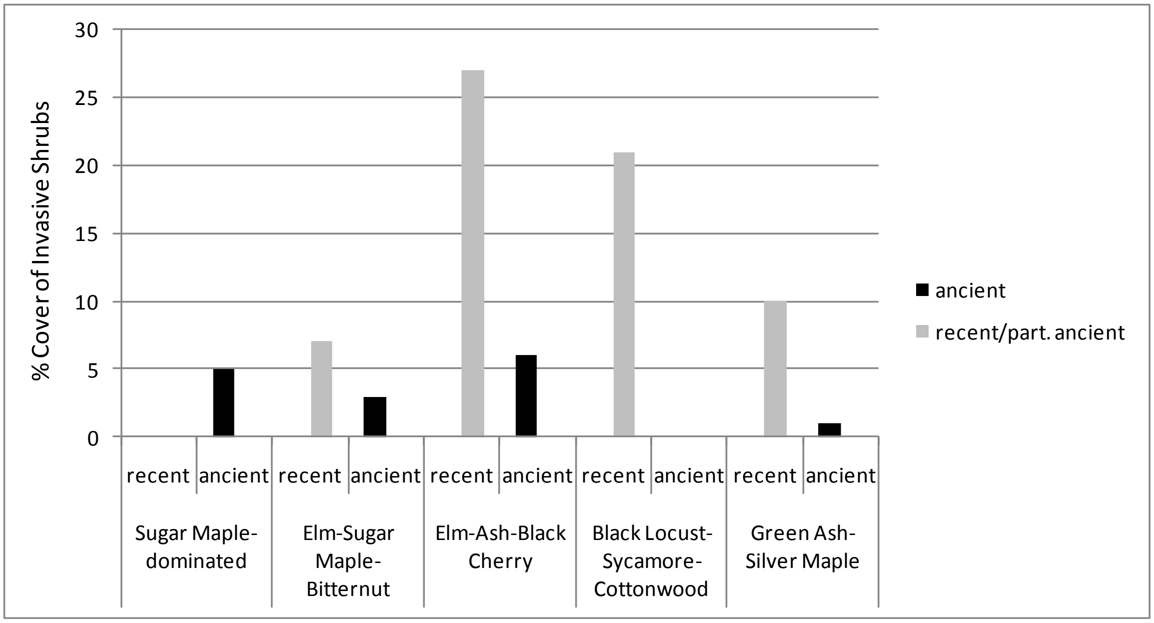

Figure 15: Comparison of invasive shrub density (average % cover) between recently reforested/partly ancient and ancient transects within the five floodplain forest types

Finally, there was a consistent pattern of a higher density of invasive shrubs in the recently reforested/partly ancient transects compared to the ancient transects within each forest type (Figure 15), and the low density of invasive shrubs in the ancient Sugar Maple – dominated transects as well as their high density in the recently reforested Black Locus – Sycamore – Cottonwood transects fit right into this overall trend. The relationships between native herb diversity, canopy cover, and invasive shrub density will be explored in more detail below at the spatial scale of sample plots.

Statistical analysis of factors associated with native plant diversity at the site level:

For the statistical analysis of the variables that are most significantly associated with native plant diversity in floodplain forests, we chose study sites (rather than transects) as the unit of analysis, because sites were statistically more independent from each other than transects. For the 31 study sites, we explored direct, one-on-one correlations of rarefied native herb diversity with a number of variables reflecting structural diversity (i.e., the Shannon-Wiener Diversity Index of microhabitats, standard deviation of height above bankfull and the standard deviation of soil texture rank) and abundance of invasive species (i.e., % coverage by small woody and herbaceous invasives, rarefied diversity of non-native plants). **None** of these correlations were statistically significant (N=31, p>.05). The only significant correlate with native herb diversity in one-on-one analysis was the % cover of native herbs (N=31, p<.001). This is hardly surprising as it essentially states that the higher the abundance of native herbs, the more diverse the native herb community is likely to be.

We explored that data in more detail by removing the % cover of native herbs as a factor (because of its close and obvious correlation to diversity) and by introducing apparent forest age as a categorical factor. For these analyses, we introduced the category of "partly ancient" along with "ancient" and "recent" to account for the fact that some sites, when considered as a whole, had small areas of ancient forest within a matrix or adjacent to recently reforested areas. We used a General Regression Model on transformed data (percentages were arcsine transformed to enhance normalcy). These analyses indicated that forest age was a statistically significant factor (GRM, N=31, p=.006) in predicting the rarefied diversity of native herbs. Native herb diversity increased by one third across the three categories of forest age and was highest in the ancient floodplain forests.

All three of our measures of structural diversity tended to be higher in the ancient vs. the more recent forests, but none of these differences was significant. The only other statistically significant factor in the General Regression Model (other than forest age) was the standard deviation of elevation relative to bankfull (one indicator of structural diversity within the site) which had a negative relationship with borderline significance (p=.03). Coverage of invasive herbs, non-native herbs or invasive shrubs was again not significantly linearly correlated with native herb biodiversity. The coverage of invasive herbaceous plants was nearly identical in recent and ancient forests. The overall model was moderately significant (GRM, N=31, r-square = .34, p=.01). Our incomplete design (i.e., the fact that some forest types had no ancient forest or no recent forest) prevented us from adequately incorporating forest type into our analyses. When assessed alone without controlling for forest age or other factors, forest type did not have a significant effect on native herb diversity (GRM, p>.05).

Forest age was not only correlated with native herb diversity, it also had a significant influence on coverage of invasive shrubs. Invasive shrub coverage decreased by over 80% between recent and ancient forests (t-test, df=22, p=.02). Although native herb diversity was significantly positively correlated with forest age and invasive shrub coverage was significantly negatively correlated with forest age, there was ***not*** a strong negative linear correlation between native herb diversity and invasive shrub coverage at the site level.

Statistical analysis of factors associated with native plant diversity at the sampling plot level:

We explored the correlations between the number of native herbaceous species and a variety of biotic and abiotic variables in 876 sample plots with a stepwise multiple regression. We included the sample sites as variables to reflect the possibility that sample plots within the same site were not statistically independent. In fact, sample site proved to be one of the highly significant variables ($p<.001$). With the variability due to site accounted for, the number of native herbaceous species found in each sample plot was again significantly positively correlated with the percent cover of native herbs, and also the cover of native small woody (dbh < 2 inch) plants ($p<.001$). Surprisingly, there was also a significant positive correlation between native species richness and the % cover of invasive herbs, as well as the % cover of other non-native herbs ($p<.001$). Our 2008 data set from mostly ancient floodplain forest sites had indicated a negative correlation between non-native herb cover and native herb richness, but this pattern obviously did not hold across a wider range of forest ages.

Interestingly, the moss cover on the forest floor was also positively correlated with the number of native herb species in the sample plots ($p<.001$).

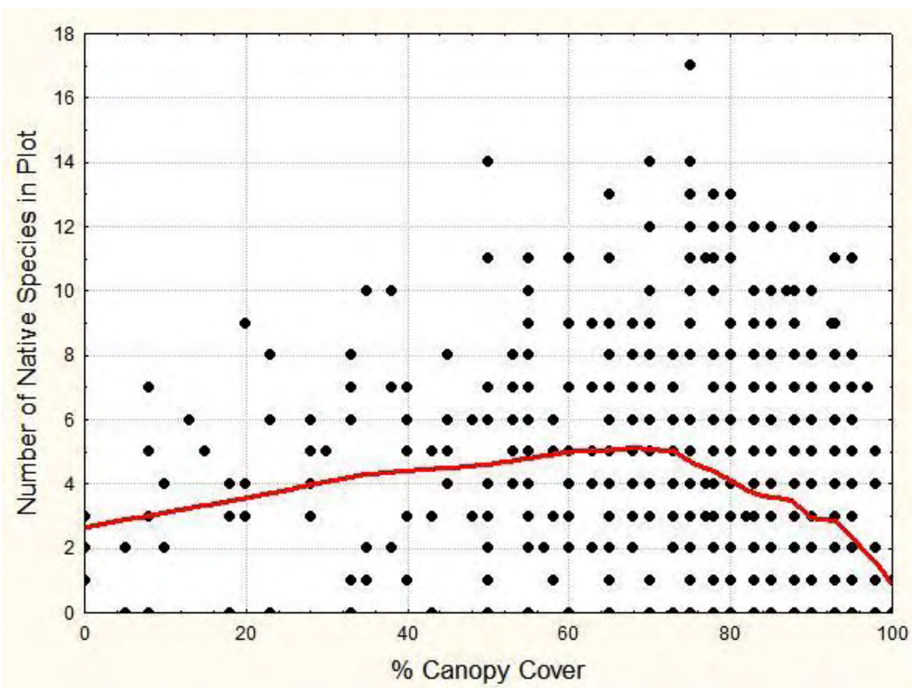

Figure 16: The relationship between the number of native herb species and % canopy cover in 878 sample plots; trend line in red.

The trend line in Figure 16 indicates, that the relationship between native herb species richness and canopy cover in the sample plots is best described as a curve, so we also included the square of %

canopy cover as a variable. In the final model both % canopy cover and (% canopy cover)^2 were highly significant ($p<.001$), the former positively and the latter negatively correlated with native species richness. As Figure 16 shows, native herb species numbers tend to increase with increasing canopy cover up to 75%, and decrease with increasing shade. The overall multiple regression model was highly significant (n=876; R2=.42; $p<.001$), but did not include the % cover by invasive shrubs.

Exploring one-on-one correlations, there was a barely significant ($p=.04$), slightly negative correlation between the native herb richness and the % cover of invasive shrubs. Upon closer examination (Figure 17), there was no relationship between these two variables as long as the coverage of invasive shrubs was below 20%. But for those 153 plots with at least 20% invasive shrub cover, there was a significant negative correlation with native herb richness ($p=.01$).

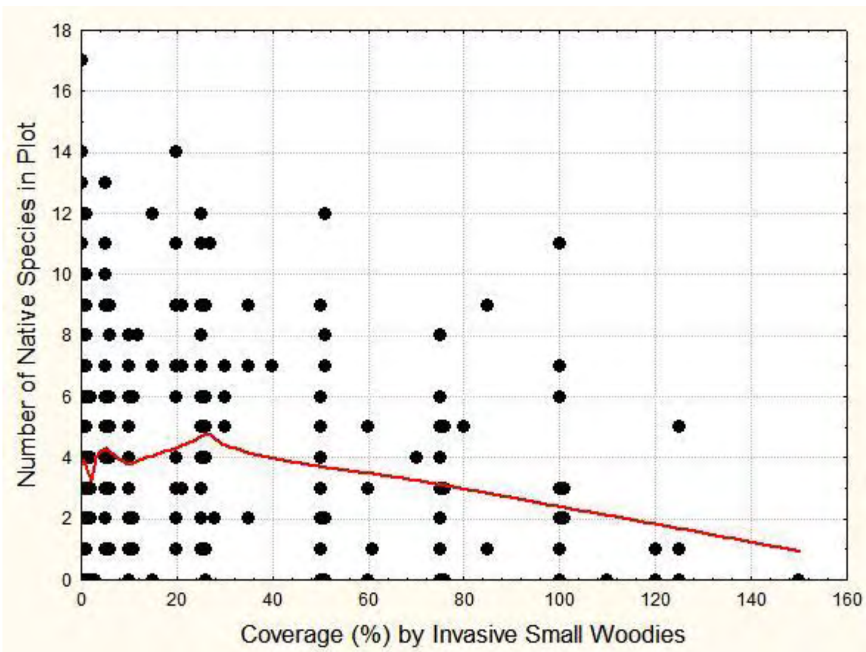

Figure 17: The relationship between the number of native herb species and the % cover of invasive shrubs in 878 sample plots; trend line in red.

