

Report for the Les Mehrhoff Research Award 2022

Climbing plants of the Northeastern United States: A preliminary assessment of diversity and distribution

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Wild cucumber (*Echinocystis lobata*) in flower at Great Meadows National Wildlife Refuge, Concord, MA. (Photo. Neela de Zoysa)

SUMMARY

This study, for the first time, collates and reviews the diversity and distribution of the climbing plants of Northeastern United States covering 800,000 sq miles and 22 states. The result is 195 species, 73 genera and 33 families. This is about 3.7 % of the total number of 5,300 species in the region. The proportion of native to non-native species is 65 % to 35 %. In New England, the native climbers are about 2.7 % of the native flora, while the non-native climbers are a high 7% of the non-native flora. A significant finding of the study is that 83 species, 65% of the native climbers are listed as rare, threatened, endangered, historic and of special concern in one or more of the 22 states in the region. At least 12 species are extirpated from parts of their original range. Among the non-native climber species, 31 species, a 45 % are designated as invasive in one or more of the 22 states. Calculations for New England indicate that invasive species are double the proportion among climbers compared with invasive species in the rest of the non-native flora. The proportion of woody climbers is 32% and herbaceous climbers is 68 %. Among the woody climbers, the high climbers and scandent shrubs are the most numerous (24%). Among herbaceous climbers, medium and low climbers comprised an equal share (28%), and the parasitic *Cuscuta* species accounted for 6 %. Stem twiners represent nearly half the climber species (48.7 %), tendril climbers (32%) with leaf twiners, prickles, barbs and aerial adventitious roots made up the rest (20%). The species richness of climbers is higher along southern edge of the region and diminishes with increasing latitude. There is a noticeable trend from east to west where woody species diminish from the coastal plain toward the inland. This study has laid the foundation for further studies on the climbing plants of the Northeastern United States.

INTRODUCTION

“*The Vines of Northeastern America*” by Charles Newhall published in 1897, is the earliest known publication dedicated to the identification of climbing and creeping plants and describes over one hundred species. In this book, Newhall quotes extensively from Charles Darwin’s important 1865 treatise “*The movement and habits of climbing plants*”. Darwin coined the term “climbing plants” to describe those plants with flexible, fast-growing axes, unable to stand erect beyond a certain height, and relying on an external support (Putz and Mooney 1991). In the literature, woody climbers are generally, but not consistently, referred to as “lianas” and herbaceous climbers as “vines” (Gentry 1991, Sperotto et al. 2020).

Climbers are considered as “structural parasites”, and the fossil record indicates that climbing was an early evolutionary innovation among land plants that occurred independently in many lineages (Burnham 2015). These plants use a variety of anatomical structures and mechanisms to aid and abet climbing; stems that twine around a support or sprawl over vegetation with the help of prickles and hooks; and those with specialized mechanisms such as tendrils, adventitious roots, and adhesive features (Darwin 1865, Isnard and Silk 2009, Schnitzler et al. 2016, Sperotto et al. 2020). It is noteworthy that Darwin’s interest was spurred by Asa Gray’s publication on the tendril movement of two New England Cucurbitaceae species, wild cucumber (*Echinocystis lobata*) and four-seeded bur-cucumber (*Sycios angulatus*) (Darwin 1865, Gray 1858).

Despite this early interest, the study of floristic diversity and ecology of climbers world-wide was largely neglected until the 1980s (Putz and Mooney 1991). The last two decades have seen rapid progress in the study of tropical woody climbers or lianas (Parthasarathy 2015, Schnitzer et al. 2014). Although woody climbers are present in temperate forests they are not well understood (Ladwig and Meiners 2015). In North America, woody climbers have historically been dismissed as pest species in forest management (Burnham 2013).

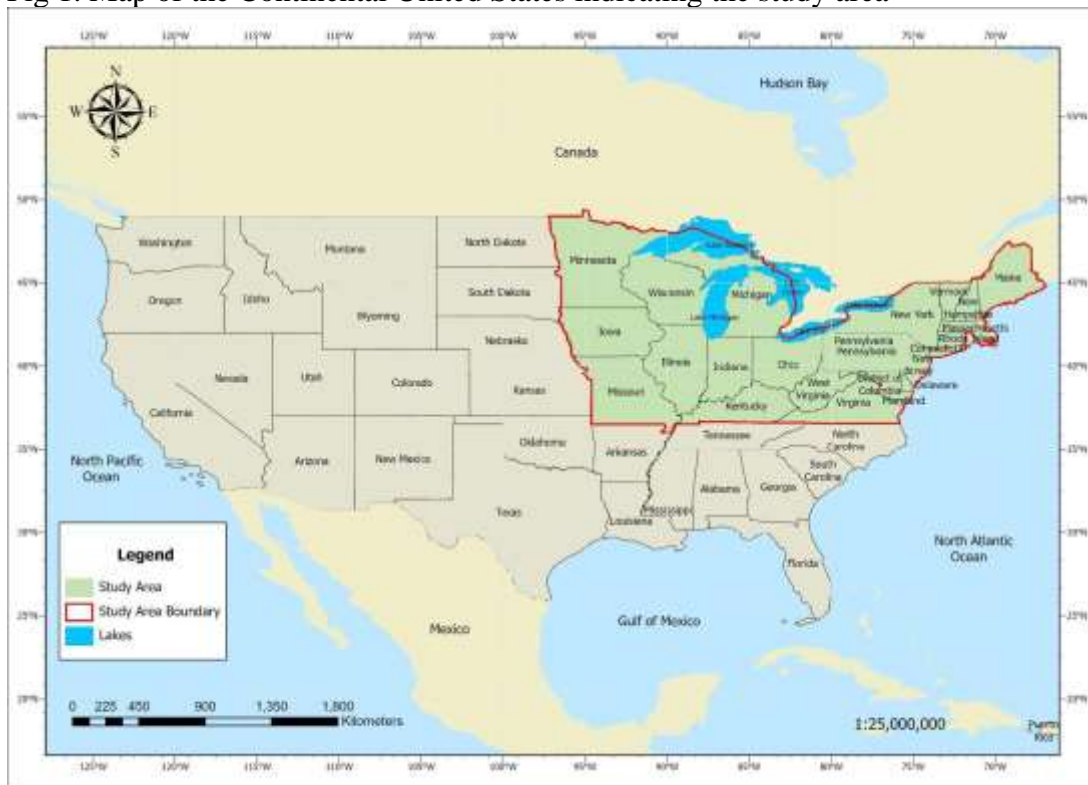
Two studies address the floristic diversity and distribution of woody and herbaceous climbers in the Northeastern United States. Burnham (2013) documented 126 species of woody and herbaceous native and non-native climbers in 26 families in a research site in Michigan. Schnitzler et al. (2016) analyzed the distribution pattern of 150 climber species at a continental scale across South and North America and demonstrated that climber species decline along increasing latitude. Further, that the climber component of the flora remains steady and is independent of taxonomy and climbing mechanisms. The study concluded that the diversity of woody climbers dwindled while that of herbaceous climbers increased with increasing latitude, and that climbers are more abundant in riverine and floodplain communities. Other relevant studies are strictly on woody climbers (lianas). In a study of invasive lianas in forest management, Leicht-Young and Pavlovic (2015) list 18 invasive species, and 75 native species that belong to 27 genera and 19 families across North America. Ecological studies on the abundance of woody climbers in successional forests in Wisconsin, New Jersey and South Carolina indicate that forest fragmentation and the warming climate are favoring the growth of climbers (Allen 2015, Ladwig and Meiners 2010, Londre’ and Schnitzer 2006).

OBJECTIVES

This study is intended to address the lack of information on the climbers of North America. The project began with the collation of climbing plants in the six New England states and was subsequently expanded to include the northeastern quarter of the United States.

The study area is largely based on Gleason and Cronquist's delineation of the Northeastern United States in their "*Manual of Vascular Plants of Northeastern United States and Adjacent Canada*" (1991), which encompasses 22 states¹. This area covers approximately 800,000 mi², which is about 25% of the area of the 48 contiguous states of the continental United States (Fig. 1). The area extends from Maine to Minnesota in the north and from Virginia to Missouri in the south. This region is covered primarily by the eastern temperate forest ecoregion² transitioning into the Great Plains grassland ecoregion west of the Mississippi River. The following 22 states are covered in this study: CT, DE, IA, IL, IN, KY, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VA, VT, WI, WV.

Fig 1. Map of the Continental United States indicating the study area



¹ The range covered in this study does not include the limited area of southeastern Canada that is included in Gleason and Cronquist (1991).

² The northern boreal forest ecoregion is present in the northernmost part of the study area in portions of Maine Michigan and Minnesota and at high elevations in the Appalachian Mountains
https://gaftp.epa.gov/EPADDataCommons/ORD/Ecoregions/cec_na/NA_LEVEL_I.pdf

The study will

- a. compile the taxonomic diversity of climbing plants in this region,
- b. examine native climbers, especially rare species,
- c. categorize the diversity of climbers in relation to woody or herbaceous, how high they climb, scandent shrubs, low herbaceous and parasitic,
- d. examine distribution trends from south to north and east to west within this region of woody and herbaceous climbers, and
- e. clarify the terms used for describing climbing plants.

