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THE UNIVERSITY OF NORTH CAROLINA AT WILMINGTON

June 24, 2005

Carol L. Williams
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Wilmington, NC 28403

Jody Shimp
Natural Heritage Administrator
Illinois Department of Natural Resources
11731 State Highway 37
Benton, IL 62812

Dear Mr. Shimp,

I'm please to inform you the IDNR Small Grants project, *Inventory of Celastrus orbiculatus invasions in Southern Illinois*, Contract No. RC05125W, has been completed. Enclosed is the summary report. Mr. Bob Lindsay has been cc'd a digital version of the report at his request. Archana Pande has complete creation of a GIS-based map, and has created a CD with all necessary files for viewing and manipulating this map. The CD is being sent to you under separate cover directly from her.

If you have any questions regarding the project, the content of the summary report, or the GIS, please feel free to contact me, as I remain the Principle-in-Charge. Be advised, however, that my contact information is changing very soon. I'm leaving UNCW for Iowa State University in late July. I've accepted a postdoc position in the Agronomy Dept. there, where I'll be engaged in research on agro-ecological zones and alternative crops in the state. I may be reached at info@greenhouseinabag.com at any time.

I appreciate the opportunity to participate in IDNR's Small Grant program.

Sincerely,

Carol L. Williams

Carol L. Williams

DEPARTMENT OF EARTH SCIENCES

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Contract Number RC05l25W June 21, 2005

Inventory of *Celastrus orbiculatus* Invasions in Southern Illinois

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Submitted to:

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Abstract

Celastrus orbiculatus Thunb., also known as Oriental Bittersweet, Asian Bittersweet and Round-leaved Bittersweet is a perennial, deciduous, woody vine (liana) introduced into North America as an ornamental circa 1860 from it's native Asia. It has become a problematic weed in many areas, and is particularly troublesome in early and late successional forests. It's aggressive growth habits and lack of natural controlling agents have led to significant ecological and economic consequences. Mechanical and chemical control methods have not been successful. Monitoring and early intervention is thought to improve invasion and damage control. *Celastrus orbiculatus* is thought to be widespread throughout Southern Illinois. However, most locations of its occurrence have been only informally noted, and a few specimens had been vouchered into state herbariums. The goal of this project was to assess existing informal accounts of the occurrence of *C. orbiculatus*. Objectives of this project were to assemble the various informal accounts of *C. orbiculatus* sightings in Southern Illinois, and through field reconnaissance, verified these accounts. Additional objectives included collection and voucher of specimens, and generation of a digital map of verified locations of *C. orbiculatus* in Southern Illinois using a geographic information system (GIS) and existing raster data. The study area included the following counties: Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Pulaski, Saline, Union and Williamson.

1.0 INTRODUCTION

1.1 Project Description

This document describes the current known distribution of *Celastrus orbiculatus*, a non-native invasive species (NIS) in Southern Illinois. This document also provides a detailed description of the ecology of the plant and its potential ecological and economic impacts. While *C. orbiculatus* is thought to be widespread throughout Southern Illinois, it presence has largely been undocumented. Locations of its occurrence have been informally noted, and few specimens had been vouchered into herbariums. Systematic survey methods and probability mapping would likely produce a comprehensive portrayal of the plant's current and potential distribution, but such undertaking was beyond the scope of this project. Rather, the goal of this project was to assess existing informal accounts of occurrence of *C. orbiculatus*. Objectives of this project were to assemble the various accounts of *C. orbiculatus* sightings in Southern Illinois, and through field reconnaissance, verify these accounts. Additional objectives included collection and voucher of specimens, and generation of a digital map of verified locations of *C. orbiculatus* in Southern Illinois using a geographic information system (GIS) and existing raster data. The study area included the following counties: Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Pulaski, Union and Williamson (Fig. 1)

1.2 Background

Celastrus orbiculatus has earned "pest" status in many states due to its invasiveness. There is growing concern about its spread in Illinois (IDNR 2000), and in Southern Illinois it appears to aggressively displace native plant species, a typical pattern found generally among NIS throughout the state (IDNR 2001). *Celastrus orbiculatus* is capable of physically damaging

native vegetation, arresting forest development, changing plant community composition and structure, changing successional pathways, and may even hybridize with the native *C. scandens* (Dreyer et al. 1987, Fike and Niering 1999, McNab and Meeker 1987). Physical and chemical control of *C. orbiculatus* has been unsatisfactory. Therefore, early detection and intervention is thought to improve control efforts (Dreyer 1994, McNab and Meeker 1987, Silveri et al. 2001). Inventory of known locations of the occurrence of *C. orbiculatus* is a first step in monitoring and future control efforts, particularly at the landscape level.

