REMNANT AMERICAN CHESTNUT (*CASTANEA DENTATA* (MARSH.) BORKH.; FAGACEAE) IN UPLAND FORESTS OF WESTERN NEW YORK

Robert G. Laport
Rhodes College, Department of Biology,
2000 North Parkway,
Memphis, TN 38112, USA
rob.laport@gmail.com

ABSTRACT

The American chestnut (*Castanea dentata* (Marsh.) Borkh.; Fagaceae) was an historically important hardwood species in eastern deciduous forests of the United States and Canada prior to being nearly eradicated by chestnut blight (*Cryphonectria parasitica* (Murr.) Barr). Several remnant populations have been identified persisting across fragmented parts of the historical range. The identification and characterization of remnant *C. dentata* populations is important for breeding and conservation efforts, as they may represent potential genetic sources of local adaptation or blight resistance, but much of the historical range remains unsurveyed. Here, I report the locations, apparent blight infection status, and reproductive status of remnant American chestnut in upland forested areas of western New York, finding several reproductive or potentially reproductive trees.

KEYWORDS: *Castanea dentata*, *Cryphonectria parasitica*, remnant populations, sensitive species, restoration.

INTRODUCTION

The American chestnut (*Castanea dentata* (Marsh.) Borkh.; Fagaceae) was an historically important hardwood species in eastern deciduous forests of the United States and Canada. Once ranging from southern Maine and Ontario to southern Georgia, and west to the Mississippi River (Peattie, 1950; Little, 1977; Russell, 1987; Smith, 2000), often as a dominant species, *C. dentata* represented a major economic species as well as a major source of edible seeds prior to its near-eradication by the fungal chestnut blight (*Cryphonectria parasitica* (Murr.) Barr) in the early 1900s (Brooks, 1937; Diamond *et al*., 2000; Jacobs *et al*., 2013; Dalgleish *et al*., 2016). The loss of this major canopy tree has altered historic tree associations (*e.g*., oak-hickory-chestnut; Keever, 1953) and patterns of forest regeneration (McCormick and Platt, 1980; Ellison *et al*., 2005; Elliot and Swank, 2008; Van Drunen *et al*., 2018), but remnant and fragmented populations persist in parts of Connecticut (Stephens and Waggoner, 1980; Paillet, 1982, 2002), Massachusetts (Paillet, 1988, 2002), Virginia (Stephenson *et al*., 1991), Ohio (Schwadron, 1995), and southern Ontario (Tindall *et al*., 2004). These studies suggest *C. dentata* persists throughout portions of its historical distribution; however, the density and ecological status of remnant trees across much of the historical range remain unclear.

The identification and ecological characterization of remnant *C. dentata* individuals and populations throughout its formerly native range—including the historical range limits—is crucial for identifying potential genetic sources of local adaptation or blight resistance (Huang *et al*., 1998; Steiner and Carlson, 2006; Bauman *et al*., 2012; Shaw *et al.*, 2012; Jacobs *et al*., 2013; Van Drunen *et al*., 2017). The demographic dynamics of populations near species range limits typically differ from populations within the core of the range as a consequence of experiencing unique ecological conditions and population genetic processes associated with small effective population sizes (Angert *et al*., 2008). Such populations may additionally display strong local adaptation, and/or harbor novel genetic variation, that may be exceptionally valuable for restoration and reintroduction efforts of threatened species such as *C. dentata* (Schemske *et al*., 1994; Jacobs *et al*., 2013).

Although active efforts are underway to identify and breed blight-resistant *C. dentata* for re-introduction (Bauman *et al*., 2012; Jacobs *et al*., 2013), the current ecological status of wild remnant populations of *C. dentata* throughout its historical native range remains relatively poorly known. For example, most previously documented individuals appear to be small, non-reproductive root crown re-sprouts from blight-affected trees, but occasional apparently healthy and reproductive *C. dentata* have been documented (Paillet, 2002), suggesting opportunities to collect novel germplasm for restoration efforts. Here, I report the discovery of several previously unknown *C. dentata* individuals occurring in small remnant populations near the historical northern range limit of the species, resulting from casual field surveys of relatively old wooded areas throughout parts of western New York state (Monroe, Steuben, and Tompkins Counties).