METHODS

Data sources and field observations: A species list of all climbing plants for the study area was compiled for each of the 22 states from the following national, regional (New England), and state specific sources:

National: BONAP-North American plant atlas, Lady Bird Johnson Wildflower Center's Native Plant database, USDA Plants database, NatureServe, EDD maps for invasive species listing.

New England: GoBotany, Flora Novae Angliae (2011), Atlas of the Flora of New England, Wildflowers of New England (2016).

State level information: Climbers Project of University of Michigan, Native Plant Society websites, state plant atlases, the latest rare plant lists for each state.

Nomenclature: Angiosperm Phylogenetic Group (APG) and Kew Plants of the World Online (POWO).

Field observations have been carried out in the New England region since 2019 and living collections observed at Garden in the Woods in Framingham and the Arnold Arboretum's Leventritt Garden. Climbers from the southern range of the study area were observed at Mt Cuba Center, DE and at the Arnold Arboretum.

Native, non-native, rare and invasive categories: Native and non-native species are categorized. Non-native species in the region, are species introduced mainly from Europe and Asia. However, at the state level, there are a small number of species which are native to parts of the study area and adventive or intentionally introduced intentionally to areas where these species are not native. These species are counted as native to whole region, but as non-native in the states where these species have been introduced.

Species included in state rare plant lists in one or more of the states as rare, threatened, endangered, historic and of special concern are categorized as "rare" in this paper. Extirpated species are noted. Similarly, species that are listed as invasive are enumerated. Native species listed as noxious weeds are not included in the analysis.

Growth forms and climbing mechanisms: Climbers are categorized as woody and herbaceous (a few are semi-woody) and within each group, further divided (tentatively) based mostly on height. Monocots are usually not considered "woody", but perennial *Smilax* species are routinely classified as woody because of their fibrous stems and are categorized as woody in this study.

Among woody climbers, 4 groups are recognized: high climbers (above 30 feet), medium climbers (below 30 feet), scandent shrubs (usually below 20 feet) and trailers that are prostrate and remain close to the ground. Herbaceous climbers are grouped into 4: medium climbers (6 feet - 30 feet), low climbers (3 feet - 6 feet), trailers (prostrate “climbers”) and parasitic dodder vines. Since their flexible stems can be variable and versatile, climbers defy easy categorization. For example, some species will climb high given the opportunity, and clamber and sprawl on the ground or be shrub-like in different circumstances. Scandent shrubs included in this study are often grouped with shrubs in data bases and are not easy to search for. Stoloniferous plants creeping at ground level with the aid of roots are excluded from this analysis.

Climbers are also categorized according to six appendages and mechanisms: stem twiners; leaf petiole twiners; prickles and barbs (that help to cling to a support and prevent them from slipping down); tendrils; and roots (adventitious aerial roots along the stem). Several genera have combinations of more than one mechanism and are categorized into the more dominant mechanism.

Species distribution at the state level and latitudinal gradients: Patterns of climber distribution in the region are examined by analyzing species richness and growth form (especially the proportionate occurrence of woody and herbaceous species) along latitudinal and longitudinal gradients. The presence of rare and invasive climber species is also noted.

Climber terminology: The plethora of terms used for describing climbers is well documented (Putz and Moony 1991; Hu and Li 2015, Sperotto et.al 2020) and posed a challenge to collating the initial list of species. These terms are explained, for better understanding of climber descriptions in the literature.

RESULTS

Taxonomic diversity

The complete list of 195 climber species in the Northeastern United States is given in Appendix 2. These species belong to 73 genera and 33 families. The great majority of 176 species (90 %) belong to 29 Dicot families. The remaining 19 species (10 %) belong to two Monocot families (Dioscoreaceae and Smilacaceae), one Magnoliid family (Aristolochiaceae) and one Monilophyte (Lygodiaceae) family (Table 1, Appendix 1).

Native climbers totaled 127 species, belonging to 60 genera and 31 families. Non-native species numbered 68, belonging to 33 genera and 19 families. The non-natives included an additional 11 genera and 2 families not represented among the native climbers.

Figure 2 shows the families represented among the climbers. Four families accounted for half the species; Fabaceae was the most numerous (22.6 %), followed by Convolvulaceae (15.9%), Vitaceae (8.2%) and Smilacaceae (6.7 %). Among the native species, the same 4 families dominated, although the Fabaceae representation was considerably reduced (15%), Convolvulaceae remained the same (15%) while Vitaceae and Smilacaceae increased slightly

(10%). In contrast, among the non-native climbers, Fabaceae dominated (32.4%), followed by Convolvulaceae (17.6%). Among the non-native components, there are species belonging to the Actinidiaceae and Lardizabalaceae families in which there are no native species in the region. By contrast, within Smilacaceae, there are many native species, but no non-native members in the region.

The proportion of native to non-native species is 65 % to 35 %. (Table 1, Appendix 1). There are 36 wide-ranging climber species recorded in all 22 states. These are listed in Table 2. These wide-ranging species are almost equally divided between native (19) and non-native species (17). Another 20 species are recorded in 20 out of the 22 states, bringing the total of wide-ranging species to 57, about 30% of the climbers.

Species impacting conservation

Among the 127 native climber species, 83 species are state listed as either rare, endangered, threatened, historic or of special concern in one or more of the 22 States. This amounts to 42.5% of the total number of climber species and 65 % of the native species (Table 1; Appendix 1). *Celastrus scandens*, *Lathyrus palustris*, *Adlumia fungosa* and *Lygodium palmatum* are wide-ranging but rare in most parts of the region. About a dozen species are extirpated from parts of their original range: the federally threatened *Apios priceana* (IL) and *Lathyrus japonica* (IL), *Adlumia fungosa* (DE, IN), *Lygodium palmatum* (VT), *Strophostyles umbellata* (RI), *Lonicera flava*, *Clematis occidentalis* and *Cuscuta coryli* (OH), *Matelea caroliniensis* (MD), *Mikania scandens* (MI), *Melothra pendula* (IN), and *Lathyrus venosus* (NJ).

The 68 non-native species include 31 species which are designated as invasive in one or more of the 22 states. This amounts to nearly 16 % of the total climber species and 45% of the non-native climber species. Many of the wide-ranging climber species in the region are invasive species such as *Celastrus orbiculatus*, *Rosa multiflora*, *Ipomoea hederacea*, *Lonicera japonica*, *Cyananchem louisae*, *Humulus scandens*, *Ampelopsis glandulosa*, *Pueraria montana* and *Euonymus fortunei*.

Table 1. The taxonomic diversity of the native and non-native climbers of the Northeastern United States including species currently listed as rare or invasive in one or more of the 22 states

	Families	Genera	Species	Proportion of each group in the total climber flora	Rare* species as a proportion of native species	Invasive species relative to non-native sp.
Total native and non-native	33	73	195			
Native	27	60	127	65 %		
Non-native	19	33	68	35 %		
Rare*			75	42.5 %	65.0 %	
Invasive			31	16.0 %		45.6 %

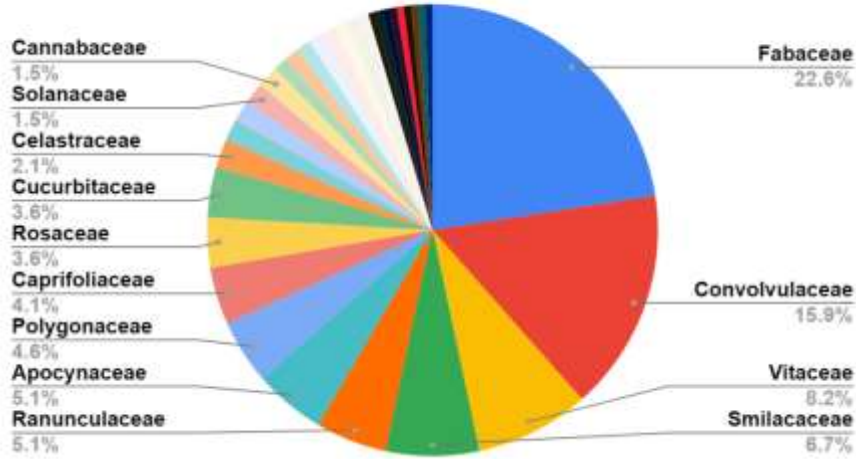
Rare* includes all categories of state listings -rare, threatened, endangered, historic and special concern

Table 2. The most widespread climber species, native and non-native in the 22 states of the Northeastern United States