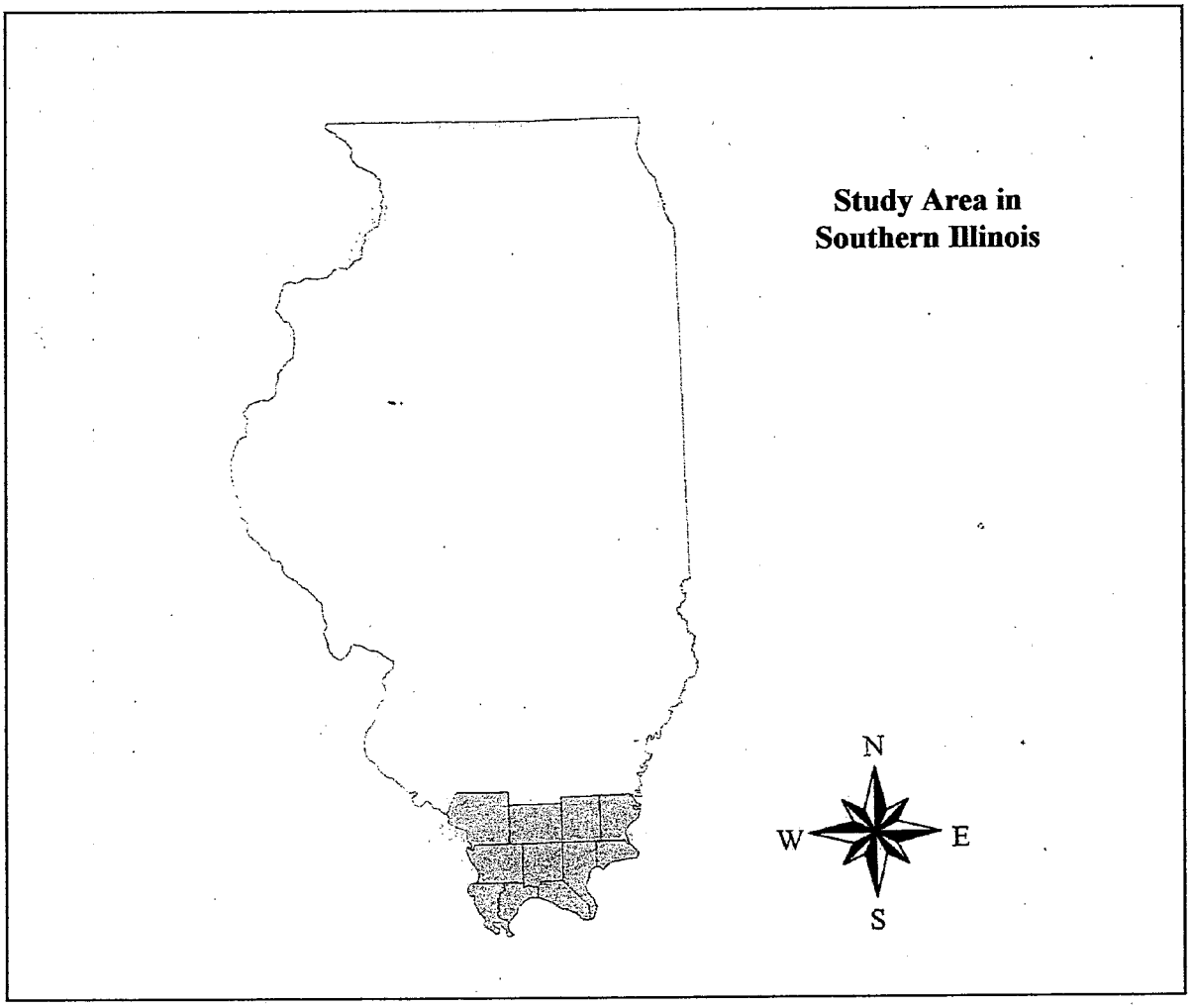

Figure 1. Study area counties: Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Pulaski, Union and Williamson.

2.0 ECOLOGY OF *Celastrus orbiculatus*

2.1 Physical Description

The following description is compiled from Dreyer 1994, Hutchison 1990, Patterson 1974, Silveri et al. 2001, and Tibbetts 2000. *Celastrus orbiculatus* Thunb., also known as Oriental Bittersweet, Asian Bittersweet and Round-leaved Bittersweet is a perennial, deciduous, woody vine (liana) native to Japan, Korea and China. It sometimes occurs as a trailing shrub. It is a member of the Celastraceae or Staff Tree Family. It is dioecious to polygamodiecious. It reproduces sexually and expands vegetatively by stolens and rhizomes, and through rootsuckering. Stems are round, smooth and vary in shades of grey or brown, usually with noticeable lenticels. Stems, which can reach 13 cm diameter at breast height (dbh), climb by twining around shrubs and trees. Unlike other vines which are limited to smaller diameter supports, *C. orbiculatus* is able to climb supports of a variety of diameters aided by spiny projections around it's buds and leaf scars which lodge into the host's bark. Leaves are glossy, smooth, finely toothed, and arranged alternately. Leaves vary in size and shape from oblong-obovate to suborbicular. Flowers have five sepals and five petals, are greenish-white in color, and occur in clusters arising from leaf axils. Fruits are showy, globose and green to yellow. Upon maturity the fruits split open to reveal red-orange fleshy arils which contain the numerous seeds.

2.2 Natural History

Celastrus orbiculatus is similar to one North American native member of the genus, *C. scandens*. *Celastrus orbiculatus* occurs within the range of *C. scandens*, where the two species are capable of hybridizing (Dreyer 1994). The native liana has elliptic or ovate leaves usually

not found in *C. orbiculatus*, but this is not a reliable means of identification. Location of female flowers and fruit can be used to reliably distinguish the two species. In *C. scandens*, female flowers and fruit occur in terminal panicles (Dreyer 1994).

There is little information on the ecology of *C. orbiculatus* in its native range. Its native habitat has been variously described as "thickets", "open woodland", "lowland slopes" and "among hedges" (Dreyer 1994, Tibbetts 2000). There is also paucity of information on diseases and predators in its native range or in North America.

Birds are primary dispersers of *C. orbiculatus* seed (Baird 1980, Burton pers. comm. 2003, McNab and Meeker 1987, Tibbetts 2000, VanClef pers. comm. 2003). The showy display of fleshy fruit in late autumn and early winter attracts many avian species that subsequently disperse seed through droppings and/or regurgitation (Malmborg and Willson 1988). Although undocumented, it is likely that avian foraging patterns contribute to spatially explicit patterns of spread of *C. orbiculatus*. Small mammals are also thought to forage on *C. orbiculatus* fruit, while humans are considered important dispersers. Fruiting stems are collected, often from areas where its has naturalized, for decorative dried flower arrangements. The plant is also available commercially in nurseries. It has historically been planted along highways for soil erosion control, and in wildlife management food plots.

2.3 Invasion of North America

Celastrus orbiculatus was introduced into North America as an ornamental vine circa 1860 (Patterson 1974). Seedlings were later cultivated and sold for landscaping, with seeds distributed to 30 states (Patterson 1974). Its hardiness and aggressive growth made it a desirable cover plant, and so was planted along highways in New Jersey, Rhode Island and Massachusetts

(Patterson 1974). It has become naturalized in at least 21 of 33 states where it was introduced (Patterson 1974). By the 1970s it was naturalized north to central Maine and throughout New England, to Ohio and west to Iowa, and south to Louisiana and Georgia (Dreyer 1994). It is cultivated in three Pacific states (Dreyer 1994). In Illinois, it has previously been reported in nine northern and central counties: Lake, Will, DuPage, Kane, Carroll, Kendall, Mason, Ogle, and Piatt; and in eight southern counties: Alexander, Hardin, Jackson, Union, Williamson, Pope, Saline, and Gallatin (Illinois Plant Information Network; Jody Shimp pers. comm.).

It is considered "weedy" throughout North America. In Michigan, and very likely throughout its range, *C. orbiculatus* has become more abundant than the native liana (Tibbetts 2000). The Illinois Department of Natural Resources (IDNR) refers to *C. orbiculatus* in its Forestwatch News (2000) as a "vine of major concern due to its rapid spread in the state". It is considered a major problem in Great Smoky Mountain National Park and is reported as an epidemic around the Asheville, NC area (Dreyer 1994).

Celastrus orbiculatus invades early and late successional forests in North America (McNab and Meeker 1987). It is found with greater frequency in mixed mesophytic than mixed oak (*Quercus*) forests (McNab and Meeker 1987, Pande 2005, Robertson et al. 1994). It is also associated with old fields, forest edges, roadsides, woodlands, stream banks, and hedgerows (McCarthy et al. 2001, Patterson 1974, Plant Conservation Alliance 1997, Robertson et al. 1994).

2.4 Factors Influencing Invasion

Although not considered a forest species in its native Asia, *C. orbiculatus* invades early and late successional forests in North America, where it is found with greatest frequency in mixed mesophytic forests (McNab and Meeker 1987, Robertson et al. 1994). McNab and Loftis

(2002) found that probability of occurrence of *C. orbiculatus* increased when oak (*Quercus spp*) did not dominate the canopy, while Ellsworth et al. (2004) found that the coarse texture of oak leaf litter was a barrier to the growth of *C. orbiculatus* seedlings. Pande (2005) found *C. orbiculatus* associated with successional forest types of Southern Illinois, and absent in oak-hickory forests.

Light availability is an important environmental factor in plant invasions (Hobbs and Huenneke 1992). As such, Robertson et al. (1994) found *C. orbiculatus* associated with old fields (i.e., higher light availability compared to forest interior). However, Ellsworth et al. (2004) report that *C. orbiculatus* is able to establish in dense forest understories, and Patterson (1974) similarly found high rates of germination in low irradiance levels. Dreyer et al. (1987) and Dreyer (1994) report however, that *C. orbiculatus* grows rapidly upon release. Pande (2005) found *C. orbiculatus* growing in forests with open and closed canopy, but its presence was more likely, and more aggressive, in areas with higher solar incidence (i.e., more open canopy).