MATERIALS AND METHODS

From 2008 to 2011, I casually surveyed several woodland and forest parcels in western New York for the presence of *C. dentata* (Fig. 1). Most of the surveys were focused on woodlands in Monroe County, including woodlands on the campus of the University of Rochester, East Irondequoit Park/Abraham Lincoln Park, Lynch Woods Park, Durand Eastman Park, and Irondequoit Bay Wetlands Park/Lucien Morin Park. However, two sites broadened the scope of the surveys to larger parks in Tompkins (Taughannock State Park) and Steuben Counties (Stony Brook State Park). The land-use and age of the woodland parcels vary significantly, ranging from eastern old growth beech-maple forest to second growth woodlands on former agriculture lands. All of the surveyed areas were characterized by being relatively small (ca. 2–90 ha, though only a portion of the larger parks was surveyed) and in most cases were surrounded by a matrix of agriculture and/or suburban habitat.

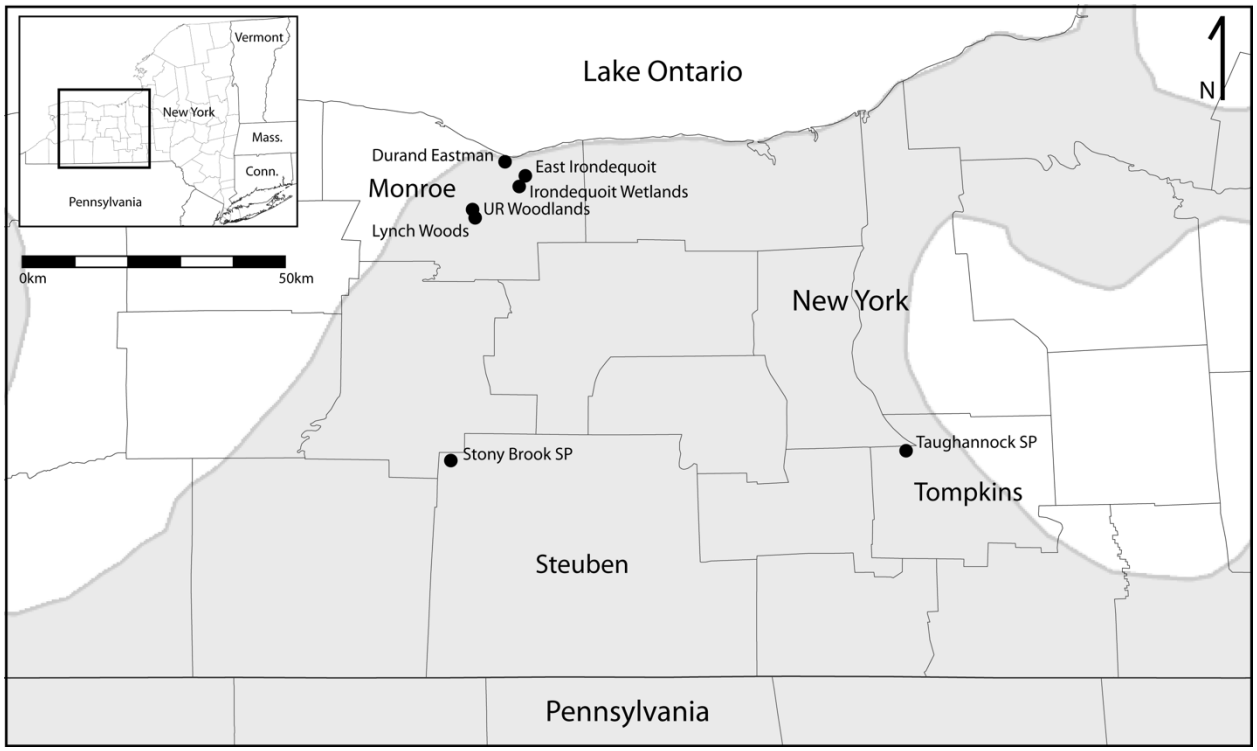

Fig. 1. *Castanea dentata* populations near the historical northern range limit in western New York. The black rectangle in the inset map indicates the location of the study area within New York. Gray shading indicates the approximate historical distribution of *C. dentata* (adapted from Little, 1977). The seven discovered populations of *C. dentata* are indicated by black circles: UR Woodlands, Lynch Woods Park, East Irondequoit Park, Irondequoit Wetlands, and Durand Eastman Park in Monroe County, Stony Brook State Park in Steuben County, and Taughannock State Park in Tompkins County.

When *C. dentata* individuals were identified, the GPS coordinates were recorded for each individual or group of individuals when trees were clustered (WGS 84 datum). The diameter at breast height (DBH) was measured with a metric diameter tape (reported as < 1 cm for very small trees and re-sprouts not reaching breast height), and the height of each stem was estimated. Additionally, I assessed the apparent reproductive status by looking for catkins and/or fruit husks beneath each tree, and evaluated the chestnut blight infection status for each individual by looking for cankers and/or dead stems (Table 1). Voucher specimens for most of the identified populations were deposited at the L. H. Bailey Hortorium Herbarium (BH) at Cornell University.

RESULTS AND DISCUSSION