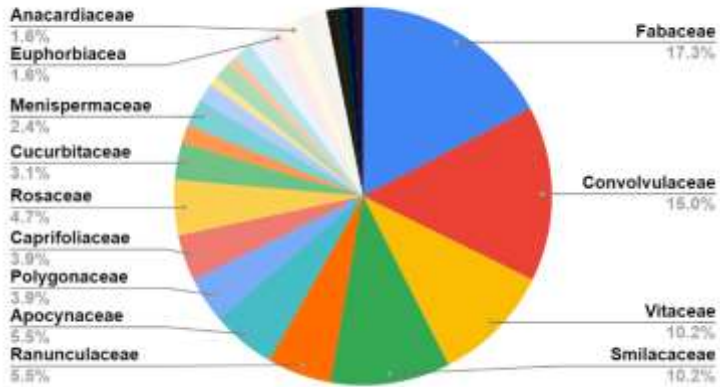
Native species	Non-native species
<i>Amphicarpaea bracteata</i> (Fabaceae)	<i>Celastrus orbiculatus</i> (Celastraceae)
<i>Apios americana</i> (Fabaceae)	<i>Convolvulus arvensis</i> (Convolvulaceae)
<i>Calystegia sepium</i> (Convolvulaceae)	<i>Cynanchum louisiae</i> (Apocynaceae)
<i>Celastrus scandens</i> (Celastraceae)	<i>Fallopia convolvulus</i> (Polygonaceae)
<i>Clematis virginiana</i> (Ranunculaceae)	<i>Fallopia dumetorum</i> (Polygonaceae)
<i>Cuscuta gronovii</i> (Convolvulaceae)	<i>Humulus scandens</i> (Cannabaceae)
<i>Echinocystis lobata</i> (Cucurbitaceae)	<i>Humulus lupulus</i> (Cannabaceae)
<i>Fallopia scandens</i> (Polygonaceae)	<i>Ipomoea purpurea</i> (Convolvulaceae)
<i>Galium aparine</i> (Rubiaceae)	<i>Ipomoea hederaceae</i> (Convolvulaceae)
<i>Galium asprellum</i> (Rubiaceae)	<i>Lathyrus latifolius</i> (Fabaceae)
<i>Lathyrus palustris</i> (Fabaceae)	<i>Lonicera japonica</i> (Caprifoliaceae)
<i>Lonicera sempervirens</i> (Caprifoliaceae)	<i>Lycium barbarum</i> (Celastraceae)
<i>Parthenocissus quinquefolia</i> (Vitaceae)	<i>Rosa multiflora</i> (Rosaceae)
<i>Persicaria sagittata</i> (Polygonaceae)	<i>Solanum dulcamara</i> (Solanaceae)
<i>Rubus flagellaris</i> (Rosaceae)	<i>Vicia cracca</i> (Fabaceae)
<i>Smilax tamnoides</i> (Smilacaceae)	<i>Vicia sativa</i> (Fabaceae)
<i>Sycios angulatus</i> (Cucurbitaceae)	<i>Vicia villosa</i> (Fabaceae)
<i>Toxicodendron radicans</i> (Anacardiaceae)	
<i>Vitis aestivalis</i> (Vitaceae)	

Fig 2. Families represented among the climbers of the Northeastern United States (see Appendix 1 for full details)

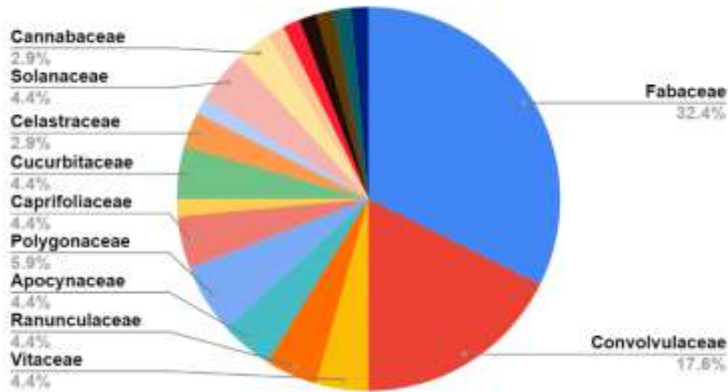
All climber families - native and non-native



Native climber families



Non-native climber families



Growth form diversity

Table 3 summarizes growth form diversity. The proportion of woody and herbaceous climbers is about one third (33%) woody and two thirds herbaceous (67 %). A few species which are mostly herbaceous can develop a woody base in the southern part of the region (*Pueraria montana*, *Cissus trifoliata* and *Brunnichia ovata*). Among the woody climbers, the high climbers and scandent shrubs are the most numerous. Among herbaceous climbers, medium and low climbers comprised an equal share, and the parasitic *Cuscuta* species accounted for 6 %. Among both woody and herbaceous climbers, there is a small proportion of trailers, prostrate plants (Table 3). Woody and herbaceous species are mostly typical of families; Vitaceae, Rosaceae and Caprifoliaceae are woody and Convolvulaceae and Cucurbitaceae herbaceous. Fabaceae is an exception and includes woody high climbers (*Wisteria*) as well as herbaceous low climbers and trailers (*Vicia*, *Lathyrus* and *Mimosa*). Smilacaceae also includes both “woody” and herbaceous species.

In this region, deciduous climbers dominate with only one evergreen native species, *Lygodium palmatum* and two non-native species *Hedera helix* and *Euonymus fortunei*. Both these non-native species are listed as invasive.

Diversity of climbing mechanisms

The climbers are categorized based on 6 climbing mechanisms. These include four active methods: stem twiners; leaf petiole and petiolule twiners; tendril climbers and aerial adventitious root climbers; passive methods such as prickles and barbs that provide support and prevent the climber from slipping or falling. Climbing mechanisms are largely characteristic of families (Table 4). Stem twiners represent nearly half the climber species (48.7 %) and belong to 17 families. Tendril climbers are the next most common with about a third of the climber species (32%) and belong to 9 families. The remaining groups, leaf twiners, prickles, barbs and aerial adventitious roots made up the rest (20%). The climbing fern, *Lygodium* has a unique climbing mechanism consisting of a twining leaf rachis. The Fabaceae include stem twiners among the woody high climbers such as *Wisteria*, tendril climbers among the low herbaceous *Vicia* and *Lathyrus*, and trailers with barbs as in *Mimosa*. Some genera exhibited a combination of strategies: *Humulus* climbed via a twining apical stem, and is aided by minute barbs along the stem, *Smilax* climbed primarily with the help of tendrils and is aided by prickles, *Rosa* and *Rubus* combined long arching stems, armed with hooked prickles. Among widespread species listed in Table 2, there are a mix of climbing mechanisms in both woody and herbaceous species.

Table 3. Growth form diversity among the climbers of the Northeastern United States (see Appendix 2 for details)

Growth form category	Number of Species	Percentage
Woody	63	32.0 %
High climbers (WH) more than 30 feet	27	13.6 %
Scandent shrubs (WS) below 30 feet	23	11.8 %
Medium climbers (WM) below 30 feet	11	5.6 %
Trailers (WT) prostrate and do not climb	2	1.0 %
Herbaceous	132	68.0 %
Medium climbers (HM) 6- 30 feet	56	28.7 %
Low climbers (HL) between 3- 6 feet	54	27.7 %
Parasitic dodder vines (HP)	12	6.2 %
Trailers (HT)	10	5.4 %

Table 4. Climbing mechanisms exhibited by the climber species of the Northeastern United States

Climbing mechanism	Species number	Percentage	Families characterized by each mechanism
Stem twiners	95	48.7%	Convolvulaceae (29), Fabaceae (20), Apocynaceae (10), Polygonaceae (6), Caprifoliaceae (8), Celastraceae (2), Menispermaceae (3), Aristolochiaceae (3), Dioscoriaceae (2), Euphorbiaceae (2), Asteraceae (1), Gelsemiaceae (1), Schisandraceae (1), Rhamnaceae (1), Actinidiaceae (1), Lardizabalaceae (1), Solanaceae (1).
Stem twiner with barbs			Cannabaceae (3)
Tendrils	63	32%	Vitaceae (13), Cucurbitaceae (7), Fabaceae (23), Passifloraceae (2), Smilacaceae (7), Sapindaceae (1)
Tendrils with adhesive pads			Vitaceae (3), Bignoniaceae (1)
Tendrils and Prickles			Smilacaceae (6)
Leaf petiole twiners	11	5.6%	Ranunculaceae (10), Papaveraceae (1)
Prickles and arching stems	8	4%	Rosaceae (6), Celastraceae (1)
Roots- adventitious	6	3%	Anacardiaceae (2), Araliaceae (1), Celastraceae (1) Bignoniaceae (1), Hydrangeaceae (1)
Barbs	5	2.5 %	Rubiaceae (2), Polygonaceae (3)
Leaf rachis twiner	1	<1%	Lygodiaceae (1)
Trailers -prostrate	7	3.5%	Rosaceae (1), Fabaceae (1), Celastraceae (1), Convolvulaceae (2) Plantaginaceae (1)

Distribution Patterns of the climber species

The total climber species for each state and the native and non-native component is presented in Table 5. The highest total numbers of species vary between 136-144 in VA and KY, the southern states of the region. The lowest numbers vary between 77 – 82 in VT, MN, NH, ME, several of the northern most states. Native species follow a similar pattern with the highest range between 91 -103 in KY, IL, MO, VA, while the lowest native climber species per state varying between 40 – 52 are in the New England states as well as MN and WI. Non-native species are highest in MA with 65 species and lowest in MN and IA with 27 species. The native to non-native proportions of climbers indicate that most states have a higher proportion of native species. At the highest is IL, KY, MO and OH with about 70% native climbers. MA with 55% and CT with 51% native climber species are the only states where the non-native climber species outnumber the native species. Species richness per unit area decreases with increasing latitude. Given the vast range in the land area of the states, this analysis may not be very reliable. If states with comparable land area is considered this pattern is noticeable:

VA (92), PA (76), NY (67);
KY (103), IN (91), OH (78), MI (63);
MO (95), IA (62), MN (54).