Discussion of Patterns of Plant Diversity in Relation to Floodplain Forest Age

The statistical analysis revealed a strong correlation between floodplain forest age and native herb diversity, confirming a pattern well-documented in upland forests throughout the Northeast (Flinn & Vellend 2005). However, our evidence for why there are more native herbs growing in older floodplain forests remains sketchy. Flinn & Vellend (2005) discuss some of the mechanisms that can lead to impoverished ground flora in recent forests.

There might be a lack of propagules (seeds, tubers, runners, etc.) that survived the period of clearing in situ or arrived from somewhere else to begin the process of recolonization since the forest began to reestablish itself. If the forest had been cleared, the soil plowed and cultivated for many years, no seeds of native herbaceous forest plants might be present in the soil by the time reforestation begins, and populations of these plants have to start "from scratch" from seeds dispersed into the recent forest.

Bellemare et al. (2002) found that some differences in the plant communities between ancient and recent forests could be related to the species' seed dispersal mode. Wind- and animal dispersed (anemo- and endochores) species exhibited greater colonization ability than species with seeds that just drop. However, if we glance over the list of rare species that occurred exclusively or mostly in ancient floodplain forests, they include a number of wind- (e.g., Maidenhair Fern, Christmas Fern, and Zig-zag Aster), and animal-dispersed (e.g., Black and Blue Cohosh, and Red and White Baneberry) species, who should not have any problem colonizing recent forests, as long as seed sources are in the vicinity. The problem for these species might have been a lack of nearby seed sources. The distribution of ancient floodplain forest fragments in Dutchess and Columbia counties (Figures 2 and 3), combined with their often small size (Figure 4) suggests the very real possibility of lack of seed sources for re-colonization of recent floodplain forests. Experiments with seed introduction or enrichment planting could help determine whether the lack of colonization is the main reason for the impoverished herb layer in recent floodplain forests. However, other factors might be at work.

Flinn (2007) has shown that in upland forests, higher diversity in micro-habitats in ancient forests facilitated better establishment and persistence of native ferns compared to the more homogeneous forest floor in recent forests growing on formerly plowed fields. We analyzed our data to see if this might be the case in our floodplains, as well. While structural diversity tended to be somewhat higher in our ancient floodplain forest sites, the differences were not statistically significant and there was no indication of a positive correlation between native herb diversity and any of our measures for structural diversity.

Our own work in mostly ancient floodplain forests of Columbia County had initially suggested that competition with non-native herbs might limit native herb diversity within ancient forests (Knab-Vispo & Vispo 2009). However, in the expanded data set, non-native herb cover by mid-summer was about as common in ancient as in recent floodplain forests and, surprisingly, there was no indication of a negative correlation between non-native herb cover and native herb diversity. In other places, a negative correlation between Garlic Mustard density and native forest herb diversity has been documented (e.g., van Riper et al. 2010). It is possible that our data do not adequately represent the potential impact of

Garlic Mustard, an invasive biennial herb most prominent in early spring. Garlic Mustard was present at every single study site, and our mid-summer surveys of the ground vegetation certainly did not reflect its maximum % cover earlier in the season. A quantitative spring flora inventory would be needed to assess the relationship between the maximum cover of Garlic Mustard and both, the density and diversity of native spring ephemerals, as well as mid-summer native herbs.

While variables related to shading did not seem to be strongly correlated with native herb diversity at the site level, a closer look at measures of shade at the spatial scale of sample plots indicated that shading might limit native herb diversity above a certain threshold. Above ~70 % canopy cover, as well as above ~20% cover of invasive shrubs, native herb diversity was significantly negatively correlated with these variables. This suggests that the removal of dense populations of invasive shrubs in recent floodplain forest sites has the potential to facilitate an increase in native herb diversity, but that native herbs seem to co-exist quite well with a low density of invasive shrubs. The relationship between native herb diversity and canopy cover is interesting. The mid-summer native forest herb community seems to be most diverse at an intermediate level of shading (Fig. 16). Dense shade, typical for the ancient Sugar-Maple dominated floodplain forest, did not allow for a diverse mid-summer forest herb community. Again, a systematic survey of spring ephemerals might be needed to complement this statement. While our mid-summer surveys certainly allowed us to document remnants of the presence of spring ephemerals at the site level, we suspect that we were not able to document the presence of all species of spring ephemerals in each sample plot by mid-summer. It is interesting to note that for those forest types that were represented with ancient and recent transects, canopy cover tended to be slightly higher in the recent transects. However, we suspect that these differences were not ecologically significant and that the native herbaceous plants in the recently reforested floodplain transects were more limited by lack of colonization and, if their seeds did make it there, by shading or other interactions with invasive shrubs than by shading from the canopy.

The big questions that our study led to are: How do we expect the recently reforested sites to develop over time? Can we expect them to naturally and by themselves turn into ancient forests as we know them, if they were given enough time? And how long would that take? Or do we expect them to develop into a different kind of forest, one in which invasive shrubs still have a high presence centuries from now and native herb diversity might never resemble that of ancient forests that were established during a time when invasive plants were not yet as prominent in the landscape as they are today? Our ideas about the likely successional development of these recently reforested floodplains will inform the direction and intensity of potential restoration efforts. For example, does it make sense to put a lot of effort into the removal of invasive plants, if another factor is much more relevant in limiting the successful establishment of native plant communities? Is there any promise to enrichment planting/seeding of native plants in a recently reforested floodplain? Finally, could it be that native plant communities are doomed no matter what, as long as we maintain the high density of deer in our landscape? During the 2008 study, we found signs of deer browsing at every floodplain forest study site. Some native plants, such as Jewelweed, Blue Cohosh, Spicebush, Ash, and Choke Cherry were browsed preferentially, while others, such as Wood Nettle, White Wood Aster, Honewort, and Zig-zag Goldenrod were browsed proportional to their availability (Knab-Vispo and Vispo 2009). But we know since Augustine et al. (1998, cited in Côté et al. 2004) that deer browsing might only have a moderate impact on a species where it is common, but can lead to its local extinction where the plant is rare. Deer might make it particularly difficult for native plants to re-establish themselves in a recently reforested floodplain, where their seeds have to arrive little by little from somewhere else and new arrivals tend to start as rare plants at the particular site.

Conclusions

Few natural riparian communities remain in Dutchess and Columbia counties and ancient floodplain forests (i.e., those that have not been cleared at least during the last 100 years, possibly for much longer) have become a rare habitat in Columbia and Dutchess counties. Only 16% and 10% of the original extent of this habitat type remain in each county, respectively, compared to the national average of 30% (Brinson 1981). We conclude that ancient floodplain forest remnants are ecologically unique and potentially irreplaceable. They deserve high priority for conservation, especially in the few areas where large ancient floodplain forests remain.

That said, it should be emphasized that even recently reforested floodplains harbor unique biodiversity and can provide environmental services not provided by other land uses on alluvial soils. A set of specialized plants and animals hardly ever occur outside of riparian forests, but can be found both in ancient and recently reforested floodplain forests. Forested floodplains (independent of their age and species composition) can play an important role in supporting the in-stream food web and microhabitats, controlling water temperature, limiting surface runoff into the stream and serving as corridors for some wildlife. Nobody knows where the natural succession of recent floodplain forests will lead, but the re-colonization of their native herb communities might be actively promoted by removal of dense invasive shrubs and the introduction of seeds or enrichment planting, especially if deer browsing can be limited.

We encourage the reforestation of floodplains wherever feasible, as well as any measure that limits soil erosion from those floodplains that remain in agricultural used. Conversion of tilled fields in the floodplain into well-managed permanent pasture/hayfields might go a long way towards keeping the soil in place and are probably the most sustainable agricultural use of floodplains. Corn or vegetable fields, even if they are no-till, likely leave the soil much more prone to erosion during a flooding event than a well-established, perennial sward of grasses and legumes.

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Appendix 1 page 1: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native[1)]/ invasive[2)]	Habitat in Columbia and Dutchess County	rarity[3)]	protected	Freq.[4)]	Freq.[5)]
Allegheny monkey-flower	*Mimulus ringens*	native				39%	*53%*
Alsike clover	*Trifolium hybridum*					6%	*13%*
Alternate-leaved dogwood	*Cornus alternifolia*	native				3%	*7%*
American beech	*Fagus grandifolia*	native				3%	*0%*
American elm	*Ulmus americana*	native				100%	*100%*
American germander	*Teucrium canadense*	native	alm. excl. floodplain	CCr, DCr		19%	*27%*
Anise root	*Osmorhiza longistylis*	native	alm. excl. floodplain	CCu, DCu		16%	*20%*
Apple	*Pyrus malus*					13%	*0%*
Arrow-lvd tearthumb	*Polygonum sagittatum*	native				55%	*80%*
Arrow-wood	*Viburnum dentatum var. lucidum*	native				3%	*7%*
Asiatic dayflower	*Commelina communis*					35%	*27%*
Autumn olive	*Elaeagnus umbellata*	invasive				6%	*0%*
Barnyard-grass	*Echinochloa crusgalli*					10%	*20%*
Barren strawberry	*Waldsteinia fragarioides*	native	rich mesic forests			3%	*7%*
Basswood	*Tilia americana*	native	rich mesic forests			97%	*100%*
Biennial gaura	*Gaura biennis*	native		CCu		3%	*0%*
Birdsfoot trefoil	*Lotus corniculatus*					3%	*7%*
Bitternut	*Carya cordiformis*	native				100%	*100%*
Bittersweet	*Solanum dulcamara*	invasive				10%	*13%*
Black ash	*Fraxinus nigra*	native		CCu		6%	*13%*
Black bindweed	*Polygonum convolvulus*					6%	*7%*
Black cohosh	*Cimicifuga racemosa*	native	rich mesic forests	CCr, DCr		3%	*7%*
Black haw	*Viburnum prunifolium*	native				6%	*0%*
Black locust	*Robinia pseudoacacia*	invasive				55%	*47%*
Black medick	*Medicago lupulina*					3%	*7%*
Black mustard	*Brassica nigra*					10%	*7%*
Black oak	*Quercus velutina*	native				3%	*7%*
Black snakeroot	*Sanicula marilandica*	native				3%	*0%*
Black walnut	*Juglans nigra*	native	mostly floodplain			13%	*13%*
Black willow	*Salix nigra*	native	mostly floodplain			10%	*7%*
Blackberries	*Rubus allegheniensis*	native				29%	*20%*
Blackcap raspberry	*Rubus occidentalis*	native				6%	*0%*
Bladder-nut	*Staphylea trifolia*	native	rich mesic forests	CCu		23%	*20%*
Bloodroot	*Sanguinaria canadensis*	native	rich mesic forests		NYS protected	77%	*87%*
Blue cohosh	*Caulophyllum thalictroides*	native	rich mesic forests	HuV-s		55%	*73%*
Blue marsh violet	*Viola cucullata*	native				10%	*13%*
Blue-eyed grass	*Sisyrinchium angustifolium*	native				3%	*0%*
Blue-stemmed goldenrod	*Solidago caesia*	native				10%	*20%*
Boneset	*Eupatorium perfoliatum*	native				26%	*53%*
Bottlebrush grass	*Elymus hystrix*	native	rich mesic forests			55%	*67%*
Boxelder	*Acer negundo*		alm. excl. floodplain			52%	*67%*
Bristly crowfoot	*Ranunculus pensylvanicus*	native				6%	*7%*