Among NIS generally, Greenberg et al. (1997) found that fine textured soils support significantly higher concentrations of invasive species. Silveri et al. (2001) found higher rates of *C. orbiculatus* seedling grow in moist circumneutral soil within a logged area in Massachusetts. McNab and Loftis (2002) concluded that mineral soil, and topographic variables and canopy composition representing greater site moisture availability were favorable to *C. orbiculatus* seedling establishment. Similarly, Pande (2005) found *C. orbiculatus* presence associated with moist, circumneutral soils with greater proportions of clay, and found it absent on drier more acidic soils with less clay.

McNab and Loftis (2002) found that probability of *C. orbiculatus* increased with increasing elevation. Pande (2005) found its presence significantly associated with higher

elevations in Southern Illinois, with greater probability of occurrence on interfluves where other suitable factors for its growth were also present.

Disturbance is an important environmental factor associated with invasion of *C. orbiculatus*. In fact, the success of *C. orbiculatus* may be due to human-caused disturbances (Robertson et al. 1994, Luken and Thieret 1996, McNab and Loftis 2002). Dreyer (1984) states that frequent and large-scale disturbance characteristics of many temperate ecosystems enhance opportunities for *C. orbiculatus* to invade and persist. Jean and Niering (1999) found the first occurrence of *C. orbiculatus* outside of cultivation in Connecticut in a natural area adjacent to a fence. McNab and Loftis (2002) found invasion associated with forest floor scarification and hurricane-caused windthrows. Occurrence has also been associated with disturbance of coastal areas and salt marshes (Dreyer 1994, Plant Conservation Alliance 1997). Pande (2005) found the distribution of *C. orbiculatus* within Giant City Park in Southern Illinois significantly associated with disturbance which included historical land use (general agriculture), park recreation (roads and trails), wildlife management (mowing and food plot cultivation), and utility rights-of-way. Meanwhile, Patterson (1974) reports that after becoming established in disturbed areas, *C. orbiculatus* subsequently invades nearby undisturbed areas.

3.0 IMPACTS OF INVASION

3.1 Ecological Impacts

Since its introduction in the U.S. in the late 20th century, *C. orbiculatus* has become a serious ecological and economic threat to native ecosystems, particularly in disturbed temperate areas (McNab and Meeker 1987, Tibbetts 2000). Once established, *C. orbiculatus* can quickly overtop native vegetation forming impenetrable thickets with dense shade preventing photosynthesis in other plants (*Dreyer* 1994, Jean and Niering 1999, Patterson 1974, McNab and Meeker 1987). It girdles native trees, and kills through constrictive twining (Patterson 1974, Dreyer et al. 1987, McNab and Meeker 1987). It can uproot plants by force (Patterson 1974, PCA 1997). Its rapid domination can damage regenerating forests and displace native vegetation, and it may hybridize with the native liana, *C. scandens* (Dreyer et al. 1987, McNab and Meeker 1987). It was even reported as potentially interfering with nesting efforts of the endangered Piping plover (*Charadrius melodus*) in Connecticut (Dreyer 1994).

Celastrus orbiculatus is reported in Southern Illinois by Hutchison (1990) at Fern Rocks Nature Preserve in Jackson County, as covering the ground and vegetation, "actually eliminating native ground-cover species". However, this was not observed at this location during the course of this project. Dense thickets, and overtopping and girdling of trees were reported by Pande (2005), and were observed at other various locations in Southern Illinois during the course of this project.

3.2 Economic Impacts

Evaluation and estimation of economic impacts by *C. orbiculatus* are unknown. However economic impacts of NIS include indirect loss in economic output (i.e., losses in crops)

and direct loss in attempts to eradicate or prevent invasions (Mack et al. 2000), and are estimated in the billions of dollars annually in the U.S. (Pimentel et al. 2000). Indirect loss due to *C. orbiculatus* may include damage to industrial/commercial forests, and damage to recreational opportunities (McNab and Meeker 1997). Control of *C. orbiculatus*, although unsatisfactory, includes chemical and mechanical means and requires special equipment and trained personnel, adding to costs of control.

4.0 METHODOLOGY

4.1 Reported Locations and Herbarium Records

In November, 2003, Mr. Jody Shimp (IDNR) reported informal accounts of sightings of *C. orbiculatus* at 14 locations in the eight southernmost counties of Illinois (Shimp pers. comm.). These informal accounts consisted primarily of personal communications among Mr. Shimp and colleagues within IDNR and other resource agencies. These communications included general, often vague descriptions of the location of the possible sighting, and did not include details of the plant's occurrence (e.g., coordinates, number/density of stems, patch size, cover type). Copies of these informal accounts were acquired. Additional informal accounts of potential sightings were gathered from faculty, staff and students within the Geography and Plant Biology Departments at Southern Illinois University - Carbondale.

At the suggestion of Mr. Bob Lindsey (IDNR), in October, 2004, a letter requesting information on possible sightings of *C. orbiculatus* were sent to District Managers of the Illinois Department of Transportation, and district personnel of the Natural Resource Conservation Service in southern Illinois (see Appendix). There was a 0% response rate. Follow up calls did not result in any accounts of possible *C. orbiculatus* locations.

Illinois herbariums were contacted for historical records of occurrence of *C. orbiculatus* within the study area. The following herbariums were contacted: the Center For Biodiversity at the Illinois Natural History Survey (Urbana), Eastern Illinois University (Charleston, IL), the Missouri Botanical Garden (St. Louis), the Field Museum of Natural History (Chicago), Morton Arboretum (Lisle, IL), and the University of Illinois Department of Plant Biology. These official records were compiled with the informal accounts (above), and formed the basis of this project.

4.2 Field Reconnaissance

Field reconnaissance was conducted in two phases, a preliminary investigation, and later follow-up for collection of more detailed information on the observed occurrences of *C. orbiculatus*. Preliminary field work began in October, 2004, and consisted of visits to each of the locations on the compiled list. During these site visits, the location was visually screened for presence of *C. orbiculatus*. Its presence or absence was noted, with a general description of the location. Photographs of the location or nearby landmark were taken to aid follow-up visits. *Celastrus orbiculatus* occurred on most of the sites, although not all, and in most cases was readily identified. However, the preliminary study was conducted during winter months when the plant did not have leaves. Young stems in particular were difficult to find and positively identify. Follow-up visits during late Spring 2005, augmented these earlier screenings.

The primary activity of the second phase of field reconnaissance was collection of geographic information on the verified locations of *C. orbiculatus* occurrence. This phase was conducted May-June, 2005. At each site, coordinate information was collected using a Global Positioning System (GPS; Garmin eTrex). To determine the spatial extent of *C. orbiculatus* at each site, the observer visually located the boundary of the invaded area while walking throughout the general area of each *C. orbiculatus* occurrence, and logging waypoints with the GPS. GPS points along the entire perimeter of the invaded sites were collected when the sites were of a size that could be mapped within one hour. Sites which were very large and were unlikely to be mapped within an hour were proportionately mapped and the actual spatial extent of the invasion is unknown. These sites have been noted (see Table 1).

Specimens for voucher into state herbariums were collected at several locations. Details may be obtained from Mr. Robert Lindsay, IDNR District Ecologist.