Every state has rare climber species, and the numbers vary widely with the highest in PA (26), VA (20), NJ and MD (19). The lowest number of rare species was in MN (2). Rare species as a proportion of native species is highest in PA (34%), NJ (28%) and greater than 20% in MA, MD, BY, VA and RI. At the state level, the proportion of rare species among the native climbers is lower than that in the whole region, which is 65%.

Invasive climber species in each state ranges from a high in WV (22), KY (20), NJ (18) to VT, MO, OH (3), IA (2). The proportion of invasive species among the non-native species in these states was 52 % in WV, 49% in KY, 40% in IN. In a further 7 states, the proportion is more than 25 %. While in some states the number of invasive species accounts for a high proportion of non-natives as in WV and KY, in other states such as MA, which has a high number of non-natives, only a small proportion of the total non-natives are invasive.

Table 5. The species richness in each state of the Northeastern United States showing proportion of native to non-native climbers, rare and invasive species (states are arranged in groups along an increasing latitude) T- Total, N- Native, Nn – Non-native, Iv -Invasive

	Total	Native	Non-Native	N/Nn %	Rare	Rare /Native %	Invasive	Iv/Nn %	T/area X1000	N/area X1000	Nn/area X1000	Area sq mi*	
ME	82	39	43	48/52	6	16	5	12	2.70	1.26	1.40	30843	ME
NH	81	42	39	52/48	6	14	10	26	9.00	4.70	4.40	8953	NH
VT	77	40	37	52/48	8	20	3	08	8.50	4.00	4.00	9217	VT
MA	118	52	66	44/56	12	24	9	14	15.00	6.70	8.50	7800	MA
CT	105	51	54	49/51	8	16	10	19	22.00	11.00	11.00	4842	CT
RI	86	51	35	59/41	11	22	9	26	82.00	48.00	33.00	1055	RI
NY	126	67	59	53/47	15	22	11	19	3.00	1.40	1.30	47126	NY
PA	133	76	57	57/43	26	34	16	28	3.00	1.70	1.30	44743	PA
NJ	119	68	51	57/43	19	28	18	35	16.00	9.25	7.00	7354	NJ
DE	103	68	35	66/34	14	21	9	26	53.00	35.00	18.00	1949	DE
MD	130	81	49	62/38	19	24	16	33	13.00	8.00	5.00	9707	MD
VA	136	92	44	68/32	20	22	14	32	3.00	2.30	1.10	39490	VA
MI	108	63	45	58/42	12	19	4	09	2.00	1.00	0.80	56539	MI
OH	126	78	48	62/38	14	18	3	06	3.00	2.00	1.00	40861	OH
IN	131	91	40	69/31	17	19	16	40	4.00	2.50	1.00	35826	IN
WV	115	73	42	63/37	8	11	22	52	5.00	3.00	1.00	24038	WV
KY	144	103	41	72/28	13	13	20	49	5.00	2.60	1.75	39486	KY
MN	81	54	27	66/33	2	04	7	26	1.00	0.70	0.34	79626	MN
WI	93	52	41	56/44	5	10	14	34	2.00	1.00	0.76	54158	WI
IA	89	62	27	70/30	8	13	2	07	2.00	1.00	0.48	55857	IA
IL	135	97	38	72/28	8	08	4	11	2.00	1.75	0.68	55519	IL
MO	133	95	38	71/29	14	15	3	08	2.00	1.40	0.55	68742	MO

*Land area only and excludes water bodies and coastal waters.

Table 6 presents the woody and herbaceous components among the climbers in each state. The proportions are notably consistent, ranging between 39% woody and 61 % herbaceous in ME to 30% woody and 70% herbaceous in MN and PA. The proportions do not vary noticeably from south to north. They are also consistent from east to west in the southern part of the region. However, among the northernmost states, there is a reduction of woody climbers from east to west with 39% in ME to 30% in MN.

Table 6. Woody and herbaceous components among the climbers in each state of the Northeastern United States showing the relative proportions of each group (states are arranged in groups along an increasing latitude). W – Woody, H- Herbaceous

	Total	Woody	Herbaceous	W/H	W/area X1000	H/area X1000	Area sq mi	
ME	82	31	51	39/61	1.00	1.65	30843	ME
NH	81	31	50	38/62	3.5	5.60	8953	NH
VT	77	26	51	36/64	2.8	5.50	9217	VT
MA	118	42	76	36/64	5.4	10.00	7800	MA
CT	105	37	69	34/66	7.60	14.00	4842	CT
RI	86	28	57	32/68	26.50	54.00	1055	RI
NY	126	42	84	33/67	0.9	1.80	47126	NY
PA	133	42	91	30/70	0.9	2.00	44743	PA
NJ	119	40	79	33/67	5.30	11.00	7354	NJ
DE	103	33	70	32/68	17.00	36.00	1949	DE
MD	130	43	87	33/67	4.43	9.00	9707	MD
VA	136	46	90	33/67	1.00	2.30	39490	VA
MI	108	34	74	31/69	0.60	1.30	56539	MI
OH	126	41	85	31/69	1.00	2.00	40861	OH
IN	131	44	85	33/67	1.20	2.40	35826	IN
WV	115	38	77	32/68	1.20	3.20	24038	WV
KY	144	47	97	32/68	1.60	2.50	39486	KY
MN	81	24	57	30/70	0.30	1.00	79626	MN
WI	93	31	62	33/67	0.60	1.00	54158	WI
IA	89	28	61	31/69	0.50	1.00	55857	IA
IL	135	45	90	34/64	0.80	2.00	55519	IL
MO	133	43	90	32/68	0.60	1.00	68742	MO

Climber terminology

There is a wide range of terms used for describing climbers. In the US, all climbers are commonly referred to as vines, woody climbers as woody vines and herbaceous climbers simply as vines. Some sources such as GoBotany, have standardized all woody climbers as lianas and all herbaceous climbers as vines. GoBotany double lists scandent shrubs in the genus *Rubus* as lianas and shrubs. Most other national and state data bases use the term vines for all climbers.

I observe the following from my review of terms encountered during this study. In Europe and Britain, a vine usually refers to a grapevine. Other climbers are called creepers and climbers. Clearly this influence can be detected in common names such as Virginia creeper (*Parthenocissus quinquefolia*) which goes back to early colonial days. Some climbers are referred to as bowers – Virgin’s bower (*Clematis*). Plants that climb by twining stems are called twiners and the mode of climbing, as “vining”. Climbing roses are called ramblers – rambling roses. Blackberries and similar plants in the genus *Rubus* are called brambles. “Woody” *Smilax* species are known as a brier; greenbrier, catbrier, sawbrier. Herbaceous *Smilax* species usually devoid of prickles are called carrion flower. Low climbers such as bedstraw (*Galium*) are called clingers, other sources refer to root climbers as clingers, since they climb a support flattened against a surface. Parasitic *Cuscuta* genus are called dodders or dodder vines.

The complete list of species in Appendix 2 includes common names and shows a large range of names.

DISCUSSION

Since the 1897 field guide by Charles Newhall, this study is the first time that the diversity of the entire range of climbing plants of the Northeastern United States inclusive of native, non-native, woody and herbaceous has been collated and reviewed.

Climbers as a growth form are unusual in that they include both woody and herbaceous forms. While most climbing species belong to a few families, the many evolutionary lineages have led to a diversity of climbing habits and mechanisms among many taxonomic groups (Burnham 2015, Hu and Li 2015). The diversity of forms among climbers, and the range of terms used to describe them, made the task of collating and categorizing this group of plants for this study challenging. This has been commented on by many who are working on these plants (Hu and Li 2015, Sperotto 2020). As with any initial study of this nature, it provides a starting point and requires more work to arrive at conclusive answers.

The total of 195 climber species as a proportion of the total flora of the Northeastern United States is approximately 3.7% based on the total flora of 5,300 species cited for the region by Naczi et. al (NYBG website). The New England region has 134 climber species which account for 3.7 % of the total flora of 3514 species. The 58 native climber species account for 2.4% of the total native species of 2458, while the 76 non-native species is 7 % of the non-native flora of 1089 species (Haines 2011, Farnsworth 2015, Anderson et.al 2021). The climbing plants as a proportion of the total native flora in the Northeastern US is lower than the estimate of 5.6 – 7% in temperate forests by Gentry (1991). Based on a regional study of Eurasia and North Africa by Hu and Li (2015), the taxonomic diversity of the native climbers in the Northeastern US, when compared with similar

latitudes in other parts of the world show that it is higher than Western Europe (17 Families, 27 genera, 106 species) and Eastern Europe (18 families, 29 genera, 124 species) and considerably lower than East Asia (41 families, 113 genera, 369 species).