Appendix 1 page 2: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native[1)]/ invasive[2)]	Habitat in Columbia and Dutchess County	rarity[3)]	protected	Freq.[4)]	Freq.[5)]
Broad-leaved dock	*Rumex obtusifolius*					42%	*60%*
Broad-leaved sedge	*Carex platyphylla*	native				6%	*13%*
Broad-leaved spring beauty	*Claytonia caroliniana*	native		CCu		3%	*7%*
Bull-thistle	*Cirsium vulgare*					3%	*0%*
Bur-cucumber	*Sicyos angulatus*	native	mostly floodplain			6%	*7%*
Bur-marigold	*Bidens cernua*	native				10%	*20%*
Bur-reed sedge	*Carex sparganoides var. sparganoides*	native				6%	*0%*
Butternut	*Juglans cinerea*	native	mostly floodplain	CCu	NYS protected	35%	*20%*
Canada brome	*Bromus altissimus*	native	alm. excl. floodplain			19%	*27%*
Canada goldenrod	*Solidago canadensis*	native				35%	*47%*
Canada mayflower	*Maianthemum canadense*	native				10%	*13%*
Canada thistle	*Cirsium arvense*	invasive				13%	*20%*
Canadian anemone	*Anemone canadensis*	native				13%	*13%*
Cardinal flower	*Lobelia cardinalis*	native	mostly floodplain	CCr	NYS protected	13%	*13%*
Carrion flower	*Smilax herbacea*	native				26%	*33%*
Catalpa	*Catalpa speciosa*	native				10%	*13%*
Celandine	*Chelidonium majus*	invasive				39%	*53%*
Chinese spindle-tree	*Euonymus fortunei*					3%	*7%*
Chinese tree lilac	*Syringa pekinensis*					6%	*0%*
Choke cherry	*Prunus virginiana*	native				52%	*60%*
Chokeberry	*Pyrus cf. melanocarpa*	native				3%	*7%*
Christmas-fern	*Polystichum acrostichoides*	native			NYS protected	16%	*20%*
Cinnamon-fern	*Osmunda cinnamomea*	native			NYS protected	6%	*7%*
Clearweed, Richweed	*Pilea pumila*	native				97%	*100%*
Cleavers	*Galium aparine*	native				52%	*53%*
Clustered snakeroot	*Sanicula canadensis*	native	rich mesic forests			13%	*7%*
Cocklebur	*Xanthium strumarium*	native				39%	*60%*
Coltsfoot	*Tussilago farfara*	invasive				32%	*53%*
Common agrimony	*Agrimonia gyrosepala*	native				3%	*40%*
Common blue heart-lvd aster	*Aster cordifolius*	native				3%	*7%*
Common blue violet	*Viola sororia (incl. V. papilionaceae)*	native				74%	*60%*
Common buckthorn	*Rhamnus cathartica*	invasive				35%	*13%*
Common burdock	*Arctium minus*					13%	*20%*
Common buttercup	*Ranunculus acris*					3%	*7%*
Common chickweed	*Stellaria media*					45%	*73%*
Common cinquefoil (or. Running five-finger)	*Potentilla simplex (or. P. canadensis)*	native				10%	*7%*
Common dodder	*Cuscuta gronovii*	native				16%	*33%*
Common elderberry	*Sambucus canadensis*	native				16%	*33%*
Common enchanter's nightshade	*Circaea lutetiana*	native				100%	*100%*
Common evening primrose	*Oenothera biennis*	native				13%	*20%*
Common flat-topped goldenrod	*Euthamia graminifolia*	native				6%	*7%*

Appendix 1 page 3: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia and Dutchess County	rarity[3]	protected	Freq.[4]	Freq.[5]
Common lamb's quarters	*Chenopodium album*					13%	*27%*
Common mikweed	*Asclepias syriaca*	native				26%	*27%*
Common mullein	*Verbascum thapsus*					3%	*7%*
Common nightshade, Black nightshade	*Solanum nigrum*	native				6%	*13%*
Common plantain	*Plantago major*					42%	*67%*
Common poison-ivy	*Toxicodendron radicans*	native				97%	*100%*
Common prickly ash	*Zanthoxylum americanum*	native				3%	*0%*
Common privet	*Ligustrum vulgare*	invasive				16%	*27%*
Common quickweed	*Galinsoga quadriradiata*					6%	*13%*
Common ragweed	*Ambrosia artemisiifolia*	native				39%	*53%*
Common reed	*Phragmites australis*	invasive				10%	*7%*
Common sneezeweed	*Helenium autumnale*	native	mostly floodplain			10%	*7%*
Common stitchwort	*Stellaria graminea*					3%	*0%*
Common tansy	*Tanacetum vulgare*					6%	*13%*
Common vervain	*Verbena hastata*	native				19%	*33%*
Common water purslane	*Ludwigia palustris*	native				16%	*27%*
Common woodreed	*Cinna arundinacea*	native				61%	*80%*
Common wood-sorrel	*Oxalis stricta*	native				94%	*100%*
Cottonwood	*Populus deltoides*	native	mostly floodplain			68%	*80%*
Crab-grass	*Digitaria sanguinalis*					6%	*7%*
Crack willow	*Salix fragilis*		mostly floodplain			10%	*7%*
Creeping buttercup	*Ranunculus repens*	invasive				3%	*0%*
Cuckoo-flower	*Cardamine pratensis*					10%	*20%*
Curly Dock	*Rumex crispus*					3%	*0%*
Cut-leaved toothwort	*Dentaria laciniata*	native	rich mesic forests			35%	*53%*
Cut-leaved water-horehound	*Lycopus americanus*	native				10%	*20%*
Dame's rocket	*Hesperis matronalis*	invasive	mostly floodplain			87%	*100%*
Dandelion	*Taraxacum officinale*					32%	*47%*
Dark green bullrush	*Scirpus atrovirens*	native				3%	*0%*
Davis's sedge	*Carex davisii*	native	alm. excl. floodplain	NYS-S2	NYS protected	32%	*27%*
Day lily	*Hemerocallis fulva*					32%	*53%*
Deer tongue grass	*Panicum clandestinum*	native				52%	*53%*
Dewberry	*Rubus flagellaris*	native				10%	*13%*
Diamond willow	*Salix eriocephala*	native				3%	*7%*
Ditch stonecrop	*Penthorum sedoides*	native				23%	*33%*
Dock-leaved smartweed	*Polygonum lapathifolium*	native				32%	*47%*
Dotted hawthorn	*Crataegus cf. punctata*	native				3%	*0%*
Dotted smartweed	*Polygonum punctatum*	native				19%	*40%*
Dotted St. John's-wort	*Hypericum punctatum*	native				6%	*13%*
Duckweed	*Lemna spp.*	native				6%	*0%*
Dutchman's breeches	*Dicentra cucullaria*	native	rich mesic forests	HuV-s?		39%	*60%*
Dwarf St. John's-wort	*Hypericum mutilum*	native				6%	*13%*

Appendix 1 page 4: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native[1)]/ invasive[2)]	Habitat in Columbia and Dutchess County	rarity[3)]	protected	Freq.[4)]	Freq.[5)]
Early goldenrod	*Solidago juncea*	native				3%	*7%*
Early meadow rue	*Thalictrum dioicum*	native	rich mesic forests			29%	*53%*
Eastern bluebell	*Mertensia virginica*	native	mostly floodplain	CCr, DCr	NYS protected	6%	*7%*
Eastern lined aster	*Aster lanceolatus*	native				19%	*40%*
Eastern red cedar	*Juniperus virginiana*	native				3%	*0%*
Eastern star-sedge	*Carex radiata*	native				19%	*20%*
Eastern willow-herb	*Epilobium coloratum*	native				10%	*13%*
Eastern woodland sedge	*Carex blanda*	native	rich mesic forests			32%	*33%*
English plantain, "Rib Grass"	*Plantago lanceolata*					3%	*7%*
Euonymus	*Euonymus sp.*					3%	*0%*
Fall panicum	*Panicum dichotomiflorum*	native				3%	*7%*
False bromegrass	*Brachypodium sylvaticum*					10%	*0%*
False buckwheat	*Polygonum scandens*					26%	*47%*
False hellebore	*Veratrum viride*	native				52%	*80%*
False mermaid weed	*Floerkea proserpinacoides*	native	alm. excl. floodplain	HuV-r		65%	*87%*
False nutsedge	*Cyperus strigosus*	native				3%	*0%*
False pimpernel	*Lindernia dubia var. dubia*	native	mostly floodplain			3%	*7%*
False Solomon's seal	*Smilacina racemosa*	native				65%	*93%*
False sunflower	*Heliopsis helianthoides*	native				3%	*7%*
False Waterpepper	*Polygonum hydropiperoides*	native				6%	*0%*
False-nettle	*Boehmeria cylindrica*	native				65%	*73%*
Field bindweed	*Convolvulus arvensis*					3%	*0%*
Field garlic	*Allium vineale*	invasive				45%	*67%*
Field peppergrass	*Lepidium campestre*					3%	*7%*
Figwort	*Scrophularia marilandica*	native	mostly floodplain	CCr, DCr		26%	*27%*
Fireweed, Pilewort	*Erechtites hieraciifolia*	native				10%	*7%*
Flatsedge	*Cyperus sp.*	native				16%	*27%*
Foam flower	*Tiarella cordifolia*	native	rich mesic forests			6%	*7%*
Forest sunflower	*Helianthus decapetalus*	native	mostly floodplain			39%	*53%*
Forest-goldenrod	*Solidago arguta*	native				6%	*13%*
Forest-muhly	*Muhlenbergia sylvatica*	native	mostly floodplain			29%	*40%*
Forked chickweed	*Paronychia canadensis*	native				3%	*7%*
Fowl mannagrass	*Glyceria striata*	native				3%	*7%*
Fox sedge	*Carex vulpinoidea*	native				3%	*0%*
Fragile fern	*Cystopteris fragilis*	native			NYS protected	10%	*20%*
Frindged bindweed	*Polygonum cilinode*	native				19%	*20%*
Fringed loosestrife	*Lysimachia ciliata*	native				29%	*33%*
Fringed sedge	*Carex crinita*	native				26%	*33%*
Frost grape	*Vitis riparia*	native				3%	*0%*
Garden loosestrife	*Lysimachia vulgaris*					3%	*0%*
Garlic mustard	*Alliaria petiolata*	invasive				100%	*100%*

