

PLANTS OF THE COLDWATER RIVER, MISSISSIPPI, USA: COMMUNITY RECORDS ALONG THE HYDROLOGIC GRADIENT IN THE LOESS HILLS

Charles M. Cooper

Ecologist, USDA Agricultural Research Service, National Sedimentation Laboratory,

P.O. Box 1157, Oxford, MS. 38655 USA

Phone: 662.232.2935 / 2912 ; Fax: 662.232.2988

ccooper@msa-oxford.ars.usda.gov

M. Bruce Huneycutt

Dean Emeritus, UM College of Liberal Arts, UM Professor Emeritus, Department of Biology, and

Former Curator of the Herbarium, University of Mississippi, USA

Sam Testa, III

Biologist, USDA Agricultural Research Service, National Sedimentation Laboratory, USA

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ABSTRACT

The natural channel of the upper Coldwater River, which drains a large (565 km²) multi-use catchment in the loess hills of Mississippi upstream of Arkabutla Reservoir, has been predominantly unimpacted by channel modifications or recent large-scale land clearing. The river is generally bordered by floodplain forest in various stages of growth, and stream-floodplain interaction occurs frequently. Currently, however, pervasive residential sprawl from the highly urbanized region near Memphis, Tennessee, is altering land use and eventually may alter significantly the hydrology, floodplain land-use, and biological communities occurring along this natural resource.

To document existing conditions, a study of plant communities at eight locations along this river reach was conducted with recurring visits to sixteen 100m transects over a period of one year. A total of 294 species from 86 families were recorded. Greatest community richness was observed

at the most upstream location with 165 plant species in 111 genera representing 59 plant families. Lowest richness (84 species) occurred at the mid-reach location. The most commonly encountered species were *Lonicera japonica* Thunb. (Japanese honeysuckle), *Impatiens capensis* Meerb. (jewelweed), *Fraxinus americana* L. (American ash) and *Sambucus nigra* L. (elderberry).

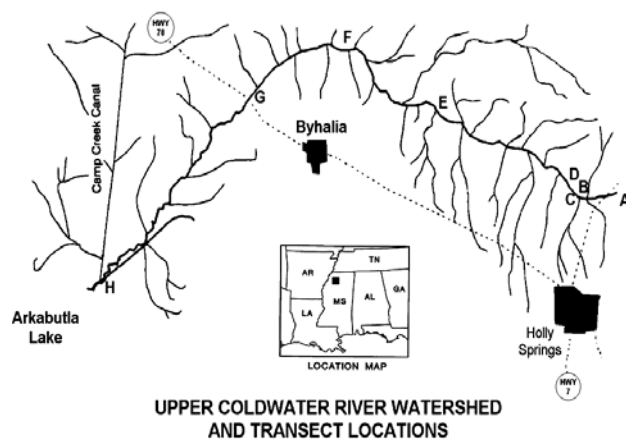
Seventeen species were collected at all eight locations while 103 species were recorded at single locations only. No records of federally-listed threatened or endangered species were made, but observations were made for *Platanthera flava* (L.) Lindl. (the palegreen orchid) which is listed as endangered, threatened or of special concern in sixteen states. Our observations also included 45 species considered to be obligate inhabitants of wetlands, including *Chelone glabra* L. (white turtlehead). Two species [*Carex pensylvanica* Lam., pensylvanica sedge; and *Lactuca biennis* (Moench), tall blue lettuce] are potentially herein reported from the state for the first

time. The upper reach of the Coldwater River is the only major hill land drainage in the Yazoo Basin which is unchannelized. Its richness of flora is reflective of its value as natural habitat.

INTRODUCTION

The Coldwater River watershed is an important stream system located in northern Mississippi, USA, which provides habitat for a large number of native plant species. It is a part of the Yazoo River drainage (32,600 km²) that ranks 2nd in species diversity of native freshwater fishes among the state's ten river basins. A total of 119 fish species have been documented in this drainage (ROSS 2002), and biodiversity within the lotic ecosystems of the southeastern United States is comparable to the biodiversity levels found in terrestrial ecosystems in the tropics (LYDEARD & MAYDEN 1995). This region harbors numerous native plant species that have potential as sources of new medicinal compounds. The area is also noted as a historically rich region for fur trapping and fishing.