The proportion of native to non-native components of the total flora of the Northeastern region is not readily available, to compare the native and non-native climber proportions. A comparison can be done with the New England flora which is about 69 % native and 31 % non-native (Farnsworth, 2015), while the climbers for this area are 43 % native to 57 % non-native. There is a much higher component of non-native species, compared with climber species for the whole Northeastern region, which is 65% native and 35% non-native. In the individual states, the non-native proportion can range from a low of 29 % in KY and MO to a high of 57% in MA. It has been pointed out that New England and the eastern coastal states being densely settled since the 1600s, have a higher component of non-native species (Farnsworth 2015). The climbers reflect this trend. Both native and non-native climber species declined with increasing latitude and this pattern is consistent with findings elsewhere (Hu and Li 2015, Schnitzler et. al 2016). KY was particularly high in native climber species (103). It is worth investigating if the occurrence of floodplains due to the many rivers that boarder this state is a contributing factor. This pattern of high climber diversity in riverine and wetland habitats is well documented (Allen 2015, Schnitzler 2016).

One of the significant findings of this study is the high number of climber species listed as rare in one or more of the states. This amounted to 83 species, 42.5% of the total climber flora and 12 extirpated in parts of their original range. As a proportion of the native climbers, the rare species were a concerning 65%. Some of the rare species are naturally sparse due to habitat requirements and rare throughout the region, while others are under a variety of threats and need to be looked at more closely. A case in point is the climbing fern (*Lygodium palmatum*) is recorded as the first plant protected by law in the US in 1869, when Connecticut passed legislation to curb the rampant collection for Christmas decorations. The species never recovered its former abundance due to habitat loss and expanding agriculture (GoBotany).

Invasive woody climbers are already receiving much attention for the damage they cause (Leicht-Young and Pavlovic, 2014). This study provides important information on both woody and herbaceous invasive species. It shows that 45% non-native climber species in the region are designated as invasive. In New England it is estimated that there are about 111 invasive species accounting for about 10% of the non-native flora (Farnsworth 2015). Among the 64 non-native climber species in New England, 12 are listed as invasive and this accounts for 19%, almost double the value of the invasive component in the rest of the non-native flora. This appears to support findings that climbers in general and non-native climbers are becoming more aggressive and becoming invasive with the warming climate. Many climber species introduced as ornamentals from milder climate regions of East Asia have become invasive many decades after their original introductions. This may be because the warming climate is now more compatible for their growth. An example is the outcompeting of the *Celastrus scandens*, one of the most wide-ranging native species now in decline and rare, due to the similarly wide-ranging invasive *C. orbiculatus* and the hybridizing between the two species (Leicht-Young and Pavlovic, 2015).

The woody and herbaceous components of climbers in the region of 32% woody and 68 % herbaceous when compared with similar parts of the world is higher in woody species than in Western Europe (18.1% woody and 81.9 % herbaceous), Eastern Europe (20.2 % woody and 79.8% herbaceous) and much lower than in East Asia (71.3% woody and 28.7 % herbaceous) (Hu and Li 2015). The woody component of climbers in this region did not noticeably dwindle with increasing latitude, instead ME recorded a higher component of woody climbers. This points to a group of woody tendril climber species in Vitaceae, root climbers such as *Toxicodendron*, and scandent shrubs in Rosaceae which appear to be well adapted to handling freezing temperatures and the associated embolization risk. Interestingly woody climbers noticeably dwindled from east to west. Whether this is indicative of the temperate forest ecoregion transitioning to grasslands might be worth investigating. It has been documented that climber species are generally higher along coastal regions and diminish in inland regions (Hu and Li 2015).

Climbers frequent forest edges and open areas where they thrive on the availability of sunlight, and only a couple of studies have systematically quantified this aspect, and that too only for lianas (Londre and Schnitzer 2006, Ladwig and Meiners 2010). These studies point to the proliferation of climbers aided by forest fragmentation and the availability of open habitat with successional vegetation. A secondary reason was that climbers are responding dramatically to rising levels of CO₂ and warming temperatures than other groups of plants. *Toxicodendron* (poison-ivy) is one such example (Mohan et. al 2006). Several native climbers including *Toxicodendron* in some states are reported as noxious weeds (BONAP). The aggressive growth of native climbers is a topic this study did not delve in to and needs to be considered.

Future directions:

This study has laid the foundation for further studies on the climbing plants of the Northeastern United States by documenting species richness and some general trends in distribution across the region. For a thorough understanding of the conservation needs of these plants, comparisons need to be made among the climber species of each state with the respective native and non-native components of the flora and other growth forms. Species distribution in relation to eco-regions and habitats is also essential for better understanding of climbing plants.

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REFERENCES

- ALLEN, B. P., 2015. Pattern of liana abundance, diversity, and distribution in temperate forests pp 7-15 *in*: Parthasarathy, N., ed., Biodiversity of lianas, vol 5, Sustainable development and biodiversity series, Springer International Publishing, Switzerland.
- BURNHAM, R. J., 2015. Climbing plants in the fossil record: Paleozoic to present. pp 205-220 *in*: eds. Schnitzer et.al. Ecology of Lianas, John Wiley & Sons, Oxford, UK.
- BURNHAM, R. J., 2013. Climbers project of the University of Michigan <http://climbers.lsa.umich.edu/>
- DARWIN, C., 1875. The movements and habits of climbing plants. John Murray, London, UK
- ELLIMAN, T., 2016. Wildflowers of New England, Timber Press.
- GLEASON, H.A., AND CRONQUIST, A., 1991. Manual of vascular plants of the Northeastern United States and adjacent Canada. 2nd Edition, Bronx New York: New York Botanical Garden.
- GRAY, A., 1858. Note on the coiling of tendrils of plants, Proceedings of the American Academy of Arts and Sciences 4: 98-99.
- HU, L., AND LI, M., 2015. Diversity and distribution of climbing plants in Eurasia and North Africa pp 57-79 *in*: Parthasarathy, N., ed., Biodiversity of lianas, vol 5, Sustainable development and biodiversity series, N. Springer International Publishing, Switzerland
- LADWIG, L.M., MEINERS S.J. 2010. Spatiotemporal dynamics of lianas during 50 years of succession to temperate forest Ecology. 2010 Mar; 91(3):671-80. doi: 10.1890/08-1738.1.
- LEICHT-YOUNG, S., AND PAVLOVIC, N.B., 2015. pp 430-441, Lianas as invasive species in North America *in*: eds. Schnitzer et.al. Ecology of Lianas, John Wiley & Sons, Oxford, UK.
- LONDRE, R. A. AND SCHNITZER, S.A., 2006. The distribution of lianas and their change in abundance in temperate forests over the past 45 years, Ecology 87: 2973 – 2978.
- MOHAN, J.E., ZISKA, L.H., SCHLESINGER W.H., THOMAS, R.B., SICHER, R.C. GEORGE, K., AND CLARK, J.S. 2006. Biomass and toxicity responses of poison ivy (*Toxicodendron radicans*) to elevated atmospheric CO₂. Proceedings of the national academy of sciences. 103(24)9086-9089.
- NEWHALL, C.S., 1897. The vines of North-Eastern America. Putnam's Son, New York.
- NACZI, R. et al. 2022. New manual of vascular plants: Revising an indispensable reference, <https://sweetgum.nybg.org/science/projects/northeastflora>, New York Botanic Gardens.

/

FARNSWORTH, E. 2015. State of the Plants: Challenges and opportunities for conserving New England's native flora. Native Plant Trust.

ANDERSON, M., PIANTEDOSI, M. AND BRUMBACK, W. (2021) Plant diversity in New England. Native Plant Trust and The Nature Conservancy.

PUTZ, F.E, AND MOONEY, H. A., 1991. The biology of vines, Cambridge University Press, Cambridge, UK.

SCHNITZER, S.A, BONGERS, F., BURNHAM, R., AND PUTZ, F.E., 2015. Ecology of Lianas, John Wiley & Sons, Oxford, UK.

SCHNITZLER, A., AMIGO, J., HALE, B., AND SCHNITZLER, C., 2016. Patterns of climber distribution in temperate forests of the Americas, *Journal of Plant Ecology*, 9: (6)724–733.

SPEROTTO, P. ACEVEDO-RODRIGUEZ, P., VASCONCELOS, T.N.C. AND ROQUE, N., 2020. Toward standardization of terminology of the climbing habit in plants, *The Botanical Review* 86:180-210.

Websites and digital resources:

ATLAS OF THE FLORA OF NEW ENGLAND

BONAP, North American plant atlas

CLIMBERS Project of University of Michigan

IPANE – Invasive plant atlas of New England

LADY BIRD JOHNSON WILDFLOWER CENTER – Native Plant database

GOBOTANY: Digital identification guide, Native Plant trust.