Appendix 1 page 5: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native1)/ invasive2)	Habitat in Columbia and Dutchess County	rarity3)	protected	Freq.4)	Freq.5)
Giant chickweed	*Stellaria aquatica*					55%	*73%*
Giant foxtail	*Setaria faberi*					13%	*27%*
Giant ragweed	*Ambrosia trifida*	native	alm. excl. floodplain	HuV-s		35%	*47%*
Gill-over-the-ground, Ground ivy	*Glechoma hederacea*	invasive				52%	*60%*
Goblet aster	*Aster lateriflorus*	native				61%	*67%*
Golden Alexanders	*Zizia aurea*	native				32%	*53%*
Golden carpet, Mossy stonecrop	*Sedum acre*					3%	*0%*
Golden ragwort	*Senecio aureus*	native				6%	*13%*
Gooseberry	*Ribes sp.*					19%	*33%*
Goutweed	*Aegopodium podagraria*	invasive				10%	*7%*
Graceful sedge	*Carex gracillima*	native				10%	*13%*
Grass	*Poa alsodes*	native				6%	*0%*
Gray's sedge	*Carex grayi*	native	mostly floodplain			29%	*27%*
Great lobelia	*Lobelia siphilitica*	native		CCu	NYS protected	6%	*0%*
Green ash	*Fraxinus pensylvanica*	native	mostly floodplain			84%	*80%*
Green dragon	*Arisaema dracontium*	native	alm. excl. floodplain	HuV-r	NYS protected	32%	*47%*
Green foxtail	*Setaria viridis*	native				3%	*7%*
Green water arum, Arrow-arum	*Peltandra virginica*	native				3%	*0%*
Green-headed coneflower, Cut-leaf coneflower	*Rudbeckia laciniata*	native	mostly floodplain	HuV-s		10%	*13%*
Grey birch	*Betula populifolia*	native				3%	*0%*
Grey-twig dogwood	*Cornus racemosa*	native				45%	*47%*
Groundnut	*Apios americana*	native		CCu		6%	*13%*
Hackberry	*Celtis occidentalis*	native	mostly floodplain	HuV-u, CCu, DCu		26%	*20%*
Hairgrass	*Deschampsia flexuosa*	native				3%	*7%*
Hairy wild-rye	*Elymus villosus*	native	alm. excl. floodplain			23%	*27%*
Hairy-fruited sedge	*Carex trichocarpa*	native	mostly floodplain?	HuV-o?		19%	*27%*
Halbert-lvd tearthumb	*Polygonum arifolium*	native				16%	*20%*
Hayscented fern	*Dennstaedtia punctilobula*	native				3%	*0%*
Heal-all	*Prunella vulgaris*					13%	*20%*
Hedge bindweed	*Calystegia sepium*					19%	*27%*
Hedge-nettle	*Stachys tenuifolia var. hispida*	native	alm. excl. floodplain	CCu		10%	*13%*
Helleborine	*Epipactis helleborine*					48%	*60%*
Hemlock	*Tsuga canadensis*	native				3%	*7%*
Hemlock-parsley	*Conioselinum chinese*					3%	*0%*
Hempnettle	*Galeopsis tetrahit*					23%	*27%*
Herb-robert	*Geranium robertianum*	native	rich mesic forests			16%	*27%*
Hispid buttercup	*Ranunculus hispidus*	native				26%	*20%*
Hog-peanut	*Amphicarpaea bracteata*	native				65%	*73%*
Honewort	*Cryptotaenia canadensis*	native	rich mesic forests			84%	*100%*

Appendix 1 page 6: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia and Dutchess County	rarity[3]	protected	Freq.[4]	Freq.[5]
Honey locust	*Gleditsia triacanthos*					19%	*20%*
Honeysuckle (not Tartarian)	*Lonicera sp.A*					3%	*0%*
Hooked crowsfoot	*Ranunculus recurvatus*	native				26%	*27%*
Hop sedge	*Carex lupulina*	native				23%	*27%*
Horse nettle	*Solanum carolinense*					3%	*0%*
Horse-balm	*Collinsonia canadensis*	native	rich mesic forests			10%	*13%*
Horse-gentian	*Triosteum aurantiacum*	native		CCu		6%	*0%*
Horsetail	*Equisetum arvense*	native				26%	*33%*
Hybrid vervain	*Verbena x engelmannii*	native		CCr		3%	*7%*
Indian pipe	*Monotropa uniflora*	native				6%	*13%*
Indian tobacco	*Lobelia inflata*	native				6%	*0%*
Interrupted fern	*Osmunda claytoniana*	native			NYS protected	10%	*13%*
Iris	*Iris sp.*					16%	*0%*
Ironwood	*Ostrya virginiana*	native				39%	*47%*
Jack in the pulpit	*Arisaema triphyllum*	native	rich mesic forests			87%	*100%*
Japanese barberry	*Berberis thunbergii*	invasive				68%	*73%*
Japanese hedge-parsley	*Torilis japonica*					23%	*27%*
Japanese hops	*Humulus japonicus*	invasive	mostly floodplain			6%	*7%*
Japanese knotweed	*Polygonum cuspidatum*	invasive	mostly floodplain			39%	*40%*
Japanese spiraea	*Spiraea japonica*	invasive				3%	*0%*
Japanese stiltgrass	*Microstegium vimineum*	invasive	mostly floodplain			77%	*80%*
Jumpseed	*Polygonum virginianum*	native				97%	*93%*
Kentucky bluegrass	*Poa pratensis*					10%	*0%*
Knotroot foxtail	*Setaria geniculata*	native				6%	*13%*
Knotweed	*Polygonum aviculare*					10%	*13%*
Lady-fern	*Athyrium filix-femina*	native			NYS protected	35%	*40%*
Lady's thumb	*Polygonum persicaria*					52%	*87%*
Large-flowered bellwort	*Uvularia grandiflora*	native	rich mesic forests	HuV-s?		6%	*7%*
Large-tooth aspen	*Populus grandidentata*	native				3%	*0%*
Leatherwood	*Dirca palustris*	native		HuV-r		3%	*7%*
Live-forever	*Sedum purpureum*					3%	*7%*
Long-bristled smartweed	*Polygonum caespitosum*	invasive				58%	*73%*
Lopseed	*Phryma leptostachya*	native	mostly floodplain	HuV-r		19%	*33%*
Low cudweed	*Gnaphalium uliginosum*					3%	*7%*
Mad-dog skullcap	*Scutellaria lateriflora*	native				19%	*33%*
Maidenhair fern	*Adiantum pedatum*	native	rich mesic forests	CCu	NYS protected	3%	*7%*
Maple-leaved viburnum	*Viburnum acerifolium*	native				3%	*7%*
Maple-leaved waterleaf	*Hydrophyllum canadense*	native	rich mesic forests	CCr		3%	*7%*
Marsh buttercup	*Ranunculus hispidus var. caricetorum*	native				42%	*53%*
Marsh pea	*Lathyrus palustris*	native	alm. excl. floodplain	HuV-r		3%	*7%*
Marsh pennywort	*Hydrocotyle americana*	native				3%	*7%*
Mayapple	*Podophyllum peltatum*	native	rich mesic forests	HuV-s		13%	*20%*
Meadow lily	*Lilium canadense*	native	mostly floodplain	HuV-s	NYS protected	42%	*47%*
Meadowsweet	*Spiraea alba var. latifolia*	native				3%	*0%*
Mint	*Mentha sp.*					23%	*33%*
Moneywort	*Lysimachia nummularia*	invasive				77%	*80%*

Appendix 1 page 7: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia and Dutchess County	rarity[3]	protected	Freq.[4]	Freq.[5]
Moonseed	*Menispermum canadense*	native		HuV-s		19%	*20%*
Moth mullein	*Verbascum blattaria*					3%	*0%*
Motherwort	*Leonurus cardiaca*					3%	*7%*
Mouse-ear chickweed	*Cerastium vulgatum*					6%	*13%*
Mugwort	*Artemesia vulgaris*					23%	*20%*
Multiflora rose	*Rosa multiflora*	invasive				100%	*100%*
Musclewood, Blue beech	*Carpinus caroliniana*	native				58%	*67%*
Nannyberry	*Viburnum lentago*	native				39%	*40%*
Narrow-leaved bittercress	*Cardamine impatiens*	invasive				32%	*0%*
Narrow-leaved spring beauty	*Claytonia virginica*	native	mostly floodplain	HuV-s?, CCu, DCu		39%	*40%*
New York fern	*Thelypteris noveboracensis*	native			NYS protected	6%	*7%*
New-England aster	*Aster novae-angliae*	native				3%	*7%*
Nodding fescue	*Festuca subverticillata*	native				55%	*87%*
Nodding trillium	*Trillium cernuum*	native	mostly floodplain	CCr, DCr	NYS protected	3%	*7%*
Northeastern mannagrass	*Glyceria melicaria*	native				10%	*7%*
Northern blueflag, Iris	*Iris versicolor*	native				19%	*40%*
Northern water-horehound	*Lycopus uniflorus*	native				6%	*13%*
Norway maple	*Acer platanoides*	invasive				39%	*40%*
Oak	*Quercus sp.*	native				3%	*0%*
Orchard grass	*Dactylis glomerata*					3%	*0%*
Oriental bittersweet	*Celastrus orbiculatus*	invasive				61%	*47%*
Ostrich fern	*Matteuccia struthiopteris*	native	alm. excl. floodplain	HuV-u	NYS protected	81%	*87%*
Panic grass	*Panicum lanuginosum*	native				6%	*13%*
Panicled hawkweed	*Hieracium paniculatum*	native				3%	*7%*
Pear	*Pyrus communis*					3%	*7%*
Pennsylvania bittercress	*Cardamine pensylvanica*	native				39%	*60%*
Pennsylvania sedge	*Carex pensylvanica*	native				10%	*13%*
Pennsylvania smartweed	*Polygonum pensylvanicum*	native				10%	*20%*
Perfoliate bellwort	*Uvularia perfoliata*	native				3%	*7%*
Periwinkle	*Vinca minor*					10%	*20%*
Pignut	*Carya glabra*	native				10%	*13%*
Pin oak	*Quercus palustris*	native				3%	*0%*
Pokeweed	*Phytolacca americana*	native				13%	*20%*
Poorman's pepper	*Lepidium virginicum*	native				3%	*0%*
Pubescent sedge	*Carex hirtifolia*	native	rich mesic forests			45%	*60%*
Purple loosestrife	*Lythrum salicaria*	invasive				58%	*80%*
Purple sneezeweed	*Helenium flexuosum*	native				3%	*7%*
Purple-flowering raspberry	*Rubus odoratus*	native				3%	*7%*
Purplestem Angelica	*Angelica atropurpurea*	native				23%	*33%*
Purplestem beggar-tick	*Bidens connata*	native				3%	*7%*
Purple-stemmed aster	*Aster puniceus*	native				3%	*7%*