FIGURE 1. Illustration of the upper Coldwater River watershed, indicating plant sampling transect locations (A – H) in relation to landmark features in north-central Mississippi.



The Coldwater River watershed has been selected for study under the United States National Water-Quality Assessment Program, the Vigil Network Global Climatic Change monitoring program, and the federal inter-agency Demonstration Erosion Control Project in the Yazoo Basin due to valued natural characteristics in some of its regions and high potential for damage from anthropogenic disturbances. The presence of a non-channelized river with natural riparian vegetation along its corridor has provided water quality protection both within the study area and further downstream. Land-cover and water quality conditions in the upper Coldwater River directly influence two important downstream resources: Arkabutla Lake, a large flood control, fishing and recreational use reservoir located above the edge of the Mississippi Alluvial Plain, and, further downstream, the Coldwater River National Wildlife Refuge that encompasses over 10 km² of protected wildlife habitat.

The study watershed (565 km²) consisted of the river drainage area upstream of Arkabutla Reservoir, where the Coldwater River flows generally westward for approximately 56 km across northern Mississippi from Benton County through Marshall, DeSoto and Tate counties. The river was bordered by floodplain forest in various stages of growth, and stream-floodplain interaction occurred frequently.

The Hills portion of the Yazoo basin lies within the Gulf Coastal Plain Physiographic Province and is composed of three major subdivisions. The western-most subdivision is the Loess Hills that is comprised of loess-covered hills rising 30 meters or more above the Yazoo Delta area (Schumm, et al., 1984).

The region was historically disturbed by agricultural investiture, beginning in 1832-1834 when it was ceded from the Chickasaw Indian Nation. Harper (1857) provided the first mention of gully formation in the hills. Hildgard (1860) gave a detailed description of massive soil loss that accompanied farming and also documented valley sedimentation which rendered the floodplains unusable and created swamps; thus, the description “swamped-out” valleys or bottoms. A series of channel cleanouts and enlargements began in the late 19th century throughout the region and continued through the 1960s, but wholesale channelization did not result as in nearby watersheds. While adjacent watersheds were completely or nearly completely channelized to promote drainage, the upper Coldwater River was only slightly affected. Floodplain habitats were allowed to regenerate, probably because the natural meandering channel promoted frequent stream-floodplain interaction which discouraged farming. Although somewhat influenced by invasive and escaped species, the upper Coldwater River represents a regional reference area for comparisons of plant community composition in the Loess Hills region of north Mississippi. Recent rural development in the upstream portion of the region, and “escapist” and “bedroom community” developments in the downstream portion of the watershed near the metropolitan region of Memphis, Tennessee, however, threaten to significantly alter the land and drainage of the study watershed, with an attendant change in the plant communities.

We hypothesized that the upper Coldwater River locations would harbor a rich and potentially important population of plants that contribute to the area’s value as a reference for the region. We also believed that there might be differences in the plant

community makeup along the hydrological gradient from upstream to downstream. With this study, we document the composition of the plant community along the upper Coldwater River from northeast of Holly Springs, MS, to near Hernando, MS, prior to the beginning of the 21st century. We also discuss the importance of selected plant species occurring along the river and differences in the communities from the upstream to downstream locations we studied.

Methods

Sixteen transects, each 100 meters long, were censused for plant species at eight locations in the Loess Hills region of Mississippi along the Coldwater River in Marshall and DeSoto counties (FIGURE 1). Transect locations were selected based on explorations throughout the study area where markedly different habitat types were observed. Greater diversity of habitats was found in the extreme upstream eastern portion of the watershed, resulting in closer proximity of transect locations in that area. Gross characteristics of each transect are given in TABLE 1, and illustrated in figures A through H.

Transects at each location originated at the center of river water surface width to allow documentation of aquatic plant species and continued, perpendicular to the thalweg, over the river bank and through the riparian zone to a point 100 m from the origin. Markers were inserted in the ground at the 5, 15, 30, 60 and 100 meter points to delineate the transect location for repeated visits and allow sub-transect assessment of community makeup. Two transects were established at each location, each originating at the same mid-river point, but extending in opposite directions perpendicular to the river thalweg.