NATIVE PLANT SOCIETY WEBSITES

NATURAL HERITAGE PROGRAM INFORMATION

USDA Plants database

Appendix 1. Taxonomic diversity of climbers in the Northeastern region of the United States;
 native, non -native species, species of conservation concern and invasive species

	Family	Total genera	Total species	Native genera	Native species	Non-native genera (additional genera)	Non- native Species	Rare species	Invasive species
1	Fabaceae	14	44	13	22	5 (1)	22	16	8
2	Convolvulaceae	6	31	5	19	4 (1)	12	15	5
3	Vitaceae	5	16	5	13	3	3	8	2
4	Smilacaceae	1	13	1	13	--	--	6	--
5	Ranunculaceae	1	10	1	7	1	3	5	1
5	Apocynaceae	5	10	4	7	2 (1)	3	6	2
6	Polygonaceae	3	9	3	5	2	4	2	2
7	Caprifoliaceae	1	8	1	5	1	3	3	1
8	Rosaceae	2	7	2	6	1	1	3	1
9	Cucurbitaceae	6	7	4	4	2 (2)	3	3	-
11	Celastraceae	2	4	2	2	2	2	1	2
12	Menispermaceae	3	3	3	3	--	--	3	-
13	Aristolochiaceae	2	3	1	2	1 (1)	1	--	--
14	Solanaceae	2	3	--	--	2	3	--	1
15	Cannabaceae	1	3	1	1	1	2	--	1
16	Bignoniaceae	2	2	2	2	--	--	--	--
17	Dioscoreaceae	1	2	1	1	1	1	1	1
18	Passifloraceae	1	2	1	2	--	--	2	--
19	Anacardiaceae	1	2	1	2	--	--	1	--
20	Rubiaceae	1	2	1	2	--	--	1	--
21	Euphorbiaceae	1	2	1	2	--	--	2	--
22	Lygodiaceae	1	1	1	1	--	--	1	--
23	Asteraceae	1	1	1	1	--	--	1	--
24	Hydrangeaceae	1	1	1	1	--	--	--	--
25	Gelsemiaceae	1	1	1	1	--	--	--	--
26	Schisandraceae	1	1	1	1	--	--	1	--
27	Papavaraceae	1	1	1	1	--	--	1	--
28	Rhamnaceae	1	1	1	1	--	--	1	--
29	Actinidaceae	1	1	--	--	1 (1)	1	--	1
30	Lardizabalaceae	1	1	--	--	1 (1)	1	--	1
31	Sapindaceae	1	1	--	--	1 (1)	1	--	1
32	Araliaceae	1	1	--	--	1 (1)	1	--	1
33	Plantaginaceae	1	1	--	--	1 (1)	1	--	--
Totals		73	195	60	127	33 (11)	68	75	31

APPENDIX 2. Complete list of native and non-native climber species in the Northeastern* United States, their conservation status, growth form and climbing mechanisms

*Region includes the 22 states of CT, DE, IA, IL, IN, KY, MA, MD, ME, MI, MN, MO, NH, NJ, NY, OH, PA, RI, VA, VT, WI, WV.

N – Native, Nc – Listed one or more of the states as rare, threatened, endangered, historic and of special concern, I – Non-native, Iv – Listed as invasive in one or more of the 22 states.

WH – Woody high climbers (above 30 feet), WM – Woody medium climbers (below 30 feet), WS - Scandent shrubs (usually below 20 feet) and WT-trailers that are prostrate and remain close to the ground. HM - Herbaceous medium climbers (6 feet - 30 feet), HL – Herbaceous low climbers (3 feet - 6 feet), HT – Herbaceous trailers and HP - Herbaceous parasitic dodder vines

Family and species	Common name	Native, non-native, rare, invasive	Growth form	Climbing mechanism
MONILOPHYTES				
LYGODIACEAE				
<i>Lygodium palmatum</i> (Bernh.) Sw.	American climbing fern	Nc	HM	Leaf rachis twiner
MONOCOTYLEDONS				
DIOSCOREACEAE				
<i>Dioscorea polystachya</i> Turcz.	Chinese yam	Iv	HM	Stem twiner
<i>Dioscorea villosa</i> L.	Wild yam	Nc	HM	Stem twiner
SMILACACEAE				
<i>Smilax biltmoreana</i> (Small) J.B.S. Norton ex Pennell	Biltmore's carrion-flower	N	HL	Tendrils paired from leaf base Tendrils paired from leaf base.
<i>Smilax bona-nox</i> L.	Sawbrier	Nc	WS	prickles

<i>Smilax glauca</i> Walt.	Glaucous-leaved greenbrier	N	WS	Tendrils paired from leaf base, prickles
<i>Smilax herbacea</i> L.	Carrion-flower	N	HM	Tendrils paired from leaf base
<i>Smilax hugeri</i> (Small) J.B.S. Norton ex Pennell	Huger's carrion-flower	N	HM	Tendrils paired from leaf base
<i>Smilax illinoensis</i> Mangaly	Illinois greenbrier	Nc	HM	Tendrils paired from leaf base
<i>Smilax lasioneura</i> Hook.	Blueridge carrion-flower	Nc	HM	Tendrils paired from leaf base Tendrils paired from leaf base,
<i>Smilax laurifolia</i> L.	Laurel greenbrier	N	WS	prickles
<i>Smilax pseudochina</i> L.	Bamboo vine	Nc	HM	Tendrils paired from leaf base
<i>Smilax pulverulenta</i> Michx.	Downy carrion-flower	Nc	HM	Tendrils paired from leaf base Tendrils paired from leaf base,
<i>Smilax rotundifolia</i> L.	Roundleaf greenbrier	N	WS	prickles
<i>Smilax tamnoides</i> L.	Bristly greenbrier	Nc	WS	Tendrils paired from leaf base, prickles
<i>Smilax walteri</i> Pursh	Coral greenbrier	Nc	WS	Tendrils paired from leaf base, prickles

DICOTYLEDONS

ACTINIDIACEAE

Actinidia arguta (Sieb.& Zucc.) Planch. ex Miq.

Taravine, Hardy kiwi Iv WM Stem twiner

ANACARDIACEAE

Toxicodendron radicans (L.) Kuntze

Poison ivy N WH

Roots -aerial adventitious

Toxicodendron rydbergii (Small ex Rydb.) Greene

Western poison ivy Nc WS

Roots – aerial adventitious

ARALIACEAE

Hedera helix L.

English-ivy Iv WH

Roots – aerial, adventitious

APOCYNACEAE

<i>Cynanchum laeve</i> (Michx.) Pers.	Climbing milkweed	Nc	HM	Stem twiner
<i>Cynanchum louiseae</i> Kartesz and Gandhi	Black swallowwort	Iv	HL	Stem twiner
<i>Cynanchum rossicum</i> (Kleopov) Borhidi	Pale swallowwort	Iv	HL	Stem twiner
<i>Gonolobus suberosus</i> (L.) R. Br.	Angelpod	Nc	HM	Stem twiner
<i>Matelea baldwyniana</i> (Sweet) Woodson	Baldwin's milkvine	N	HM	Stem twiner
<i>Matelea carolinensis</i> (Jacq.) Woodson	Maroon carolina milkvine	Nc	HM	Stem twiner
<i>Matelea decipiens</i> (Alexander) Woodson	Oldfield milkvine	Nc	HM	Stem twiner
<i>Matelea obliqua</i> (Jacq.) Woodson	Limerock milkvine	Nc	HM	Stem twiner
<i>Periploca graeca</i> L.	Silk vine	I	HM	Stem twiner
<i>Thyrsanthella difformis</i> (Walter) Pichon	Climbing dogbane	Nc	WH	Stem twiner

ARISTOLOCHIACEAE

<i>Aristolochia clematitis</i> L.	Creeping birthwort	I	HL	Stem twiner
<i>Isotrema macrophyllum</i> (Lam.) C.F. Reed	Large-leaved dutchman's pipe	N	WH	Stem twiner
<i>Isotrema tomentosum</i> (Sims) Huber	Wooly dutchman's pipe	N	WH	Stem twiner

ASTERACEAE

<i>Mikania scandens</i> (L.) Willd.	Climbing hempvine	Nc	HM	Stem twiner
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BIGNONIACEAE

<i>Bignonia capreolata</i> L.	Crossvine	N	WH	Tendrils with adhesive discs
<i>Campsis radicans</i> L. (Seem ex Bureau)	Trumpet-creeper	N	WH	Roots – aerial adventitious

CANNABACEAE

<i>Humulus americanus</i> Nutt.	American hop	N	HM	Stem and barbs
<i>Humulus scandens</i> (Lour.) Merr.	Japanese hop	Iv	HM	Stem and barbs
<i>Humulus lupulus</i> L.	Common hop	I	HM	Stem and barbs

CAPRIFOLIACEAE

<i>Lonicera caprifolium</i> L.	Italian honeysuckle	I	WS	Stem twiner
<i>Lonicera dioica</i> L.	Wild honeysuckle	Nc	WS	Stem twiner
<i>Lonicera flava</i> Sims	Yellow honeysuckle	Nc	WS	Stem twiner
<i>Lonicera hirsuta</i> Eaton	Hairy honeysuckle	Nc	WS	Stem twiner
<i>Lonicera japonica</i> Thunb.	Japanese honeysuckle	Iv	WS	Stem twiner
<i>Lonicera periclymenum</i> L.	European honeysuckle	I	WS	Stem twiner
<i>Lonicera reticulata</i> Raf.	Grape honeysuckle	N	WS	Stem twiner
<i>Lonicera sempervirens</i> L.	Trumpet honeysuckle	N	WS	Stem twiner