Appendix 1 page 8: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native1)/ invasive2)	Habitat in Columbia and Dutchess County	rarity3)	protected	Freq.4)	Freq.5)
Red baneberry	*Actaea rubra*	native	rich mesic forests	HuV-s	NYS protected	3%	*7%*
Red garden current	*Ribes sativum*					3%	*7%*
Red maple	*Acer rubrum*	native				61%	*53%*
Red mulberry	*Morus rubra*	native		HuV-r?s?		6%	*7%*
Red oak	*Quercus rubra*	native				68%	*67%*
Red trillium	*Trillium erectum*	native			NYS protected	29%	*47%*
Reed canary-grass	*Phalaris arundinacea*	invasive				81%	*100%*
Rice cutgrass	*Leersia oryzoides*	native				10%	*13%*
Rose	*Rosa sp.*					3%	*0%*
Rough cinquefoil	*Potentilla norvegica*	native				3%	*0%*
Rough-stemmed avens	*Geum laciniatum*	native				3%	*7%*
Round-lobed hepatica	*Hepatica americana*	native				10%	*20%*
Royal fern	*Osmunda regalis*	native			NYS protected	6%	*0%*
Rue anemone	*Anemonella thalictroides*	native	rich mesic forests			3%	*7%*
Russian olive	*Elaeagnus angustifolia*	invasive				3%	*7%*
Sandwort	*Arenaria lateriflora*	native				3%	*7%*
Sawbeak sedge	*Carex stipata*	native				3%	*0%*
Scarlet hawthorn	*Crataegus cf. coccinea*	native				3%	*0%*
Scouring rush	*Equisetum hyemale*	native				10%	*20%*
Sedge	*Carex appalachica*	native				3%	*0%*
Sedge	*Carex bromoides*	native				10%	*0%*
Sedge	*Carex cephalophora*	native				3%	*0%*
Sedge	*Carex cf. rosea*	native				3%	*0%*
Sedge	*Carex granularis*	native				3%	*0%*
Sedge	*Carex grisea*	native	alm. excl. floodplain?			26%	*0%*
Sedge	*Carex intumescens*	native				3%	*0%*
Sedge	*Carex leptonervia*	native				6%	*0%*
Sedge	*Carex normalis*	native				6%	*0%*
Sedge	*Carex projecta*	native				3%	*0%*
Sedge	*Carex tribuloides*	native				3%	*0%*
Sensitive fern	*Onoclea sensibilis*	native			NYS protected	77%	*80%*
Sessile-leaved bellwort	*Uvularia sessilifolia*	native				29%	*40%*
Shadbush	*Amelanchier sp.*	native				3%	*0%*
Shagbark hickory	*Carya ovata*	native				29%	*13%*
Shallow sedge	*Carex lurida*	native				3%	*0%*
Silky dogwood	*Cornus amomum var. amomum*	native				19%	*20%*
Silky willow	*Salix sericea*	native				3%	*7%*
Silver maple	*Acer saccharinum*	native	alm. excl. floodplain			55%	*40%*
Skunk cabbage	*Symplocarpus foetidus*	native				65%	*73%*
Slippery elm	*Ulmus rubra*	native	mostly floodplain			55%	*40%*
Small-flowered agrimony	*Agrimonia parviflora*	native				3%	*0%*
Small-flowered crowfoot, Kidney-leaved buttercup	*Ranunculus abortivus*	native	rich mesic forests			19%	*27%*
Smooth alder?	*Alnus cf. serrulata*	native				3%	*0%*

Appendix 1 page 9: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia and Dutchess County	rarity[3]	protected	Freq.[4]	Freq.[5]
Smooth goldenrod, Late goldenrod	*Solidago gigantea*	native				81%	*93%*
Soapwort	*Saponaria officinalis*					19%	*33%*
Soft rush	*Juncus effusus*	native				3%	*0%*
Solomon's seal	*Polygonatum biflorum*	native				10%	*20%*
Solomon's seal	*Polygonatum pubescens*	native				10%	*13%*
Solomon's seal	*Polygonatum sp.*	native				29%	*40%*
Speckled alder	*Alnus incana*	native				3%	*40%*
Spicebush	*Lindera benzoin*	native				71%	*60%*
Spotted jewelweed	*Impatiens capensis*	native				94%	*100%*
Spotted Joe-pye-weed	*Eupatorium maculatum*	native				42%	*67%*
Spotted knapweed	*Centaurea maculosa*	invasive				3%	*7%*
Spreading dogbane	*Apocynum androsaemifolium*	native				3%	*0%*
Sprengel's sedge	*Carex sprengelii*	native	alm. excl. floodplain	HuV-r?		6%	*0%*
Squarrose sedge	*Carex squarrosa*	native		HuV-s		3%	*0%*
St. John's-wort	*Hypericum perforatum*					16%	*13%*
Staghorn sumac	*Rhus typhina*	native				19%	*33%*
Star-of-Bethlehem	*Ornithogalum umbellatum*					39%	*60%*
Stickseed	*Hackelia virginiana*	native				55%	*53%*
Stinging nettle	*Urtica dioica*	native				61%	*80%*
Strawstem beggar-tick	*Bidens comosa*	native				6%	*13%*
Streambank wild rye	*Elymus riparius*	native	mostly floodplain			48%	*40%*
Sugar maple	*Acer saccharum*	native				84%	*93%*
Swamp azalea	*Rhododendron viscosum*	native				3%	*7%*
Swamp candle	*Lysimachia terrestris*	native				3%	*0%*
Swamp rose	*Rosa palustris*	native				3%	*7%*
Swamp white oak	*Quercus bicolor*	native				23%	*27%*
Swamp-milkweed	*Asclepias incarnata*	native				10%	*20%*
Sweet cicely	*Osmorhiza claytonii*	native	rich mesic forests	CCu		26%	*27%*
Sweet-scented bedstraw	*Galium triflorum*	native				3%	*7%*
Sycamore	*Platanus occidentalis*	native	mostly floodplain			84%	*80%*
Tall meadow rue	*Thalictrum pubescens*	native				45%	*53%*
Tall white beard-tongue	*Penstemon digitalis*	native				3%	*0%*
Tartarian honeysuckle	*Lonicera sp.*	invasive				68%	*60%*
Thimbleweed	*Anemone virginiana*	native				3%	*0%*
Three- seeded mercury	*Acalypha rhomboidea*	native				23%	*40%*
Thyme-leaved speedwell	*Veronica serpyllifolia var. serpyllifolia*					13%	*27%*
Toothwort	*Dentaria diphylla*	native	rich mesic forests			26%	*47%*
Toringo crab	*Pyrus sieboldii*					3%	*0%*
Tree of heaven	*Ailanthus altissima*	invasive				19%	*13%*
Trembling aspen	*Populus tremuloides*	native				23%	*7%*
Trout lily	*Erythronium americanum*	native	mostly floodplain			65%	*100%*
True forget-me-not	*Myosotis scorpioides*	invasive				29%	*47%*
Tulip-tree	*Liriodendron tulpifera*	native				3%	*0%*

Appendix 1 page 10: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native[1])/ invasive[2])	Habitat in Columbia and Dutchess County	rarity[3])	protected	Freq.[4])	Freq.[5])
Turtlehead	*Chelone glabra*	native			NYS protected	26%	*53%*
Tussock sedge	*Carex stricta*	native				23%	*33%*
Twisted sedge	*Carex torta*	native	alm. excl. floodplain			6%	*7%*
Virginia creeper	*Parthenocissus quinquefolia*	native				100%	*100%*
Virginia waterleaf	*Hydrophyllum virginianum*	native	rich mesic forests			32%	*53%*
Virgin's bower	*Clematis virginiana*	native				35%	*40%*
Water hemlock	*Cicuta maculata*	native				3%	*0%*
Water speedwell	*Veronica anagallis-aquatica*					16%	*27%*
Water starwort	*Callitriche sp.*	native				3%	*0%*
Watercress	*Rorippa nasturtium-aquaticum*	invasive				3%	*0%*
Water-horehound	*Lycopus virginicus*	native				3%	*7%*
Waterpepper	*Polygonum hydropiper*					52%	*93%*
Water-plantain	*Alisma sp.*	native				16%	*20%*
White ash	*Fraxinus americana*	native				42%	*67%*
White avens	*Geum canadense*	native				58%	*47%*
White baneberry, Dolls-eyes	*Actaea alba*	native	rich mesic forests		NYS protected	6%	*13%*
White birch	*Betula papyrifera*	native				3%	*7%*
White clover	*Trifolium repens*					10%	*20%*
White grass	*Leersia virginica*	native	mostly floodplain			94%	*93%*
White oak	*Quercus alba*	native				3%	*7%*
White pine	*Pinus strobus*	native				3%	*0%*
White snakeroot	*Eupatorium rugosum*	native				65%	*80%*
White sweet clover	*Melilotus alba*					10%	*20%*
White vervain	*Verbena urticifolia var. urticifolia*	native				58%	*73%*
White wood aster	*Aster divaricatus*	native				65%	*73%*
Whorled loosestrife	*Lysimachia quadrifolia*	native				3%	*7%*
Wild black cherry	*Prunus serotina*	native				81%	*93%*
Wild carrot, Queen Ann's Lace	*Daucus carota*					13%	*13%*
Wild cucumber	*Echinocystis lobata*	native	mostly floodplain			16%	*13%*
Wild geranium	*Geranium maculatum*	native	rich mesic forests			71%	*73%*
Wild ginger	*Asarum canadense*	native	rich mesic forests	CCu		48%	*33%*
Wild leek	*Allium tricoccum*	native	rich mesic forests			87%	*93%*
Wild lettuce	*Lactuca canadensis*	native				10%	*13%*
Wild madder	*Galium mollugo*					16%	*20%*
Wild mint	*Mentha arvensis*					6%	*7%*
Wild onion	*Allium canadense*	native	mostly floodplain			58%	*67%*
Wild radish, Jointed charlock	*Raphanus raphanistrum*					10%	*20%*
Wild rye	*Elymus canadensis*	native	mostly floodplain			19%	*33%*
Wild rye	*Elymus virginicus*	native	alm. excl. floodplain			32%	*40%*
Wild stonecrop	*Sedum ternatum*	native				10%	*7%*

Appendix 1 page 11: List of plants documented in 31 floodplain forest study sites in Columbia and Dutchess County
(footnotes at bottom of last page)