4.3 Digital Map and Database Creation

All GPS points recorded in the field were downloaded as shapefiles in ArcView (Version 3.3, ESRI) for map preparation. GPS points recorded in each patch were used to prepare polygons, lines, or points to represent a particular site of invasion. Polygons were drawn for those sites where *C. orbiculatus* occurred as a relatively large patch. Line features were drawn where the invasion occurred in a narrow, linear fashion such as along roadsides, or in the case when a very large patch occurred along the road and into adjacent forest, but was too large to verify its perimeter (Table 1). Patch size was calculated using the Patch Analyst extension. An attribute table containing coordinate information was created for all polygons, lines and points, and was edited to incorporate text information regarding patch size (when available), cover type at the location of invasions, and other small notes on the nature of the location.

Polygons, lines and points prepared in ArcView were then overlaid on a basemap of county boundaries and road coverages. The basemap was georeferenced, using the WGS 1984 datum, and using the WGS 1984 UTM Zone 16N projection. County boundaries and road shapefiles were downloaded from USDA Geospatial Data Gateway (http://datagateway.nrcs.usda.gov). Finalized digital files were copied to CD, and a final map image (.jpg) was created in ArcMap.

5.0 RESULTS

5.1 *Celastrus orbiculatus* in Southern Illinois.

Thirty-two sites were visited for verification of presence of *C. orbiculatus* within the study area. Sites occurred within eight counties: Gallatin, Hardin (previously unreported in this county), Jackson, Johnson, Pope, Saline, Union, and Williamson. No reports were found for Alexander, Massac, or Pulaski counties, and thus these counties were not visited. Of the 32 reported locations of *C. orbiculatus* presence, 16 were verified to have *C. orbiculatus* at or near the reported location (Fig. 2). A few locations were noted as having *C. orbiculatus* present during the first phase of field reconnaissance, but the plant was not found during follow-up visits (see discussion on *Euonymus* below). Several reported locations had more than one patch of

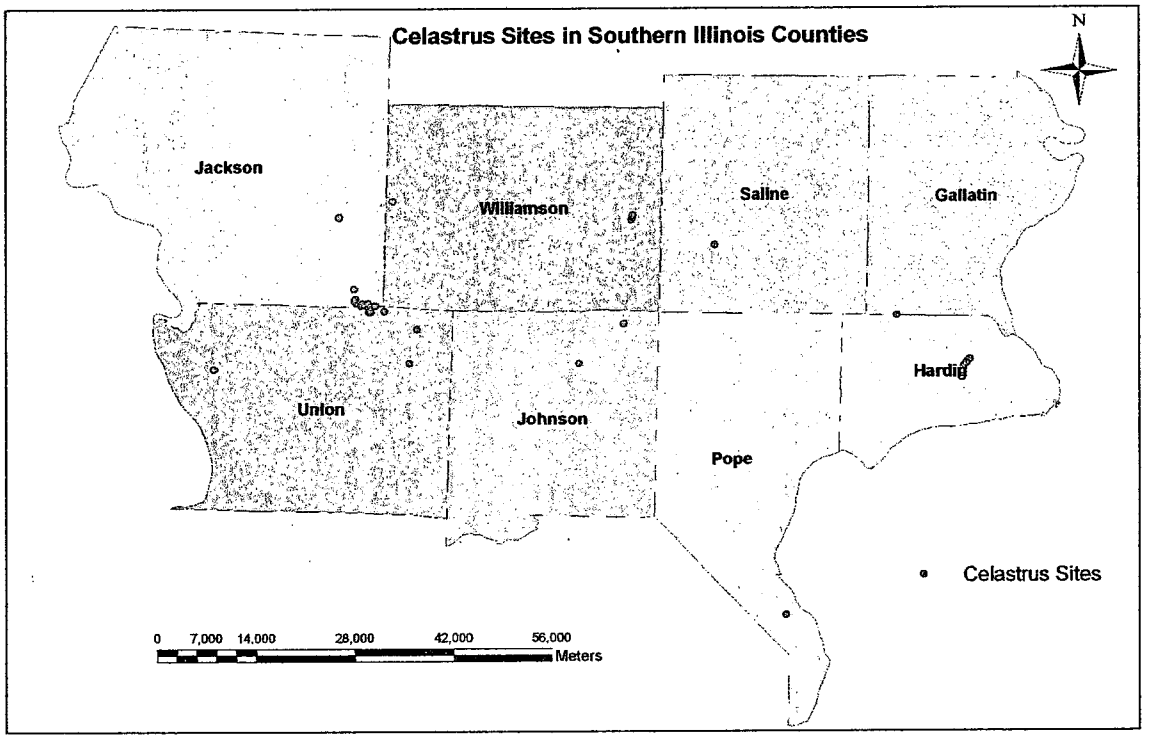

Figure 2: Verified locations of *C. orbiculatus* occurrence in Southern Illinois.

Table 1: Location general information.

Name	County	Description	*Celastrus* recorded?	No. of invaded sites (patches)
High Knob	Gallatin	Near picnic and camping area along R.-to-R. trail	Y	1
Garden of the Gods	Gallatin	Near picnic and camping areas	N	0
William Hills	Gallatin	West hill of Herod	N	0
Eastern Hills	Gallatin	East hill of Herod	N	0
*FS Rd 1749	Hardin	NE of Rock Creek, towards C.R. 845	Y	5
*County Rd 845	Hardin	Intersection of C.R. 845 and FS Rd. 845	Y	1
* Rock Creek	Hardin	Along Rock Creek towards south	Y	2
Near SIUC	Jackson	W. end of parking area on W. side of Comm. Bldg.	Y	2
Raccoon Valley	Jackson	Raccoon Valley Rd.	N	0
C'Dale Reservoir	Jackson	Near old fields	N	0
New Burnside	Johnson	Along Tunnel Hill Tr, mi marker 207 & 208	Y	2
Tunnel Hill	Johnson	Along Tunnel Hill Tr., opp mi marker 214	Y	1
Cedar Bluff	Johnson	Along River-to-River Trail	N	0
Ferne Clyff	Johnson	Along hiking & bridle trails	N	0
Bay City	Pope	Along FS 485 and at intersection with Bay City Rd.	Y	1
Lusk Creek Canyon	Pope	Along hiking & bridle trails, in camping area	N	0
Bell Smith Springs	Pope	Along hiking & bridle trails, in camping area	N	0
Tunnel Hill Tr, Harrisburg	Saline	E. of Tunnel Hill Tr., next to Route 45	N	0
Tunnel Hill Tr., Stonefort	Saline	East of Tunnel Hill Tr., north of mi marker 205	N	0
Carrier Mills	Saline	Below water tank, along hedgerow	Y	1
Panther Den	Union	N. side of Panther Den Rd, 1mi E. of Rocky Comf. Rd.	Y	1
Pitts Rd.	Union	S. of Panther Den Rd., W. side of Pitts Rd.	N	0
*Pine Hills CG	Union	On both sides of creek	Y	2
Spurlocks Res	Union	Among cedar trees along rd.	Y	1
Antioch	Union	N. of cemetery long River-to-River Tr.	Y	1
W. Liberty Cem.	Union	In cemetery on Progress Ln.	N	0
Giant City Park	Union	Throughout	Y	12
Kerr Canyon	Union	S. of Giant City Park	N	0
Crab Orchard NWR, Playport Rd.	Williamson	E. side of Spillway Rd, near boating area	Y	1
Crab Orchard NWR, Cambria Rd.	Williamson	Along Cambria Rd.	N	0
Herrin	Williamson	Near power line	N	0
Dykersburg	Williamson	Intersection of Dykersberg and old Delta Mine Rd.	Y	3