CELASTRACEAE

<i>Celastrus orbiculatus</i> Thunb.	Asian bittersweet	Iv	WH	Stem twiner
<i>Celastrus scandens</i> L.	American bittersweet	Nc	WH	Stem twiner
<i>Euonymus fortunei</i> (Turcz.) Hand. Mazz	Climbing spindle-tree	Iv	WH	Roots – aerial, adventitious
<i>Euonymus obovatus</i> Nutt.	Running euonymus	N	WT	Roots – aerial adventitious

CONVOLVULACEAE

<i>Calystegia catesbeiana</i> Pursh	Catesby's false-bindweed	Nc	HT	Stem twiner
<i>Calystegia macounii</i> (Green) Brummitt	Macoun's false-bindweed	N	HM	Stem twiner
<i>Calystegia pubescens</i> Lindl.	Hairy false-bindweed	I	HM	Stem twiner
<i>Calystegia sepium</i> (L.) R. Br.	Hedge false bindweed	N	HM	Stem twiner
<i>Calystegia silvatica</i> (Kit.) Griseb.	Short-stalked false-bindweed	Nc	HM	Stem twiner
<i>Calystegia soldanella</i> (L.) R.Br.	Beach morning glory	I	HT	Stem twiner
<i>Calystegia spithamea</i> (L.) Pursh	Upright false bindweed	Nc	HL	Stem twiner
<i>Convolvulus arvensis</i> L.	Field bindweed	Iv	HL	Stem twiner
<i>Cuscuta approximata</i> Bab.	Alfalfa dodder	I	HP	Stem twiner with haustoria
<i>Cuscuta campestris</i> Yuncker	Field dodder	Nc	HP	Stem twiner with haustoria
<i>Cuscuta cephalanthi</i> Englem.	Buttonbush dodder	Nc	HP	Stem twiner with haustoria
<i>Cuscuta compacta</i> Juss. ex Choisy	Compact dodder	Nc	HP	Stem twiner with haustoria
<i>Cuscuta coryli</i> Engelm.	Hazel dodder	Nc	HP	Stem twiner with haustoria

<i>Cuscuta epithymum</i> L.	Clover dodder	I	HP	Stem twiner with haustoria
<i>Cuscuta europaea</i> L.	Greater dodder	I	HP	Stem twiner with haustoria
<i>Cuscuta gronovii</i> Willd. ex J.A. Schultes	Common dodder	N	HP	Stem twiner with haustoria
<i>Cuscuta indecora</i> Choisy	Collared dodder	Nc	HP	Stem twiner with haustoria
<i>Cuscuta obtusiflora</i> Kunth	Peruvian dodder	Nc	HP	Stem twiner with haustoria
<i>Cuscuta pentagona</i> Engelm.	Bush-clover dodder	Nc	HP	Stem twiner with haustoria
<i>Cuscuta polygonorum</i> Englem.	Smartweed dodder	Nc	HP	Stem twiner with haustoria
<i>Ipomoea coccinea</i> L.	Red morning-glory	Iv	HM	Stem twiner
<i>Ipomea cristulata</i> Hallifer f.	Scarlet creeper	N	HM	Stem twiner
<i>Ipomea hederacea</i> Jacq.	Ivy-leaved morning-glory	Iv	HL	Stem twiner
<i>Ipomoea hederifolia</i> L.	Scarlet morning-glory	I	HL	Stem twiner
<i>Ipomoea lacunosa</i> L.	White morning-glory	Nc	HL	Stem twiner
<i>Ipomoea pandurata</i> (L.) G.F.W. May.	Wild sweet-potato morning-glory	Nc	HM	Stem twiner
<i>Ipomoea purpurea</i> (L.) Roth	Common morning-glory	Iv	HM	Stem twiner
<i>Ipomoea quamoclit</i> L.	Cypress-vine morning-glory	Iv	HM	Stem twiner
<i>Ipomoea tricolor</i> Cav.	Granny morning-glory	I	HM	Stem twiner
<i>Jacquemontia tamnifolia</i> (L.) Griseb.	Hairy cluster-vine	N	HM	Stem twiner
<i>Stylisma pickeringii</i> (Torr. ex M.A. Curtis) A.Gray	Pickering's dawnflower	Nc	HT	Trailer

CUCURBITACEAE

<i>Cayaponia quinqueloba</i> (Raf.) Shinnery	Five-lobe cucumber	Nc	HM	Tendrils 1-3 branched
<i>Cucurbita maxima</i> Duchesne	Winter squash	I	HT	Tendrils 2-5 branched
<i>Cucurbita pepo</i> L.	Pumpkin	I	HT	Tendrils 1-6 branched
<i>Echinocystis lobata</i> (Michx.) Torr. & A. Gray	Wild cucumber	Nc	HM	Tendrils 3 branched
<i>Melothria pendula</i> L.	Guadeloupe cucumber	Nc	HT	Tendrils
<i>Sicyos angulatus</i> L.	One-seeded bur-cucumber	N	HM	Tendrils 3-4 branched
<i>Thladiantha dubia</i> Bunge	Manchu tuber gourd	I	HL	Tendrils -unbranched

EUPHORBIACEAE

<i>Tragia cordata</i> Michx.	Heartleaf noseburn	Nc	HL	Stem twiner
<i>Tragia urticifolia</i> Michx.	Nettleleaf noseburn	Nc	HL	Stem twiner

FABACEAE

Faboideae, Phaseoleae

<i>Amphicarpaea bracteata</i> (L.) Fern.	Hog-peanut	N	HL	Stem twiner
<i>Apios americana</i> Medik.	Common groundnut	N	HM	Stem twiner
<i>Apios priceana</i> B.L. Rob.	Price's groundnut	Nc	HM	Stem twiner
<i>Centrosema virginianum</i> (L.) Benth	Spurred butterfly pea.	Nc	HT	Stem twiner
<i>Clitoria mariana</i> L.	Atlantic pigeonwings	Nc	HL	Stem twiner
<i>Dioclea multiflora</i> (Torr. & A.Gray) C. Mohr	Boykin's cluster pea	Nc	HL	Stem twiner
<i>Galactia regularis</i> (L.) Britton, Sterns & Poggenb.	Eastern milkpea	Nc	HL	Stem twiner
<i>Galactia volubilis</i> (L.) Britton	Downy milkpea	Nc	HL	Stem twiner
<i>Phaseolus coccineus</i> L.	Scarlet bean	I	HL	Stem twiner
<i>Phaseolus polystachios</i> (L.) B.S.P.	Wild bean	Nc	HL	Stem twiner
<i>Phaseolus vulgaris</i> L.	Kidney bean	I	HM	Stem twiner
<i>Pueraria montana</i> (Lour.) Merr.	Kudzu	Iv	WH	Stem twiner
<i>Rhynchosia difformis</i> (Elliot) DC.	Doubleform snoutbean	Nc	HL	Stem twiner
<i>Rhynchosia latifolia</i> Nutt. ex Torr. & A.Gray	Prairie snoutbean	N	HL	Stem twiner
<i>Strophostyles helvola</i> (L.) Elliot	Annual wooly bean	Nc	HL	Stem twiner
<i>Strophostyles leiosperma</i> (Torr. & A.Gray) Piper	Small-flowered wooly bean	N	HL	Stem twiner
<i>Strophostyles umbellata</i> (Muhl.) Britt.	Perennial wooly bean	Nc	HL	Stem twiner

Faboideae, Fabeae

<i>Lathyrus aphaca</i> L.	Yellow vetchling	I	HL	Tendrils - modified terminal leaflet
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<i>Lathyrus japonicus</i> Willd.	Beach vetchling	Nc	HL	Tendrils - modified terminal leaflet
<i>Lathyrus latifolius</i> L.	Everlasting vetchling	I	HL	Tendrils - modified terminal leaflet
<i>Lathyrus ochroleucus</i> Hook.	Cream vetchling	Nc	HL	Tendrils - modified terminal leaflet
<i>Lathyrus odoratus</i> L.	Sweet vetchling	I	HL	Tendrils - modified terminal leaflet
<i>Lathyrus palustris</i> L.	Marsh vetchling	Nc	HL	Tendrils - modified terminal leaflet
<i>Lathyrus pratensis</i> L.	Meadow vetchling	I	HL	Tendrils - modified terminal leaflet
<i>Lathyrus sativus</i> L.	White vetchling	I	HL	Tendrils - modified terminal leaflet
<i>Lathyrus sylvestris</i> L.	Narrow-leaved vetchling	I	HL	Tendrils - modified terminal leaflet
<i>Lathyrus tuberosus</i> L.	Tuber vetchling	I	HL	Tendrils - modified terminal leaflet
<i>Lathyrus venosus</i> Muhl. ex Willd.	Bushy vetchling	Nc	HL	Tendrils - modified terminal leaflet
<i>Vicia americana</i> Muhl. ex Willd.	American vetch	Nc	HL	Tendrils - modified terminal leaflet
<i>Vicia caroliniana</i> Walter	Carolina vetch	Nc	HL	Tendrils - modified terminal leaflet
<i>Vicia cracca</i> L.	Bird vetch	Iv	HL	Tendrils - modified terminal leaflet
<i>Vicia faba</i> L.	Broad vetch	I	HL	Tendrils - modified terminal leaflet
<i>Vicia grandiflora</i> Scop.	Large yellow vetch	Iv	HL	Tendrils - modified terminal leaflet
<i>Vicia hirsuta</i> (L.) S.F. Gray	Tiny vetch	Iv	HL	Tendrils - modified terminal leaflet
<i>Vicia lathyroides</i> L.	Spring vetch	I	HL	Tendrils - modified terminal leaflet
<i>Vicia pannonica</i> Crantz	Hungarian vetch	I	HL	Tendrils - modified terminal leaflet
<i>Vicia sativa</i> L.	Common vetch	Iv	HL	Tendrils - modified terminal leaflet
<i>Vicia sepium</i> L.	Hedge vetch	I	HL	Tendrils - modified terminal leaflet
<i>Vicia tetrasperma</i> L. Schreb.	Four-seeded vetch	Iv	HL	Tendrils - modified terminal leaflet
<i>Vicia villosa</i> Roth	Hairy vetch	Iv	HL	Tendrils - modified terminal leaflet