Each transect was sampled at least 4 times during 42 collecting trips between August 1989 and November 1990. Sampling visits were not made during the cold season months of December through February. Sampling was done by walking the transect length and identifying and recording all plant species which occurred within one meter on either side of the transect line. Specimens (usually only portions of individuals) were taken for any individual that required additional scrutiny. Specimens were identified to species if possible. Multiple visits throughout the growing season targeted specimens that were ephemeral or that produced structures required for identification during only a portion of the year. A total of 2,576 observations of plant species were made during the study.

TABLE 1. General characteristics and location of plant transects sampled during this study.

TRANSECT	DESCRIPTION	LOCATION
A-North	Bottomland Hardwood	N34° 50.710'
A-South	Swamp-bottomland Hardwood-Field	W89° 25.063'
B-North	Bottomland Hardwood	N34° 50.852'
B-South	Open Marsh	W89° 26.763'
C-North	Bottomland Hardwood	N34° 50.976'
C-South	Swamp / Marsh	W89° 26.819'
D-North	Open Marsh	N34° 51.057'
D-South	Open Marsh	W89° 26.932'
E-North	Bottomland Hardwood	N34° 53.747'
E-South	Bottomland Hardwood	W89° 33.836'
F-North	Bottomland Hardwood	N34° 56.320'
F-South	Bottomland Hardwood	W89° 39.499'
G-North	Bottomland Hardwood- Open Marsh	N34° 54.961'
G-South	Bottomland Hardwood	W89° 44.416'
H-North	Bottomland Hardwood, note: both sides of transect H traverse a large levee	N34° 47.941'
H-South	Bottomland Hardwood to Wet Meadow	W89° 52.589'

An attempt was made to identify every encountered plant to species level, but this was not possible in a few cases due to unavailability of necessary fruiting or other discriminatory structures at the time of visits. Such taxa, identified only to genus or a higher level, were included in the taxonomic list and counted in taxa richness tabulations if weight of evidence indicated they represented a separate taxon not already identified to species within that sub-transect. In a few cases, more than one species was possibly represented by a higher identified taxon, especially in the cases of Poaceae (grasses) and Cyperaceae (sedges).

Taxonomy, remarks on species characteristics, and distributions were taken mainly from the PLANTS database (USDA, NRCS 2004), with additional support and anecdotal information taken from RADFORD et al. (1968), RICKETT (1975) and TIMME (1989). The Morisita-Horn index of community similarity has been shown to be a robust indicator for comparing community makeup between locations (MAGURRAN 1988), and is calculated according to COLWELL (1997).

Results

Taxa Richness and Importance

A total of 294 plant species from 86 families and 189 genera were recorded. Greatest community richness was observed at the most upstream location with 165 plant species in 111 genera representing 59 plant families. Lowest richness (84 species) occurred at the mid-watershed location. A summary of total plant taxa richness at each transect and location is given in TABLE 2.

The most commonly encountered species were *Lonicera japonica* Thunb. (Japanese honeysuckle), *Impatiens capensis* Meerb.

(jewelweed), and *Sambucus nigra* L. (elderberry). Other species observed with 50% or greater overall frequency of occurrence during our study [number of occurrences at any sub-transect range at any location or transect divided by 80 (total number of sub-transect ranges as defined above)] were *Fraxinus americana* L. (American ash), *Acer negundo* L. (boxelder), *Bignonia capreolata* L., *Boehmeria cylindrica* (L.) Sw., *Smilax rotundifolia* L., *Polygonum hydropiperoides* Michx., and *Commelina virginica* L.. (Note that sub-transects were unequal in length and presence/absence frequency calculations given here are not density values.)

Seventeen species were collected at all eight locations (TABLE 3), while 103 species were recorded at only one location (TABLE 4). No collections of federally-listed threatened or endangered species were made, but observations were made for *Platanthera flava* (L.) Lindl. (the palegreen orchid) which is listed as endangered, threatened or of special concern in sixteen states. Our observations also included 45 species considered to be obligate inhabitants of wetlands (TABLE 4), including *Chelone glabra* L. (white turtlehead). Two species, *Carex pensylvanica* Lam. and *Lactuca biennis* (Moench), are herein reported from the state potentially for the first time.