Common Name	Scientific Name	native[1]/ invasive[2]	Habitat in Columbia and Dutchess County	rarity[3]	protected	Freq.[4]	Freq.[5]
Wild strawberry	*Fragaria virginiana*	native				3%	*0%*
Wild yam, Colic-root	*Dioscorea villosa*	native				32%	*0%*
Winged burning bush	*Euonymus alatus*	invasive				6%	*13%*
Winged monkeyflower	*Mimulus alata*	native	alm. excl. floodplain	NYS-S3	NYS protected	10%	*13%*
Winter cress	*Barbarea vulgaris*					29%	*53%*
Winterberry	*Ilex verticillata*	native			NYS protected	6%	*7%*
Witch-grass	*Panicum capillare*	native				3%	*0%*
Witch-hazel	*Hamamelis virginiana*	native				6%	*13%*
Wood anemone	*Anemone quinquefolia*	native				29%	*33%*
Wood strawberry	*Fragaria vesca*	native				3%	*0%*
Wood-fern	*Dryopteris spinulosa*	native			NYS protected	6%	*13%*
Wood-nettle	*Laportea canadensis*	native	mostly floodplain			90%	*87%*
Wool grass	*Scirpus cyperinus*	native				3%	*0%*
Wrinkle-leaved goldenrod	*Solidago rugosa*	native				13%	*13%*
Yellow avens	*Geum aleppicum*	native				3%	*0%*
Yellow bedstraw	*Galium verum*					3%	*7%*
Yellow birch	*Betula alleghaniensis*	native				3%	*0%*
Yellow forest-violet	*Viola pubescens*	native				61%	*60%*
Yellow foxtail	*Setaria glauca*					13%	*27%*
Yellow touch-me-not	*Impatiens pallida*	native				74%	*93%*
Yellow water-cress	*Rorippa palustris var. fernaldiana*	native	mostly floodplain			10%	*13%*
Zig-zag aster	*Aster prenanthoides*	native	mostly floodplain	CCu		32%	*53%*
Zig-zag goldenrod	*Solidago flexicaulis*	native	rich mesic forests			71%	*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-?: occurrence uncertain in Hudson Valley; DCr: rare in Dutchess County; Dcu: uncommon in Dutchess County (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 31 Columbia and Dutchess County study sites where plant species were observed in 2008 or 2009

5) Percentage of 15 Columbia County study sites where plant species were observed in 2008

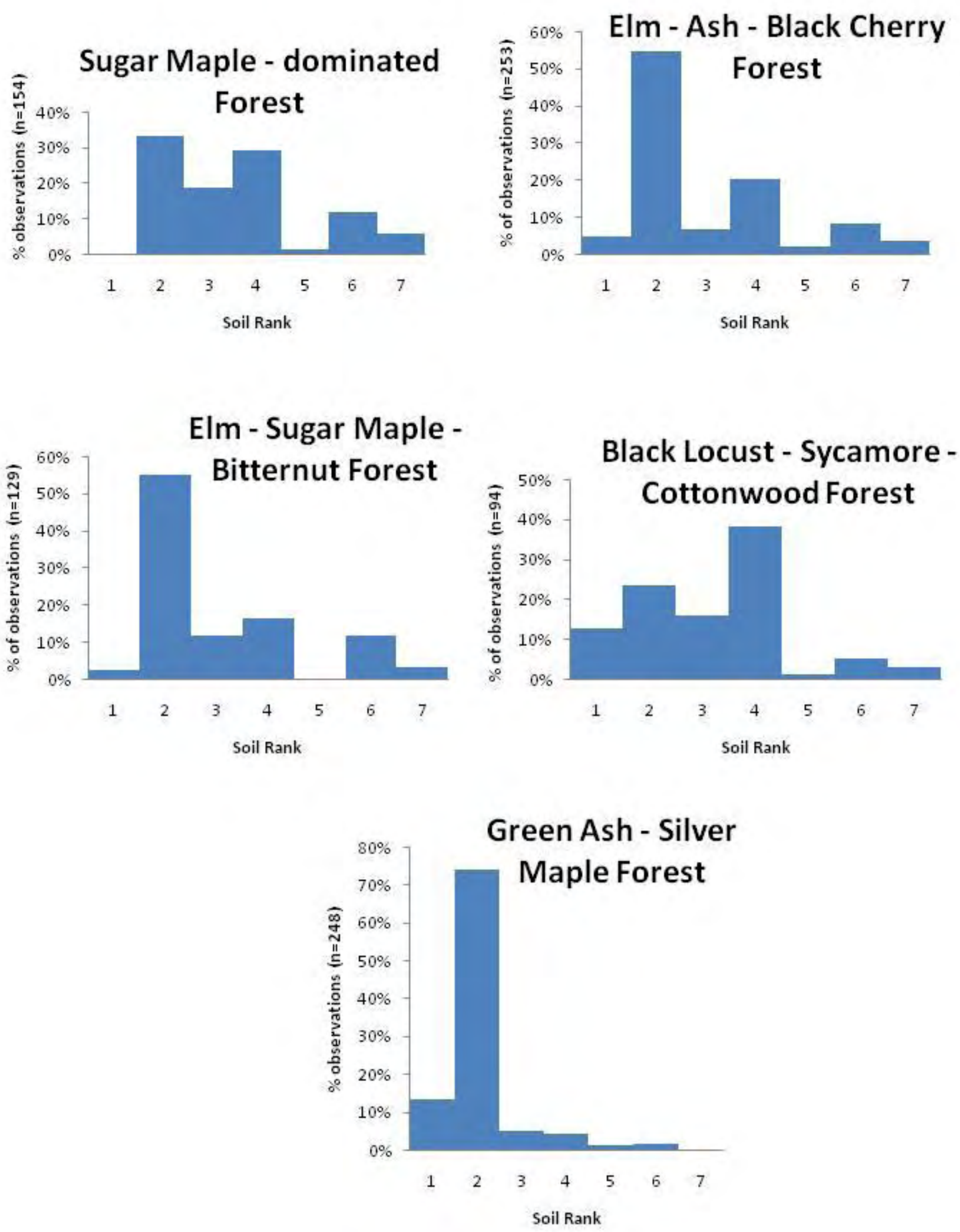
Appendix 2: Average percentage of woody plant species (dbh ≥ 2’’) in the five floodplain forest types

**) significant indicator at p<.001, *) significant indicator at p<0.05, for corresponding indicator values, see Table 6

	Floodplain Forest Type				
	Sugar Maple - dominated	Elm - Sugar M. - Bitternut	Elm - Ash - Black Cherry	Black Locust - Sycamore - Cottonwood	Green Ash - Silver Maple
	n=11	*n=10*	*n=23*	*n=8*	*n=19*
Sugar maple	**70****	30	6	4	1
Ironwood	**2****	<1	<1		<1
Witchhazel	<1				
Pignut	<1	<1			
Catalpa	<1			<1	
Red oak	1	1	1	<1	<1
Slippery elm	<1	**7****	3	1	<1
Bitternut	6	**15****	6		5
Basswood	2	**5****	2	<1	2
Norway maple	1	5	<1	1	<1
Hackberry	<1	1	<1		<1
Choke cherry	<1	1	<1		<1
Shagbark hickory	<1	1	<1		<1
Virginia creeper		<1	<1		<1
Black oak		<1			
Shadbush		<1			
Yellow birch		<1			
Tree-of-heaven		<1			
Honey locust		<1	<1	<1	
Black cherry	<1	1	**5****	2	1
American elm	4	11	**18****	4	9
Ash sp.	2	7	**14****	1	5
Honeysuckle		<1	**3****	1	<1
Grape sp.	<1	2	**4***	<1	2
Musclewood	3	2	5	1	<1
White ash	1	<1	2	<1	<1
Dotted Hawthorn			1		
Hawthorn sp.	<1	<1	1		<1
Black walnut	<1	<1	1		
Pear			<1		
Mulberry			<1		
White birch			<1		
Bladdernut			<1		
Poplar sp.			<1		
Trembling aspen		<1	<1		
Buckthorn			<1		<1
Grey-twig dogwood			<1		<1
Apple			<1		<1
Speckled alder			<1		<1
Butternut			<1	<1	<1
Black locust	<1	0	1	**24****	<1
Sycamore	4	3	6	**18****	1
Cottonwood	1	2	3	**18****	3
Boxelder	<1	<1	3	**10****	4
Oriental bittersweet				**1****	<1
Toringo crab				**3****	
Willow sp.			<1	1	
Hemlock				<1	
Black willow				<1	
Autumn olive				<1	
Silver maple		1	1	2	**28****
Green ash	<1	3	5	3	**27****
Nannyberry		<1	<1		**1****
Spicebush	1		<1		**2****
Swamp oak			<1		**1***
Black ash		<1			2
Red maple	<1		2	1	2
Poison ivy	<1	<1	1	1	1
Privet					<1
Winterberry					<1
Crab apple					<1
Black haw					<1
Silky dogwood					<1
White oak					<1
Smooth alder					<1

Appendix 3: Texture of surface soil (top 2 inches) in five floodplain forest types

The ranks correspond to 1: silt/clay; 2: loam; 3: sandy loam; 4: sand; 5: fine pebbles <1cm; 6: coarse pebbles/gravel 1-7cm; 7: cobbles >7cm



Appendix 4: Indicator values of small woody plant species (dbh < 2 inches) for the five floodplain forest types. (* p<0.1; ** p<0.05). The indicator value for each species in each forest type was calculated as the product of the species' proportional abundance in each forest type relative to the abundance of that species in all forest types and its proportional frequency (the proportion of transects in each forest type that contained the species). The indicator values could range from 0 (no indication) to 100 (perfect indication). Perfect indication means that the presence of a species points to a particular forest type without error, at least within the data set at hand (McCune & Grace 2002).

	Floodplain Forest Type				
	Sugar Maple - dominated	Elm - Sugar M. - Bitternut	Elm - Ash - Black Cherry	Black Locust - Sycamore - Cottonwood	Green Ash - Silver Maple
	n=11	*n=10*	*n=23*	*n=8*	*n=19*
White ash	**33****	0	1	0	0
Sugar maple	**29****	**29****	6	0	0
Bitternut	19	**27***	11	0	3
Tartarian Honeysuckle	5	0	**30****	12	0
Raspberry	0	6	**27***	2	0
Oriental Bittersweet	1	0	0	**40****	3
Toringo Crab	0	0	0	**38****	0
Multiflora Rose	2	7	30	**37****	11
Boxelder	0	0	0	**33****	0
Blackberry	1	0	1	**20***	0
Sycamore	3	2	3	**20***	1
Common privet	1	3	12	8	**44****
Silver maple	0	0	0	0	**21****

Appendix 5: Average density of most common herbaceous species in the five floodplain forest types. These values should be read as "average maximum % cover", because % cover had been estimated in the field in 7 classes, i.e., 0, <1, 1-<10, 10-<25, 25-<50, 50-<75, and 75-100 and averages were calculated by averaging the upper limit of the respective classes; **) significant indicator at p<.001, *) significant indicator at p<0.05, for corresponding indicator values, see App. 6