Papilionidae

<i>Wisteria floribunda</i> Willd. DC.	Japanese wisteria	Iv	WH	Stem twiner
<i>Wisteria frutescens</i> (L.) Poir	American wisteria	Nc	WM	Stem twiner
<i>Wisteria sinensis</i> (Sims.) DC.	Chinese wisteria	Iv	WH	Stem twiner

Mimosoideae

<i>Mimosa quadrivalvis</i> L.	Sensitive briar	N	HT	Prickles
GELSEMIACEAE				
<i>Gelsemium sempervirens</i> (L.) J.St.-Hil	Carolina jessamine	N	HM	Stem twiner
HYDRANGEACEAE				
<i>Decumaria barbara</i> L.	Climbing hydrangea, Wood vamp	N	WM	Roots aerial adventitious
LARDIZABALACEAE				
<i>Akebia quinata</i> (Houtt.) Dcne.	Chocolate-vine	Iv	WM	Stem twiner
MENISPERMACEAE				
<i>Calycocarpum lyonii</i> (Pursh) Nutt. ex A.Gray	Cupseed	Nc	WH	Stem twiner
<i>Cocculus carolinus</i> (L.) DC.	Carolina coral bead	Nc	WM	Stem twiner
<i>Menispermum canadense</i> L.	Canada moonseed	Nc	WM	Stem twiner
PAPAVERACEAE				
<i>Adlumia fungosa</i> (Alt.) Green ex B.S.P	Allegheny-vine	Nc	HM	Leaf petiole and leaflet petiolule twiner
PASSIFLORACEAE				
<i>Passiflora incarnata</i> L.	Purple passion-vine	Nc	HM	Tendrils
<i>Passiflora lutea</i> L.	Yellow passion-vine	Nc	HM	Tendrils
PLANTAGINACEAE				
<i>Cymbalaria muralis</i> P.G. Gaertn., B. Mey. & Scherb.	Kenilworth-ivy	I	HT	Stem twiner
POLYGONACEAE				

<i>Brunnichia ovata</i> (Walter) Shinnars	American buckwheat vine	N	HM	Stem twiner
<i>Fallopia baldschuanica</i> (Regel) Holub	Chinese bindweed	I	WM	Stem twiner
<i>Fallopia cilinodis</i> (Michx.) Holub	Fringed bindweed	Nc	HM	Stem twiner
<i>Fallopia convolvulus</i> (L.) A. Love	Black bindweed	Iv	HL	Stem twiner
<i>Fallopia dumetorum</i> (L.) Holub	Thicket bindweed	I	HM	Stem twiner
<i>Fallopia scandens</i> (L.) Holub	Climbing bindweed	N	HM	Stem twiner
<i>Persicaria arifolia</i> (L.) Haroldson	Halberd-leaved smartweed	Nc	HL	Barbs
<i>Persicaria perfoliata</i> (L.) H. Gross	Asiatic smartweed	Iv	HT	Barbs
<i>Persicaria sagittata</i> (L.) H. Gross	Arrow-leaved tearthumb	N	HL	Barbs

RANUNCULACEAE

<i>Clematis addisonii</i> Britton	Addison's leather-flower	Nc	HL	Leaf petiole twiner
<i>Clematis crispa</i> L.	Swamp leather-flower, blue jasmine	Nc	HM	Leaf petiole twiner
<i>Clematis florida</i> Thunb.	Asian virgin's bower	I	HM	Leaf petiole twiner
<i>Clematis occidentalis</i> (Hornem.) DC.	Purple clematis	Nc	HM	Leaf petiole twiner
<i>Clematis pitcheri</i> (Torr.) Gray	Purple leather-flower, Bluebill	Nc	HM	Leaf petiole twiner
<i>Clematis terniflora</i> DC.	Yam-leaved virgin's bower	Iv	HM	Leaf petiole twiner
<i>Clematis versicolor</i> Small ex Rydb.	Pale leather-flower	I	HM	Leaf petiole twiner
<i>Clematis viorna</i> L.	Vasevine, leather-flower	Nc	HL	Leaf petiole twiner
<i>Clematis virginiana</i> L.	Virginia virgin's-bower	N	HM	Leaf petiole twiner
<i>Clematis vitalba</i> L.	White virgin's bower	I	HM	Leaf petiole twiner

RHAMNACEAE

<i>Berchemia scandens</i> (Hill) Koch	Alabama supple-jack, rattan vine	Nc	WH	Stem twiner
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ROSACEAE

<i>Rosa multiflora</i> Thunb. ex Murr.	Rambler rose	Iv	WS	Prickles arching stems
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<i>Rosa setigera</i> Michx.	Climbing rose	Nc	WS	Prickles arching stems
<i>Rubus arenicola</i> Blanch.	Sandy field blackberry	Nc	WS	Prickles arching stems
<i>Rubus enslenii</i> Tratt.	Enslen's blackberry	N	WS	Prickles arching stems
<i>Rubus flagellaris</i> Willd.	Northern blackberry	N	WS	Prickles arching stems
<i>Rubus hispidus</i> L.	Bristly blackberry	Nc	WT	Prickles trailing stem
<i>Rubus recurvicaulis</i> Blanch.	Arching blackberry	Nc	WS	Prickles arching stems

RUBIACEAE

<i>Galium asprellum</i> Michx.	Rough bedstraw	Nc	HL	Barbs
<i>Galium aparine</i> L.	Scratch bedstraw	Nc	HL	Barbs

SAPINDACEAE

<i>Cardiospermum halicacabum</i> L.	Balloon-vine	Iv	HM	Tendrils -paired apical
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SCHISANDRACEAE

<i>Schisandra glabra</i> (Brickell) Rehder	American star-vine	Nc	WH	Stem twiner
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SOLANACEAE

<i>Lycium barbarum</i> L.	Matrimony vine	I	WS	Prickles
<i>Lycium chinense</i> P.Mill.	Chinese matrimony vine	I	WS	Prickles
<i>Solanum dulcamara</i> L.	Climbing nightshade	Iv	HM	Stem twiner

VITACEAE

<i>Ampelopsis cordata</i> Michx.	Heart-leaved pepper-vine	N	WM	Tendrils -paired
<i>Ampelopsis glandulosa</i> (Wallich) Momly	Porcelain-berry, Amur pepper-vine	Iv	WM	Tendrils -paired
<i>Cissus trifoliata</i> (L.) L.	Cow-itch vine	Nc	HM	Tendrils -paired
<i>Nekemias arborea</i> (L.) J.Wen & Boggan	Pepper vine	N	WM	Tendrils -paired
<i>Parthenocissus inserta</i> (Kerner) Fritsch	Thicket-creeper	N	WH	Tendrils -paired
<i>Parthenocissus quinquefolia</i> (L.) Planch.	Virginia-creeper	N	WH	Tendrils -paired

<i>Parthenocissus tricuspidata</i> (Sieb. & Zucc.) Planch.	Boston-ivy	Iv	WH	Tendrils -paired
<i>Vitis aestivalis</i> Michx.	Summer grape	Nc	WH	Tendrils -paired
<i>Vitis cinerea</i> (Englem.) Millardet	Winter sweet grape	Nc	WH	Tendrils -paired
<i>Vitis labrusca</i> L.	Fox grape	Nc	WH	Tendrils -paired
<i>Vitis palmata</i> Vahl	Catbird grape	Nc	WH	Tendrils -paired
<i>Vitis riparia</i> Michx.	Riverbank grape	N	WH	Tendrils -paired
<i>Vitis rotundifolia</i> Vahl	Muscadine	Nc	WH	Tendrils -paired
<i>Vitis rupestris</i> Scheele	Rock grape, Sand grape	Nc	WH	Tendrils -paired
<i>Vitis vinifera</i> L.	European grape	I	WM	Tendrils -paired
<i>Vitis vulpina</i> L.	Frost grape	Nc	WH	Tendrils -paired