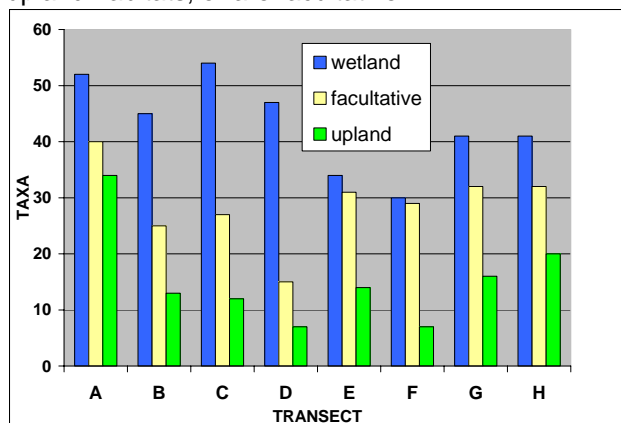
TABLE 2. Summary of total plant taxa richness measured at each 100-meter transect and location (two transects, north and south of the river, combined for each location) in the upper Coldwater River watershed.

LOCATION - TRANSECT	TRANSECT RICHNESS	LOCATION RICHNESS
A-North	88	-
A-South	133	165
B-North	58	-
B-South	80	102
C-North	81	-
C-South	94	118
D-North	63	-
D-South	61	85
E-North	81	-
E-South	69	102
F-North	73	-
F-South	67	84
G-North	72	-
G-South	86	111
H-North	76	-
H-South	94	121

Differences Along the Hydrologic Gradient

Wetland affiliated taxa dominated at all sites, as would be expected due to the influence of the river (FIGURE 2). Locations A, B, C and D near the upper end of the river system harbored the largest number of obligate and facultative wetland species. In addition to having the second highest number of wetland species, the most upstream location, A, also had the highest number of facultative and upland taxa, reflecting the diversity of land relief and cover there. Location A was similar in community makeup to sites B and C (Morisita-Horn community similarity indexes 0.68 and 0.67 respectively) but not nearly as similar to location D (index 0.51), though distances between sites B, C and D were small. Low community similarity also was observed between location A and locations E, F and G, but with somewhat heightened similarity to site H (FIGURE 3).

FIGURE 2. Number of plant taxa at each location that characteristically prefer wetland or upland habitats, or are facultative.



Discussion and Conclusion

The most commonly encountered species was a non-native species. *Lonicera japonica* (commonly known as Japanese honeysuckle) is an introduced perennial vine that occurs throughout much of the continental United States and has been listed as an invasive and noxious weed by numerous authorities. It was once a common stock of nurseries for household plantings and has lived as an escaped ornamental for decades. Japanese honeysuckle occurred at all 8 locations and was encountered with a 76.25% frequency of occurrence. Perhaps this should emphasize the importance of describing and monitoring the community makeup of our natural resources in order to identify and track the progress of invasions.

Impatiens capensis is a native herbaceous annual species found throughout the continental U.S. with the exception of the southwest. Jewelweed (also known as “lady’s-earrings”, “orange balsam”, “orange touch-me-not”, “snapweed”, and “spotted jewelweed”) is commonly found in boggy shaded areas and is a facultative wetland species (estimated 67%-99% probability of occurrence in wetlands). Historically, it had

ethnic use as a treatment for eczema and rashes. It has been used by at least 14 Native American tribes as an ingredient in various medicines, especially to relieve itching associated with poison ivy, stinging nettle and insect bites, and as a dye. Jewelweed had a 75% frequency of occurrence during our study.