	Floodplain Forest Type				
	Sugar Maple - dominated	Elm - Sugar M. - Bitternut	Elm - Ash - Black Cherry	Black Locust - Sycamore - Cottonwood	Green Ash - Silver Maple
	n=11	*n=10*	*n=23*	*n=8*	*n=19*
White wood aster	**5****	2	<1	<1	
White snakeroot	**3**	1	**2**	<1	<1
Lady's thumb	**3**	<1	<1	2	1
Japanese knotweed	**2**	<1	<1	<1	
Blue cohosh	<1	**2****	<1		<1
Violet sp.	<1	**3****	<1	<1	1
Wild ginger		**3****	<1		
Zig-zag goldenrod	**2**	**2***	<1		<1
Honewort	1	**3***	2	<1	1
Skunk cabbage		**2***	<1		<1
Virginia creeper	2	**4**	**4**	2	2
Jack in the pulpit	1	**2**	1	<1	2
Japanese stiltgrass	2	3	**8***	<1	4
Garlic mustard	5	**7**	**9**	**7**	4
Common enchanter's nightshade	1	**3**	**4**	**3**	1
Dame's rocket	1	<1	**3**	1	2
Soapwort				**2****	
Purple loosestrife	<1	<1	<1	**3****	<1
Yellow touch-me-not	2	<1	**10**	**12**	5
Ostrich fern	**9**	**10**	**10**	**12**	**11**
Common burdock				**2**	
Reed canary-grass	<1	<1	<1	**2**	<1
Wood-nettle	<1	3	2	2	**17****
Moneywort	<1	<1	<1	<1	**3****
Common woodreed	<1	<1	<1	<1	**2****
Clearweed	2	3	**5**	3	**8****
Sensitive fern	2	1	1	<1	**6****
Jumpseed	<1	1	**3**	1	**4****
Common poison-ivy	<1	<1	<1	<1	**4****
Avens sp.	<1	<1	<1	2	**3***
Spotted jewelweed	1	1	**4**	3	**5**
Smooth goldenrod, Late goldenrod	1	1	**3**	2	**4**
White grass	2	**3**	**3**	1	**4**
Long-bristled smartweed	1	2	<1	<1	**3**
Common blue violet	<1	<1	2	<1	**3**
Common wood-sorrel	2	2	2	2	**3**
Goblet aster	<1	<1	<1	<1	**2**
Nodding fescue	<1	<1	<1	<1	**2**

Appendix 6: Indicator values of herbaceous species for the five floodplain forest types. (* p<0.1; ** p<0.05). The indicator value for each species in each forest type was calculated as the product of the species' proportional abundance in each forest type relative to the abundance of that species in all forest types and its proportional frequency (the proportion of transects in each forest type that contained the species). The indicator values could range from 0 (no indication) to 100 (perfect indication). Perfect indication means that the presence of a species points to a particular forest type without error, at least within the data set at hand (McCune & Grace 2002).

	Floodplain Forest Type				
	Sugar Maple - dominated	Elm - Sugar M. - Bitternut	Elm - Ash - Black Cherry	Black Locust - Sycamore - Cottonwood	Green Ash - Silver Maple
	n=11	*n=10*	*n=23*	*n=8*	*n=19*
White wood aster	65**	25	7	2	0
Sanicula sp.	0	94**	6	0	0
Blue cohosh	12	75**	8	0	5
Violet sp.	9	55**	11	4	21
Wild leek	27	59**	6	0	8
Bloodroot	0	100**	0	0	0
Wild ginger	0	99**	1	0	0
Hairy wild-rye	0	82**	18	0	0
Zig-zag goldenrod	38	40*	15	0	7
Honewort	17	35*	30	2	16
Skunk cabbage	0	65*	13	0	22
Virgin's bower	0	0	89**	0	11
Pennsylvania bittercress	0	0	88**	9	4
Ditch stonecrop	0	0	100*	0	0
Japanese stiltgrass	10	18	45*	3	23
Soapwort	0	0	0	100**	0
Purple loosestrife	2	2	19	73**	4
Flatsedge	0	0	0	100**	0
Common water purslane	0	0	26	74**	0
Deer tongue grass	35	0	7	58**	0
American germander	0	0	6	71**	23
False buckwheat	22	0	5	46*	26
Yellow foxtail	42	0	0	58*	0
Brassicaceae sp.	0	0	15	85*	0
Wood-nettle	3	11	8	9	69**
Moneywort	2	12	10	12	64**
Common woodreed	10	3	9	4	74**
Clearweed	11	15	22	13	39**
Sensitive fern	15	14	11	2	58**
Jumpseed	5	11	31	14	39**
Common poison-ivy	5	6	7	9	73**
Avens sp.	3	11	8	33	45*
False-nettle	13	0	25	0	61*
Elymus sp.	14	0	13	9	64*

Appendix 7: Average density of small woody plant species (dbh < 2 inches) in the five floodplain forest types. These values should be read as "average maximum % cover", because % cover had been estimated in the field in 7 classes, i.e., 0, <1, 1-<10, 10-<25, 25-<50, 50-<75, and 75-100 and averages were calculated by averaging the upper limit of the respective classes; **) significant indicator at p<.001, *) significant indicator at p<0.05, for corresponding indicator values, see App. 4

	Floodplain Forest Type				
	Sugar Maple - dominated	Elm - Sugar M. - Bitternut	Elm - Ash - Black Cherry	Black Locust - Sycamore - Cottonwood	Green Ash - Silver Maple
	n=11	*n=10*	*n=23*	*n=8*	*n=19*
Sugar maple	**2****	**1****	<1	<1	<1
White ash	**<1****		<1		<1
Choke cherry	**2**	<1	<1		<1
Bitternut	1	**1***	<1	<1	<1
Elm	1	**2**	**2**	<1	<1
Tartarian honeysuckle	2	<1	**9****	5	<1
Raspberries	<1	<1	**2***	<1	<1
Virginia creeper	<1	**5**	**5**	**5**	2
Oriental bittersweet	<1	<1	<1	**4****	<1
Toringo crab				**5****	
Multiflora rose	1	2	**10**	**11****	**6**
Boxelder	<1	<1	<1	**<1****	<1
Blackberries	<1		<1	**1***	
Sycamore	<1	<1	<1	**1***	<1
Common privet	<1				**<1****
Silver maple		<1			**<1****
Common poison-ivy	<1	<1	3	2	**6**
Spicebush		2	2	<1	**4**

Appendix 8: Comparison of the physical environment and structural characteristics of seven microhabitats in floodplain forests of Columbia and Dutchess County

*)These values should be read as "average maximum % cover", because % cover had been estimated in the field in 7 classes, i.e., 0, <1, 1-<10, 10-<25, 25-<50, 50-<75, and 75-100 and averages were calculated by averaging the upper limit of the respective classes

**)These averages were calculated from seven ranks (1: silt/clay; 2: loam; 3: sandy loam; 4: sand; 5: fine pebbles <1cm; 6: coarse pebbles/gravel 1-7cm; 7: cobbles >7cm)

	Microhabitat						
	very closed forest on high terrace	**closed forest on high terrace**	**closed forest on low ground**	**fine-textured 2nd channels, backwaters**	**open forest on low terrace**	**shaded shores**	**sunny beaches**
CCA-Code	**2**	**14**	**1**	**9**	**10**	**8**	**43**
number of sampling plots	n=101	n=74	n=320	n=78	n=141	n=99	n=35
distance from bankfull (ft)	131.0	136.8	112.5	211.6	99.0	43.3	-29.1
elevation relative to bankfull (ft)	1.2	1.4	-0.3	-2.0	-0.1	-1.3	-2.0
% cover herbs *)	28.0	62.6	60.7	70.5	84.8	51.9	57.5
height herbs (ft)	0.8	3.4	1.8	2.2	4.4	1.6	2.1
% cover bare ground*)	6.2	10.7	31.2	40.5	20.2	42.8	45.7
% cover leaf litter *)	60.4	39.1	16.5	16.1	16.5	12.2	8.6
% cover fine woody debris *)	11.8	11.4	13.5	13.5	10.6	12.5	6.4
% cover moss *)	0.5	2.1	4.2	17.5	4.1	1.9	0.3
topsoil rank)**	2.2	2.1	2.6	2.0	2.8	4.7	5.5
% canopy cover	89.7	82.4	83.0	82.7	66.0	70.1	27.9

Appendix 9: Indicator values of herbaceous species for the seven floodplain forest microhabitats (* p<0.1; ** p<0.05). The indicator value for each species in each microhabitat was calculated as the product of the species' proportional abundance in each forest type relative to the abundance of that species in all forest types and its proportional frequency (the proportion of transects in each forest type that contained the species). The indicator values could range from 0 (no indication) to 100 (perfect indication). Perfect indication means that the presence of a species points to a particular forest type without error, at least within the data set at hand (McCune & Grace 2002).

	Microhabitat						
	very closed forest on high terrace	closed forest on high terrace	closed forest on low ground	fine-textured 2nd channels, backwaters	open forest on low terrace	shaded shores	sunny beaches
CCA-Code	**2**	**14**	**1**	**9**	**10**	**8**	**43**
number of sampling plots	n=101	n=74	n=320	n=78	n=141	n=99	n=35
White wood aster	9**	0	1	0	0	0	0
Zig-zag goldenrod	8**	3	1	0	0	0	0
Wild leek	5**	0	0	0	0	0	0
False hellebore	3**	0	0	0	0	0	0
Violet sp.	6**	1	4	0	1	1	0
Garlic mustard	12	20**	11	1	13	3	1
Wrinkle-leaved goldenrod	0	4**	0	0	0	0	0
Eastern woodland sedge	0	4**	0	1	0	0	0
Jack in the pulpit	1	6**	2	2	2	0	0
Lady-fern	0	4**	0	0	0	0	0
Blue cohosh	3	3**	0	0	0	0	0
Gill-over-the-ground, Ground ivy	0	4**	1	2	2	0	0
Mayapple	0	2*	0	0	0	0	0
Osmorhiza sp.	0	3*	0	0	0	0	0
False Solomon's seal	1	3*	0	0	0	0	0
Virginia creeper	2	7*	3	0	4	3	1
Long-bristled smartweed	0	0	1	16**	1	3	0
Sensitive fern	0	1	2	11**	0	0	0
Galium sp.	0	0	0	6**	0	0	0
Wood-nettle	0	2	2	10**	10**	0	0
Elymus sp.	0	0	1	6**	0	0	0
Common woodreed	0	0	1	6**	3	0	0
Clearweed	0	1	9	13**	9	11	6
Nodding fescue	0	0	1	5**	1	0	0
Cardamine impatiens	1	0	0	4**	0	0	0
Skunk cabbage	1	0	1	4**	0	0	0
White grass	0	1	5	10**	6	9	5
White avens	0	2	1	4**	0	0	0
Goblet aster	1	0	2	4*	1	0	0
False-nettle	0	0	0	2*	0	0	0
Frindged bindweed	0	0	0	2*	0	0	0
Common blue violet	0	1	2	5*	4	0	0
Yellow touch-me-not	0	7	1	0	13**	2	0
Smooth goldenrod, Late goldenrod	0	2	1	0	17**	1	0
Ostrich fern	0	11	4	2	15**	1	0
Dame's rocket	0	5	1	1	12**	1	0
Moneywort	0	0	1	2	6**	1	0
Common enchanter's nightshade	3	7	5	1	9**	1	0
Eastern lined aster	0	0	0	0	0	4**	0
Barnyard-grass	0	0	0	0	0	4**	0
Cocklebur	0	0	0	0	0	3**	0
Dock-leaved smartweed	0	0	0	0	0	3*	1
Common Wood-sorrel	0	2	7	4	8	9*	3
Thyme-leaved speedwell	0	0	0	0	0	2*	0
Bidens tri- or 5-foliate	0	0	1	1	1	4*	3

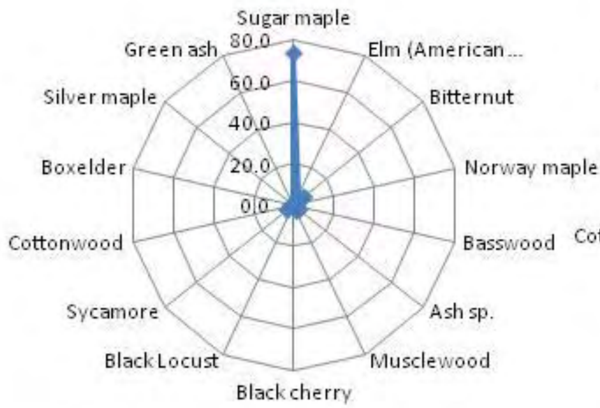
Appendix 9 (cont.)**: Indicator values of herbaceous species for the seven floodplain forest microhabitats** (* p<0.1; ** p<0.05). The indicator value for each species in each microhabitat was calculated as the product of the species' proportional abundance in each forest type relative to the abundance of that species in all forest types and its proportional frequency (the proportion of transects in each forest type that contained the species). The indicator values could range from 0 (no indication) to 100 (perfect indication). Perfect indication means that the presence of a species points to a particular forest type without error, at least within the data set at hand (McCune & Grace 2002).