Table 2. Celastrus Site Details

Celastrus Site	Size (ha.)	X coordinate	Y coordinate
Trillium trail, Giant City Park	9.67	305755.1871	4166162.721
Near Campground, Giant City Park	7.82	308139.7254	4163572.03
Pine 7, Giant City Park	4.62	308211.6106	4162800.765
Pine 5, Giant City Park	13.45	307896.234	4162782.675
Opposite visitor center, Giant City Park	9.66	306936.4583	4163923.723
Landing Strip, Giant City Park	13.68	307769.0879	4163973.932
Church road small, Giant City Park	5.99	305829.5168	4164401.822
Church road big, Giant City Park	48.02	305836.2361	4164783.015
Campground, Giant City Park	19.98	309018.8681	4163824.192
Arrowwood, Giant City Park	4.87	306776.3745	4163746.918
Near field 5, Giant City Park	1.5	308124.9088	4163034.752
Indian creek, Giant City Park	3.22	307471.5486	4163765.411
Tunnel hill	0.04	337740.9747	4155452.404
Spurlocks Residence	*	313598.8404	4155497.243
SIU1_communication	0.27	303722.0792	4176520.071
SIU2_communication	*	303694.9977	303694.9977
Rock creek2	*	392232.328	4153319.042
Rock creek1	*	392271.1042	4153352.891
Pine hill1	2.36	285902.477	4154665.231
Pine hill2	1.21	285956.6553	4154682.819
Panther den	*	314623.4384	4160379.275
High knob	*	382938.0819	4162217.092
Forest Road 1749i	0.11	393198.5782	4155918.081
Forest Road 1749ii	0.28	393166.3673	4155930.306
Forest Road 1749iii	0.14	392976.5526	4155673.182
Forest Road 1749iv	1.2	393013.1391	4155622.405
Forest Road 1749v	*	392792.7451	4155439.56
Intersection of FR 1749 & CR 845	0.15	392404.9513	4154938.43
Dykersburg1	0.89	345176.8246	4176015.947
Dykersburg2	14.18	345268.1134	4176330.907
Dykersburg3	1.39	345372.5235	4176669.297
Crab orchard	0.81	311250.7745	4178652.893
Carrier mills	0.12	357034.1066	357034.1066
Burnside1	0.29	344089.8244	4161085.283
Burnside2	0.22	344113.357	4161099.56
Baycity	0.53	367223.4975	4119513.937
Antioch	5.95	310029.1849	4162942.319

* *Celastrus* sites which occur along road for which area could not be calculated.

C. orbiculatus within the vicinity (Table 1). The total number of patches encountered was 37. Twelve patches occurred within Giant City Park, Jackson County, and were comprehensively studied as part of a Master's thesis at SIUC. A summary of the results of that study are provided below.

Patch size ranged from < 1 ha to over 50 ha. However, some patches were so large their actual perimeter could not be located within budgeted time, and so are larger than reported (Table 1). At some locations the plant occurred as a linear patch along roads and trails, appearing to be restricted to edge environments. In other locations it occurred as very large, non-linear patches extending into the forest interior.

Other alien plant species including *Euonymus fortunei*, *Lonicera japonica*, and *Pueraria lobata*, were observed at locations reported to be invaded by *C. orbiculatus*. *Euonymus fortunei* was found growing prolifically in some locations, and was found at two locations which during preliminary field visits had been noted as having *C. orbiculatus* present, but during follow-up *C. orbiculatus* was not found. At some locations, leaves of the two species looked very similar, and greater effort was required to distinguish the plants. We believe, therefore, that *E. fotunei* may be routinely confused for *C. orbiculatus* by the casual observer in Southern Illinois, especially when fruits are not present. This may result in over-reporting of it's occurrence.

Overall, much fewer than expected informal reports of *C. orbiculatus* were collected. It appears that its presence is not well known colloquially, or among land and resource professionals. Although this project verified the existence of 37 patches of *C. orbiculatus* among 16 locales within 8 counties in Southern Illinois, it is certain to exist more extensively and in many more locations. A systematic survey for locations of its potential or probable

occurrence is necessary to fully understand its distribution. Habitat suitability models, like that reported below, are most likely to produce more useful results than those reported here.

5.3 Giant City Park: A Regional Invasion

Ms. Archana Pande, Department of Geography, SIUC, conducted field research within Giant City Park (GCP), 2004-05, wherein she examined significant environmental factors that facilitate invasion by *Celastrus orbiculatus*. Presence/absence information, as well as density (stems m^{-2}), dbh, and number of mature stems (> 1.5cm dbh) of *C. orbiculatus* were obtained in plots within patches of *C. orbiculatus* patches. Forest cover type, canopy cover (%), elevation, slope, aspect, soil pH, soil texture, distance to nearest road, and potential annual direct incident radiation were recorded/calculated for patches and adjacent non-invaded areas.

The study was conducted in two phases. A preliminary study was conducted in March (2004) to search for possible locations of *C. orbiculatus* within GCP. Digital Ortho Quadrangles, Digital Raster Graphics, and landcover classification maps were used to identify landcover types for the entire GCP area, and forest cover types at locations where *C. orbiculatus* was found. The exploration resulted in location of 12 patches of *C. orbiculatus*, ranging from approximately 1.5 ha to 48 ha (Fig. 3). Tremendous variation in cover type was encountered, as were topographic circumstances. Cover types included pine (*Pinus spp*), and early- and late-successional forests.

Elevation, slope, soil pH, soil texture (%clay), oak presence/absence and distance to road were significant factors influencing presence/absence of *C. orbiculatus* in GCP. Probability of occurrence of *C. orbiculatus* was highest on interfluves with forest canopy not dominated by oak and possessing mesic, less acidic soil, and at locations furthest from roads. *Celastrus orbiculatus*

was mostly associated with successional forest types, and *C. orbiculatus* patches with successional forest types held higher proportion of mature stems. Light availability was not a significant factor in presence/absence of *C. orbiculatus*. That is, it was found under all light conditions without significant difference in its density. Where there was greater light availability however, its growth was usually more aggressive (e.g., overtopping trees and occurring in dense thickets).

Disturbance was also found to be a major factor in the distribution of *C. orbiculatus* within GCP. Areas of level-to-gentle slope at higher elevations (interfluves) which were previous locations of farming, were coincident with occurrence of *C. orbiculatus*. Introduction of the liana most likely originates at abandoned home sites (farms) within the park, where in the 20th century its use for soil conservation and as an ornamental was probably encouraged. It has since expanded into suitable environments within GCP.

Figure 4, illustrates the hypothesized interrelation among the significant factors influencing presence and distribution of *C. orbiculatus* within GCP. Elevation, slope, soil texture (% clay), and greater distance to road are coincident with land areas used for farming and settlement many decades ago. Therefore, suitability of areas within GCP are both intrinsic and extrinsic. That is, absolute qualities of the factors influencing occurrence of *C. orbiculatus* derived from bio-geophysical processes (e.g., climate regime, soil formation processes, evapotranspiration rates), while their spatio-temporal context and modification is associated with disturbance from land use prior to and after establishment of GCP. Therefore, land use history must be considered a major factor contributing to invasion by *C. orbiculatus* in GCP.