Sambucus nigra, or common elderberry (ssp. *canadensis* (L.) R. Bolli) is a large deciduous shrub that is a facultative wetland inhabitant (estimated probability 67%-99%). Its known range includes most of the continental United States except the extreme northwestern and west-central states. Elderberry produces a showy edible fruit that attracts many species of birds and other wildlife and is used by humans to make preserves, jellies, pies and wine. Portions of this plant have been shown to contain 49 phytochemicals with a variety of medicinal or toxicological actions. The plant has been used widely by the Native American tribes throughout the United States for both medicinal and food purposes. Elderberry was encountered with a 67.50% frequency in our study.

TABLE 3. Plant taxa collected at all eight locations and their wetland affinity (USFWS 1988 – legend repeated at end of this paper**).

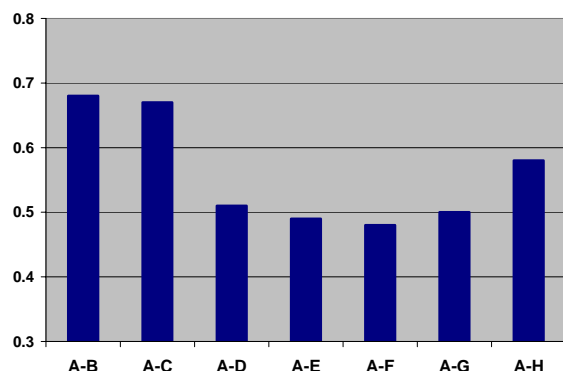
Scientific Name	Wetland Affinity
<i>Acer negundo</i> L.	FACW
<i>Acer rubrum</i> L.	FAC
<i>Betula nigra</i> L.	FACW
<i>Boehmeria cylindrica</i> (L.) Sw.	FACW+
<i>Chasmanthium latifolium</i> (Michx.) Yates	FAC-
<i>Cicuta maculata</i> L.	OBL
<i>Clematis virginiana</i> L.	FAC+
<i>Commelina virginica</i> L.	FACW
<i>Fraxinus americana</i> L.	FACU
<i>Impatiens capensis</i> Meerb.	FACW
<i>Lonicera japonica</i> Thunb.	FAC-
<i>Lycopus virginicus</i> L.	OBL
<i>Onoclea sensibilis</i> L.	FACW
<i>Polygonum hydropiperoides</i> Michx.	OBL
<i>Sambucus nigra</i> L.	NI
<i>Smilax rotundifolia</i> L.	FAC
<i>Viola</i> L.	NI

Fraxinus americana is a common large woody native tree known as American ash or white ash. This species usually occurs in other settings but is occasionally found in wetlands (estimated probability 1%-33%). [Authors note: Records of this species in our study probably include immature specimens of *Fraxinus caroliniana* P. Mill. (Carolina ash) which is an obligate wetland inhabiting species.] It occurs throughout the eastern and most of the central United States, and is cultivated in Hawaii. Wood from this tree is economically important, especially for use as tool handles and baseball bats. American ash provides a seed that is an important food source for numerous birds including wood ducks and quail, as well as many small mammals, and the bark is eaten by deer, cattle, beaver, porcupine and rabbits. If broken, this tree readily forms cavities that

are very important to tree nesters such as red-headed, red-bellied, and pileated woodpeckers, and are secondarily used by wood ducks, owls, nuthatches, and gray squirrels. American ash has been shown to contain the phytochemical, Betulin that has pharmacologic antiHIV, anticarcinomic, antifeedant, antifu, anti-inflammatory, antitumor, antiviral, aphidifuge, cytotoxic, hypolipemic, prostaglandin-synthesis-inhibitor, and topoisomerase-II-inhibitor activities. Parts of the plant have been used ethnobotanically by at least 8 Native American tribes as an aperitif, aphrodisiac, astringent, treatment for snakebite, cancer, a diuretic, medicine poultice, puerperium, for sores, as a sudorific, and as a tonic for other medicinal purposes. American ash occurred with 58.75% frequency during our study.

Acer negundo, or boxelder, is a small to large tree with irregular form that occurs throughout the United States. It is noted to grow along lakes and streams, in floodplains, and in other low-lying wet places with abundant moisture. Boxelder has little economic importance because its branches are weak and break easily, and the soft wood of the trunk is susceptible to rot. The species is, however, very important to wildlife for the habitat it creates within the riparian corridor, and its seeds are eaten by both birds and squirrels. The sap of boxelder contains abundant sugar, and has been used by humans to make a pleasant beverage, boiled for its sugar, and mixed with inner animal hide scrapings to make a type of candy by Native American tribes. Also known as ash-leaf maple and three-leaf maple, we encountered boxelder with a 56.25% frequency of occurrence.