	Microhabitat						
	very closed forest on high terrace	closed forest on high terrace	closed forest on low ground	fine-textured 2nd channels, backwaters	open forest on low terrace	shaded shores	sunny beaches
CCA-Code	**2**	**14**	**1**	**9**	**10**	**8**	**43**
number of sampling plots	n=101	n=74	n=320	n=78	n=141	n=99	n=35
Lady's thumb	0	0	1	0	1	7	23**
Purple loosestrife	0	0	0	0	0	2	23**
Common chickweed	0	0	0	0	0	1	20**
Waterpepper	0	0	0	0	0	1	17**
Giant chickweed	0	0	0	0	0	3	17**
Dandelion	0	0	0	0	0	2	11**
Broad-leaved dock	0	0	0	0	0	1	11**
Boneset	0	0	0	0	0	0	8**
Giant foxtail	0	0	0	0	0	0	9**
Convolvulaceae sp.	0	0	0	0	0	0	10**
Water speedwell	0	0	0	0	0	0	9**
Flatsedge	0	0	0	0	0	0	9**
Brassicaceae sp.	0	0	0	0	0	0	7**
Common lamb's quarters	0	0	0	0	0	0	8**
Panicum sp.	0	0	0	0	0	2	8**
Poaceae sp.	0	0	1	1	1	2	14**
Common plantain	0	0	0	0	0	1	7**
Yellow foxtail	0	0	0	0	0	0	7**
Hop clover	0	0	0	0	0	0	5**
Knotweed	0	0	0	0	0	0	6**
White clover	0	0	0	0	0	0	6**
Fleabane	0	0	0	0	0	0	6**
Winter cress	0	0	0	0	0	0	5**
Arrow-lvd tearthumb	0	0	0	0	0	4	6**
Japanese knotweed	0	0	0	0	2	0	5**
Wild madder	0	0	0	0	0	0	5**
Common burdock	0	0	0	0	0	0	4**
Common ragweed	0	0	0	0	0	1	4**
Dotted smartweed	0	0	0	0	0	0	4**
Smartweed	0	0	2	1	0	1	6**
Reed canary-grass	0	0	0	0	1	0	4**
Three- seeded mercury	0	0	0	0	0	1	3**
Giant ragweed	0	0	0	0	2	0	4**
Hempnettle	0	0	0	0	0	0	3**
Agrostis sp.	0	0	0	0	0	0	3**
Juncus sp.	0	0	0	0	0	0	3**
Spotted knapweed	0	0	0	0	0	0	3**
Halbert-lvd tearthumb	0	0	0	0	0	0	3**
Crab-grass	0	0	0	0	0	0	3**
English plantain, "Rib Grass"	0	0	0	0	0	0	3**
Common evening primrose	0	0	0	0	0	0	3**
Dwarf St. John's-wort	0	0	0	0	0	0	3**
Bidens entire-lvd	0	0	0	0	0	1	3*
White vervain	0	0	0	0	1	1	3*
Asiatic dayflower	0	0	0	0	0	0	2*
Soapwort	0	0	0	0	0	1	2*
Spotted Joe-pye-weed	0	0	0	0	0	0	2*
Dock	0	0	0	0	0	0	2*

Appendix 10: Indicator values of small woody plants (dhb < 2 inch) for the seven floodplain forest microhabitats (* p<0.1; ** p<0.05). The indicator value for each species in each microhabitat was calculated as the product of the species' proportional abundance in each forest type relative to the abundance of that species in all forest types and its proportional frequency (the proportion of transects in each forest type that contained the species). The indicator values could range from 0 (no indication) to 100 (perfect indication). Perfect indication means that the presence of a species points to a particular forest type without error, at least within the data set at hand (McCune & Grace 2002).

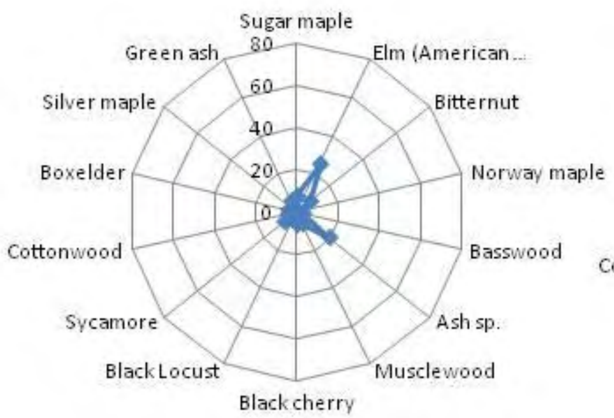
	Microhabitat						
	very closed forest on high terrace	closed forest on high terrace	closed forest on low ground	fine-textured 2nd channels, backwaters	open forest on low terrace	shaded shores	sunny beaches
CCA-Code	**2**	**14**	**1**	**9**	**10**	**8**	**43**
number of sampling plots	n=101	n=74	n=320	n=78	n=141	n=99	n=35
Bitternut	18**	6	5	1	1	1	0
Sugar Maple	12**	5	3	1	1	1	0
Virginia Creeper	9*	7	2	1	7	4	0
Cherry	7**	0	0	0	0	0	1
Musclewood	4*	1	1	0	0	0	0
Bladder-nut	2*	1	0	0	0	0	0
Ironwood	2*	0	0	0	0	0	0
Choke Cherry	3	6**	1	1	0	0	0
Raspberry	3	5**	0	0	0	1	0
White Ash	2	4*	1	0	0	0	0
Toringo Crab	0	4**	0	0	0	0	0
Grey-twig Dogwood	0	0	0	3*	0	0	1
Multiflora Rose	5	5	3	1	9*	4	0
Sycamore	0	0	0	0	0	0	36**
Elm	3	1	1	1	2	4	18**
Cottonwood	0	0	0	0	0	0	14**
Trembling Aspen	0	0	0	0	0	0	6**
Willow	0	0	0	0	0	0	6**
Black Willow	0	0	0	0	0	0	3**
Honey Locust	0	0	0	0	0	0	3**

Appendix 11: Distribution of Common Tree Species (% of trees with dbh ≥ 2") in Five Floodplain Forest Types (shown are only those species that compose at least 5% of the trees in one of the forest types)



Sugar Maple - Dominated

Elm - Sugar Maple - Bitternut

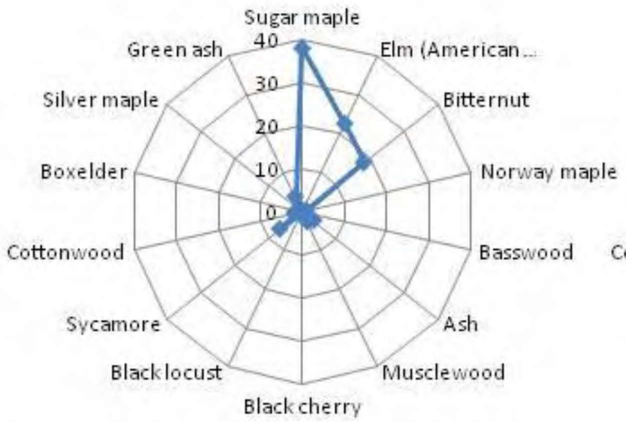


Elm – Ash - Black Cherry

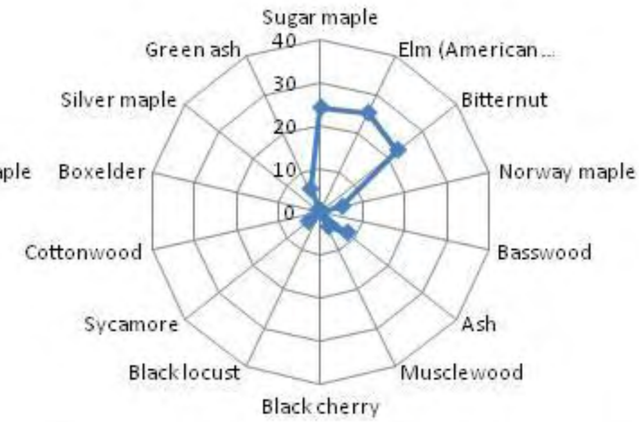
Black Locust – Sycamore - Cottonwood

Green Ash – Silver Maple

Appendix 12: Distribution of the Regeneration of Common Tree Species (estimated % of seedlings and saplings with dbh < 2") in Five Floodplain Forest Types (the species correspond to those in App. 11).

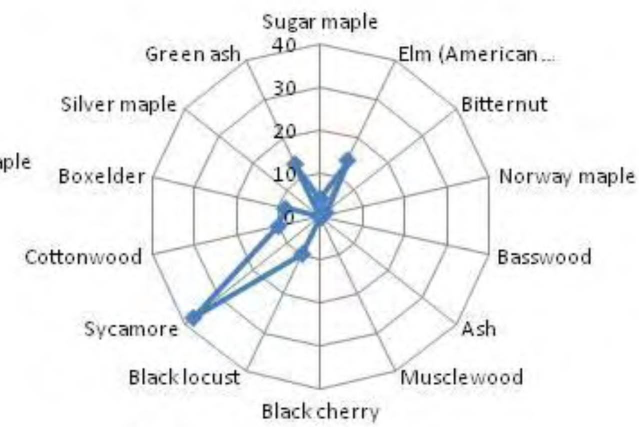


Sugar Maple - Dominated



Elm - Sugar Maple - Bitternut

Elm – Ash - Black Cherry



Black Locust – Sycamore - Cottonwood

Green Ash – Silver Maple