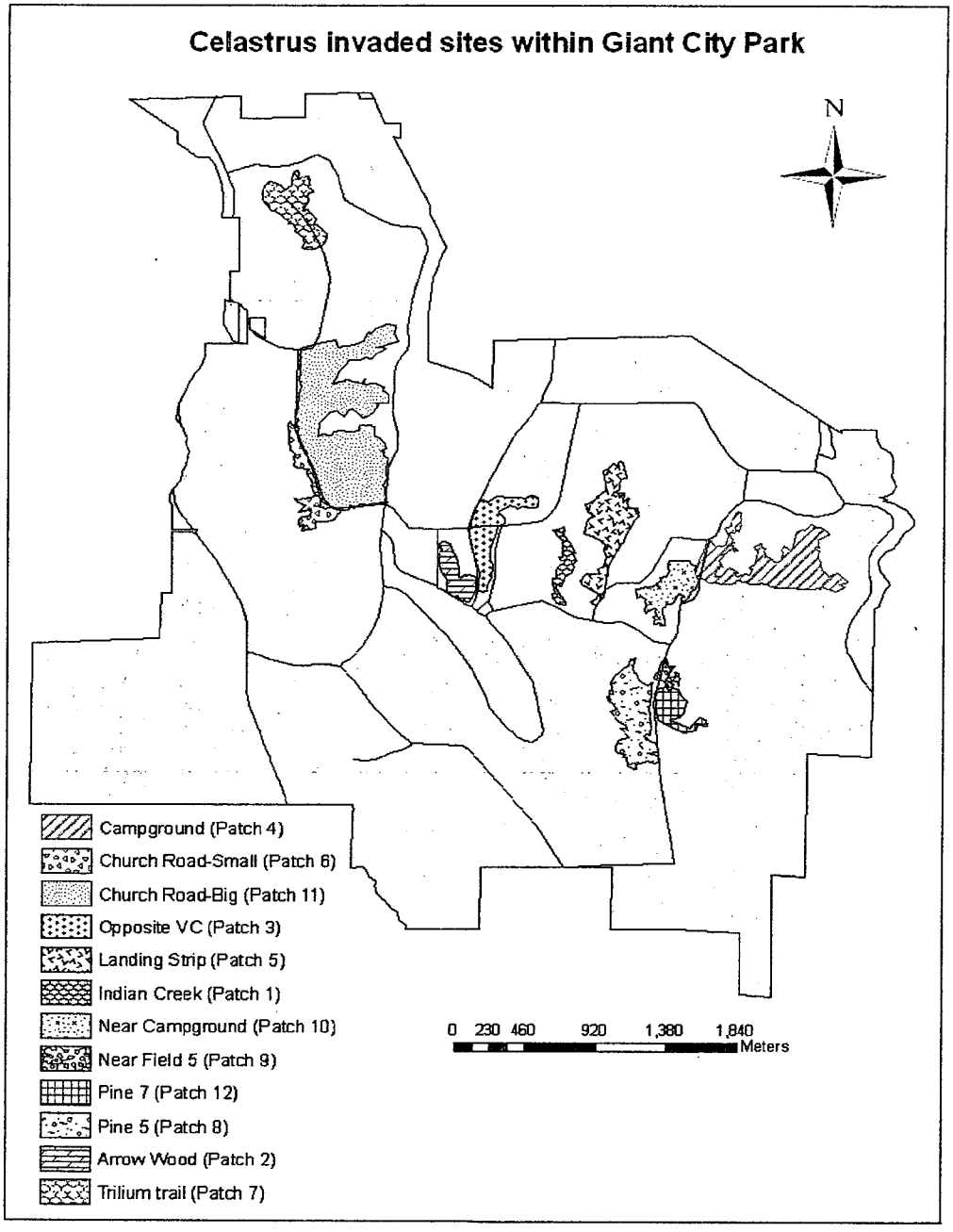

Figure 3: Occurrence of *C. orbiculatus* in Giant City Park, Southern Illinois

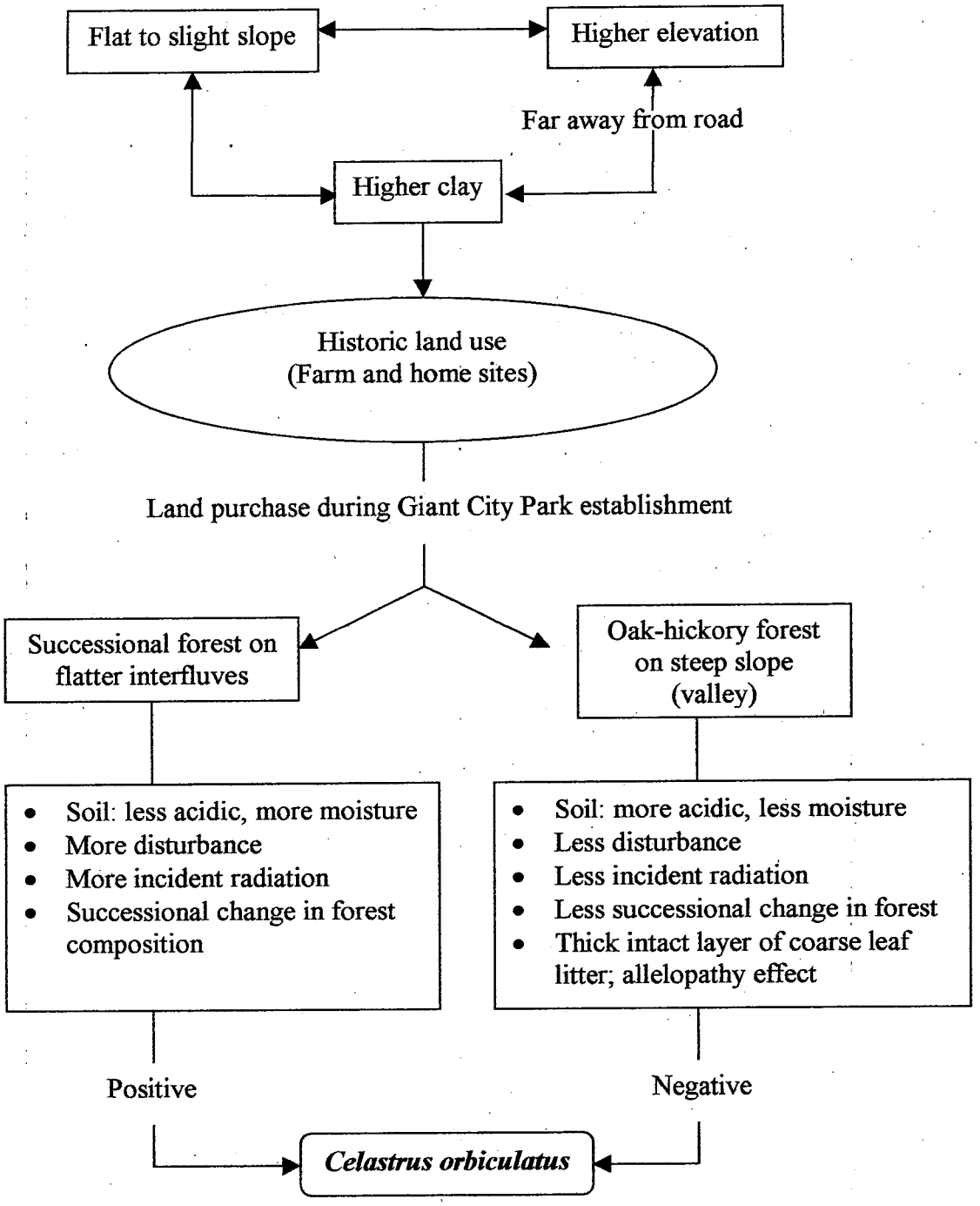

Figure 4: Hypothesized interrelation among the significant environmental variables and *C. orbiculatus*. Double arrows show the variables are acting together and single arrow show that the factors are finally contributing towards positive or negative consequences on invasion by *C. orbiculatus*.