FIGURE 3. Morisita-Horn community similarity index values for the plant community at location A (most upstream location where highest overall diversity occurred) and each other location sampled in this study. Higher values indicate more similarity.



Bignonia capreolata is a native vine that may grow up to 15 meters, usually along forest edges or gaps, with fragrant showy orange-red trumpet-shaped flowers. It is often found climbing the trunks of tall trees or sprawling along the ground through east-central and the southeastern United States. Known as crossvine, this species is noted to grow in low woods and swamps, but is facultative, with about an even chance of occurrence within or outside of wetlands. It occurs throughout the eastern U.S., where it has been used as a cover for fences, arbors, walls, pillars or large trellises. It has been used ethnobotanically as an alterative, analgesic, antirheumatic, for obesity, to cleanse the blood, for “thirst”, and to make soap. The common name derivation may be discerned by cutting the stem, which reveals a marking resembling the Greek cross. The cylindrical pod-like seed capsules, that are about 7 inches long, often persist from late summer through fall. The foliage remains evergreen in much of the South, including Mississippi. It occurred in our study with a 52.50% frequency, as did the following two species.

Boehmeria cylindrica, or smallspike false nettle (sometimes called bog-hemp), occurs as a perennial herb throughout the eastern and central U.S. It is most likely to be found in wetlands, but is facultative, and may be found occasionally in upland forest, shrub and sedge-meadow habitats. Its common habitat, however, is low ground, bogs, swamp forests, marshes and alluvial woods. This species resembles stinging nettles (*Urtica* spp.) but lack the stinging trichomes. Alkaloids from this species have been found to have active antimicrobial, antiviral and strongly anticarcinomic properties (FARNSWORTH ET AL. 1969, KRMPOTIC ET AL. 1972, AL-SHAMMA ET AL. 1982).

Smilax rotundifolia is a native woody vine that may climb 3 to 6 meters. Known as roundleaf greenbrier or common greenbrier, this species occurs throughout the eastern and central U.S. but is listed as invasive in the northeast. It is a facultative species that is equally likely to occur within or outside of wetlands. Roundleaf greenbrier regenerates by rhizomes and seeds from berries. The rhizomes have been shown to survive for years after the plant has been top-killed by fire or other disturbances. The persistent fruits are an important late winter and early spring food for wintering birds, and white-tailed deer browse foliage, shoots and canes of this plant. Because it may form a prickly impenetrable thicket, this plant can provide protective habitat for birds and other small animals. It has been used by Native American tribes as an analgesic, antirheumatic, and as a dermatologic aid for skin burns, galls, and boils.

Polygonum hydropiperoides is a small perennial upright plant with “spiked” pinkish flower heads. It is an obligate wetland plant species. Swamp smartweed, as it is known, occurs throughout most of

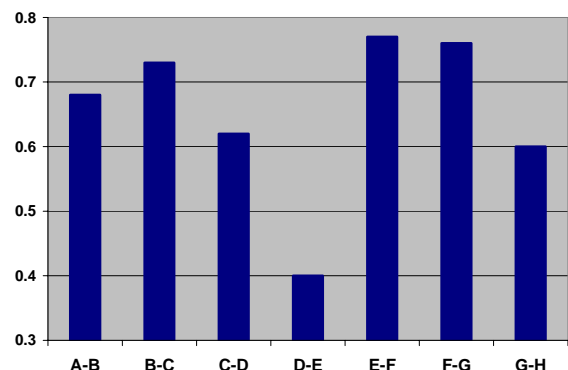
the United States with the exception of the west-central mountain states. It is listed as threatened in both Indiana and New York. Swamp smartweed has been found to contain at least 11 phytochemicals of interest, and has also been found capable of the phytoaccumulation of potentially toxic trace elements (QIAN ET AL. 1999), making it of potential use in remediation of contaminated lands.

Commelina virginica is a perennial herb that grows to a height of 1 meter in wet places, especially swamps, river and stream banks, ditches, and bottomlands. It occurs throughout the southeastern U.S. toward the northeast, where it has been listed as extirpated from Pennsylvania. Virginia dayflower, as it is commonly called, is a predominantly wetland species, with an estimated probability 67%-99% of occurrence in wetland habitats but can be facultative and occasionally occurs elsewhere. It flowers in mid-summer with pale blue petals. It has been used ethnically as a diuretic, for fever, nerves and spasm. *Commelina virginica* occurred with 50.00% frequency during our study.

Of those taxa found at all locations (TABLE 3), most were facultative wetland inhabitants, but three were obligate wetland species. *Cicuta maculata*, or spotted water hemlock, occurs throughout the continental United States and is an obligate wetland species in our region. Its toxic effects on man have been known for nearly two centuries (ELY 1814). It is also the culprit in numerous accounts of livestock poisoning dating back to at least 1899 (WILCOX 1899, BURROWS 1989), probably accounting for one of its other common names, spotted cowbane. The phytochemical, cicutine, has been isolated from spotted water hemlock, but no useful medical activities have been associated with

this compound, Researchers (KONOSHIMA & LEE 1986) have studied the extract, cicutoxin, and its derivatives as an anti-leukemic principle. The plant has been used ethnobotanically for contraception (chewing the root to cause sterilization) and to treat tumors but is most notably used for suicide. Native American tribes have used spotted water hemlock as an insecticide, disinfectant, and as an anti-rheumatic and dermatologic aid for sores or lesions.

FIGURE 4. Morisita-Horn similarity indices for site-to-site community comparisons along the hydrologic gradient from the most upstream location, A, to the most downstream location, H.



The obligate wetland species *Lycopus virginicus* (Virginia water horehound) occurs throughout the east and most of the central U.S. in North America and is a member of the mint family, Lamiaceae. It contains at least 24 phytochemicals with wide-ranging actions (245 potential economic actions studied and reported) (DUKE 2005). The root of this plant was used by the Cherokee as a snakebite remedy and to give them “eloquence of speech”, while other ethnic uses have been as an astringent, narcotic, sedative, for diabetes and diarrhea, and for ailments of the lung, including cough and tuberculosis.

Polygonum hydropiperoides (discussed earlier) is the final obligate wetland

inhabitant found at all locations during our study. The species occurs throughout most of the contiguous United States, with exception of the four west-central states of Colorado, Utah, Wyoming, and Montana. Known as swamp smartweed or false water-pepper, the 11 phytochemicals produced by this plant have been shown to have over 200 potential economically exploitable actions. While references to ethnic uses for this plant were not available, it seems likely from the known activities of this plant that use did occur.

While the river channel has not been straightened nor the entire floodplain cleared, most of the Coldwater River landscape has been impacted by human activities. It is likely that the floodplain forest was spoiled with the rest of the landscape after 1832 although recent timber harvest has been fragmented. The array of plants found at each of the cross-sections provided a successional-oriented snapshot of a dynamic floodplain. Few trees were observed that were estimated to be over 60 years old. Tree growth in some sections was much younger as suggested by both diameter and species. Topographical features that provided elevation differences always provided species variability. Species diversity was affected most visibly by ponding, especially in reaches where excessive sediments were deposited, old cutoffs collected water, or where natural levee-building was dominant. Lowest diversity in mid-reach was at sites D and E which were strongly influenced by habitat type. As an open marsh, Site D was dominated by grasses and sedges. Site E supported hardwoods with a dense canopy which shaded out potential herbs.

The upper reach of the Coldwater River is the only major hill land drainage in the Yazoo Basin that is unchannelized. Its

richness of flora is reflective of its value as natural habitat. Its botanical characteristics and floral diversity provide a snapshot of not just a river corridor exhibiting stream/floodplain interactions, but one which reflects stream/floodplain/human interactions. Such landscapes supply habitat not found otherwise and provide helpful ecosystem functions such as water quality improvement and flood flow retardment. Their plants may also provide us with an array of natural products.

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