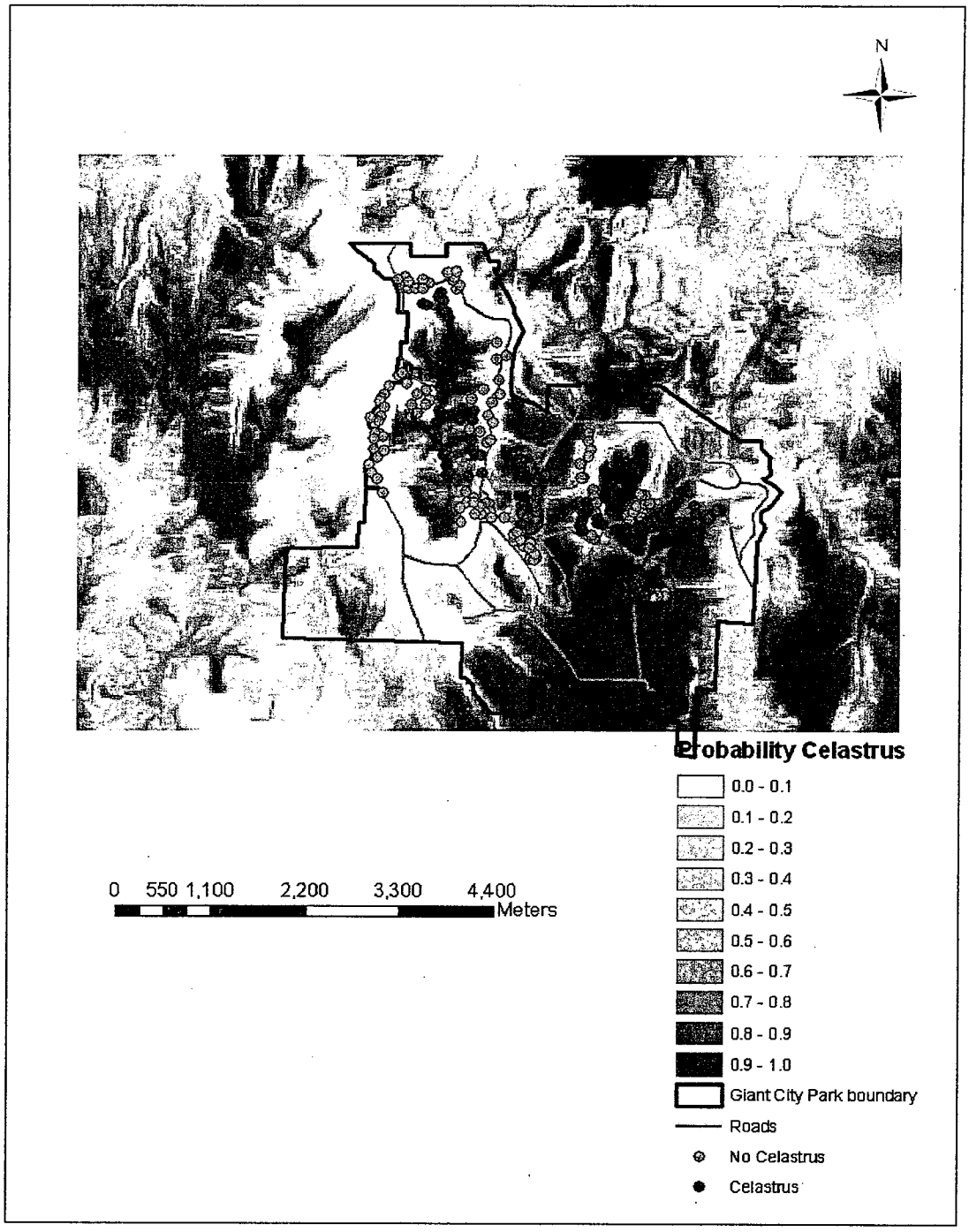

Figure 5: Probability Surface Map – GCP: Lighter shade indicates less probability of *C. orbiculatus* occurrence, darker shade is greatest probability of occurrence. Points are locations where presence/absence has been verified through field observation.

A large portion of GCP is under pressure of invasion by different exotic plant species including *C. orbiculatus*. Therefore the entire park was evaluated for risk of invasion by *C. orbiculatus* using GIS and the significant factors identified earlier in the study as input criteria. A probability map for the entire park was developed using available raster data and map algebra techniques. Input raster data included elevation, slope, radiation index, and distance to road. Although pH, slope position, soil texture (% clay), and oak absence were identified as significant factors in *C. orbiculatus* presence, existing raster datasets were unavailable and therefore these variables were omitted from the model. The probabilities were visualized a shaded relief map (Fig. 5). Points where *C. orbiculatus* presence/absence had been verified in the field were overlaid on the map. The model achieved overall 85% correct prediction of *C. orbiculatus* presence/absence within the preserve.

5.2 Vouchered Specimens

Specimens were collected at a number of verified locations of C. orbiculatus. Collection was conducted by Mr. Daniel Cox while an intern at IDNR. Information on the methods of collection, the number of specimens, preparation of specimens and the herbariums to which specimens were sent was not available at the time of preparation of this document. Mr. Robert Lindsay, IDNR District Field Ecologist, should be contacted for further information.

6.0 CONCLUSION

This project resulted in location of 37 patches of *C. orbiculatus* among 16 locales within eight Southern Illinois counties (Gallatin, Hardin, Jackson, Johnson, Pope, Saline, Union, and Williamson), based on a compilation of informal accounts of its occurrence. Two locations from the complied list did not have *C. orbiculatus*. A digital map using GIS and existing raster data was produced, providing a visualization of the locations where *C. orbiculatus* was verified to exist. The map also provides detailed information as text within "look-up" attribute tables accessible by placing the mouse pointer over a location on the map and clicking.

An intensive study conducted in Giant City Park (Pande 2005), although not an activity of this project, provides useful information on the nature of occurrence of *C. orbiculatus* within a portion of this project's study area. That is, mesic environments of higher elevation lacking oak, and with a history of disturbance are most likely to have, or in the future be invaded by, *C. orbiculatus*. While this project did not analyze the biogeophysical environments of the locations where *C. orbiculatus* was verified, it appears likely that conditions may be very similar to those discovered by Pande.

While this project has resulted in useful information, it is preliminary at best. It is highly recommended that robust methods of systematic survey and probability mapping such as that used by Pande (2005) be employed to produce a comprehensive portrayal of the current and potential distribution of *C. orbiculatus* within Southern Illinois if not the entire state. Such an undertaking will greatly enhance management goals which rely on early intervention.

Approximately 350 man-hours were required to complete this project. A majority of the field work was completed by Ms. Archana Pande, but assistance from Ms. Kari Foster, Mr. Daniel Cox, and Ms. Lisa Wait were essential. Their tireless efforts are duly acknowledged.

LITERATURE CITED AND REFERENCES

Baird, J.W. 1980. The selection and use of fruit by birds in an eastern forest. *Wilson Bull.* 92: 63-73.

Dreyer, G. 1984. Spontaneous naturalization of woody plants in the Connecticut Arboretum-II. *Newsletter of Connecticut Botanical Society* 12(3): 2.

Dreyer, G. 1994. Element Stewardship Abstract for *Celastrus orbiculatus. The Nature Conservancy.* 12 pp.

Dreyer, G.D., L. M. Braid and C. Fickler. 1987. *Celastrus scandens* and *Celastrus orbiculatus*: Comparison of Reproductive Potential between a Native and an Introduced Woody Vine. *Bulletin of the Torrey Botanical Club* 114(3): 260-264.

Ellsworth, J.W., R.A. Harrington and J.H. Frownes. 2004. Survival, growth and gas exchange of *Celastrus orbiculatus* seedlings in sun and shade. Am. Midl. Naturalist 151(2): 233-240.

ESRI. 2002. ArcView 3.2. Environmental Systems Research Institute, Redlands, CA.

Fike, J. and W.A. Niering. 1999. Four decades of old field vegetation development and the role of *Celastrus orbiculatus* in the northeastern United States. J. Veg. Sci. 10: 483-492.

Greenberg, C.H., S.H. Crownover and D.R. Gordon. 1997. Roadside soils: A corridor for invasive of xeric scrub by non-indigenous plants. *Natural Areas Journal* 17: 99-109.

Hobbs, R.J., and L.F. Huenneke. 1992. Disturbance, diversity, and invasion: Implications for conservation. *Conservation Biology* 6: 324-337.

Hutchison, M. 1990. Vegetation Management Guideline Manual 1(20). Illinois Department of Natural Resources, Natural History Survey, Urbana, IL.

Illinois Department of Natural Resources. 2000. Lewis and Clark Monitor (1) 3: ForestWatch News. Natural History Survey, Urbana, IL.

_____. 2001. Critical Trends in Illinois Ecosystems. Critical Trends Assessment Program, Illinois Natural History Survey. 8M/PRT 3201144.

Jean, F., and W.A. Niering. 1999. Four Decades of Old Field Vegetation Development and the Role of *Celastrus orbiculatus* in the Northeastern United States. *Journal of Vegetation Science* 10: 483-492.

Luken, J.O., and J.W. Thieret. 1996. Amur Honeysuckle: Its Fall from Grace. Lessons from the Introduction and Spread of a Shrub Species May Guide Future Plant Introductions. *BioScience* 46: 18-24.

Mack, R., D. Simberloff, W. Lonsdale, H. Evans, M. Clout and F. Bazzaz. 2000. Biotic Invasions: Causes, Epidemiology, Global Consequences and Control. *Ecological Applications* 10: 34-56

Malmborg, P.K. and M.F. Willson. 1988. Foraging ecology of avian frugivores and some consequences for seed dispersal in an Illinois woodlot. *Condor* 90: 173-186.

McCarthy, B.C., C.J. Small and D.L. Rubino. 2001. Composition, Structure, and Dynamics of Dysart Woods, an Old-growth Mixed Mesophytic Forest of Southeastern Ohio. *Forest Ecology and Management* 140: 193-213.

McNab, W.H. 1988. Oriental Bittersweet: Another Kudzu? *Proceedings of Annual Hardwood Symposium of the Hardwood Research Council* 16: 190-191.

McNab, W.H. and D. Loftis. 2002. Probability of Occurrence and Habitat Features of Oriental Bittersweet in an Oak Forest in the Southern Appalachian Mountains, USA. *Forest Ecology and Management* 155: 45-54.

McNab, W.H. and M. Meeker. 1987. Oriental Bittersweet: A Growing Threat to Hardwood Silviculture in the Appalachians. *Northern Journal of Applied Forestry* 4: 174- 177.

Office of Technology Assessment (OTA). 1993. *Harmful Non-indigenous Species in the United States*. Washington DC: U.S. Government Printing Office. Report OTA-F-565.

Pande, A. 2005. Habitat modeling to assess the risk of invasion by *Celastrus orbiculatus* on public lands in southern Illinois. Master's Thesis. Southern Illinois University – Carbondale.

Patterson, D.T. 1974. The Ecology of Oriental Bittersweet. *Celastrus orbiculatus*, A Weed Introduced Ornamental Vine. Ph.D. Dissertation, Duke University, Chapel Hill, North Carolina, USA.

Patterson, D.T. 1975. Photosythetic acclimation to irradiance in *Celastrus Orbiculatus* Thunb. *Photosynthetica* 9(2): 140-144.

Pimentel, D., L. Lach, R. Zuniga and D. Morrison. 2000. Environmental and Economic Costs of Indigenous Species in the United States. *Bio-Science* 50(1): 53-64.

Plant Conservation Alliance, Alien Plant Working Group. August 1997. *Oriental Bittersweet* (*Celastrus orbiculatus* Thunb.). http://www.nps.gov/plants/alien/fact/ceor1.htm.

Robertson, D.J., M.C. Robertson and T. Tague. 1994. Colonization Dynamics of Four Exotic Plants in a Northern Piedmont Natural Area. *Bulletin of the Torrey Botanical Club* 121(2): 107-118.

Silveri, A., P. Dunwiddie and H. Michaels. 2001. Logging and Edaphic Factors in the Invasion of an Asian Woody Vine in a Mesic North American Forest. *Biological Invasions* 3: 379-389.

Tibbetts, T. 2000. The Ecology of the Exotic, Invasive Temperate Liana *Celastrus orbiculatus* (Oriental bittersweet) Ph.D. Dissertation. University of Michigan, East Lansing, MI, USA.

PERSONAL COMMUNICATIONS

Dennis Burton, Director of Land Restoration, Schuylkill Center for Environmental Education, Philadelphia, PA.

Jody Shimp, Regional Administrator, Illinois Department of Natural Resources, Benton, IL.

Michael VanClef, Director of Science and Stewardship, The Nature Conservancy's Skylands Program at Newton, NJ.

APPENDIX: LETTER OF SOLICITATION

Oct 18, 2004

Dr. Carol L. Williams
127 Deloach Hall
Department of Earth Sciences
University of North Carolina – Wilmington
Wilmington, NC 28403

Dear ,

I'm conducting an invasive plant project in southern Illinois under the sponsorship of the Illinois Department of Natural Resources and the Wildlife Preservation Fund. Also working on this project is Ms. Archana Pande-Lamachani, a graduate student in the Geography Department at SIUC. The purpose of the project is to identify locations where *Celastrus orbiculatus* (Asian Bittersweet) has invaded in southern Illinois. We're requesting your help.

Celastrus orbiculatus, originally from Asia, is an aggressive, woody vine. It has become a pest in southern Illinois, as elsewhere in the eastern U.S. In southern Illinois it has caused damage to native vegetation, possibly hybridized with our native bittersweet, and altered ecosystem processes. It's been identified by IDNR as a plant of major concern. Our project area includes the following counties: Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Pulaski, Saline, Union and Williamson. We'd like to know of potential sightings of the plant within the study area.

We request that you, your employees and associates be on the lookout. For your convenience, a plant identification memo is attached. If you've seen this plant, please provides us with the following information: date of the sighting, and location of the sighting. Please include a street address, if known, or reference to nearest intersection or landmark. Any additional description of the area would also be helpful.

Based on your reports, and those of others, we will verify the locations of the sightings using GPS, then compile the information into an interactive computer-based map. This map will then be made available to IDNR, academic and other interests.

Thank you for your assistance!

Sincerely,

Carol L. Williams