Up until about 100 years ago, *Castanea dentata* was one of the most dominant trees of eastern North American forests (Russell, 1987). The decimation of *C. dentata* significantly altered eastern forest ecosystems, but the post-blight ecological significance of *C. dentata* remains relatively unclear. While the species persists throughout parts of its historical range, relatively few large potentially or actually reproductive individuals have been identified (Paillet, 2002). However, significant effort toward understanding the history (Russell, 1987; Diamond *et al*., 2000; Dalgleish *et al*., 2016) and genetics (Huang *et al*., 1998; Stillwell *et al*., 2003; Kubisiak and Roberds, 2006; Shaw *et al*., 2012) of *C. dentata* is informing current efforts to breed blight resistant trees and to reintroduce the species to its former native range (Paillet, 2002; Bauman *et al.*, 2012; Jacobs *et al*., 2013).

In total, I discovered 61 previously unknown *C. dentata* individuals persisting in mixed hardwood forests near the species' historical northern range limit in western New York, ranging from 1 to 32 individuals per site (Table 1). About a third of the identified individuals (34.4%) had a single live stem with a DBH ≤ 5.0 cm and could not clearly be classified as root-crown re-sprouts (*i.e*., no apparent stump). However, several individuals (11.5%) were characterized by large (DBH ≥ 10 cm) live or dead trunks surrounded at the base by re-sprouting growth. Many of these re-sprouts were appreciable in size (DBH ~1–3 cm). Only 21% of the identified individuals showed evidence of blight at the time of discovery, while 8.3% of identified individuals were large (DBH ≥ 20 cm; see LW 1; UR 1, UR 3, and UR 5; T 4 and T 5; and IW 16; all in Table 1) and apparently unaffected by blight at the time of discovery. The University of Rochester Woodlands (UR) site was noteworthy for the number of large *C. dentata* (4 trees with DBH ≥ 10 cm) in a relatively small ~17 ha woodland, with nearly all of the *C. dentata* being clustered along the edges of, or pathways through, a ~3.5 ha section comprising older and mature upland forest. The greatest number of individuals were identified at the Irondequoit Wetlands site (IW), 6 of which were large (DBH ≥ 10 cm), with all of the discovered trees occurring in two clusters on well-drained west- or southwest-facing slopes in relatively high-quality forest overlooking Irondequoit Creek (along the White Trail). Most (60%) of the largest trees were reproductive, having visible catkins at the time of discovery, or are potentially reproductive with indications of old fruit husks on the forest floor (Table 1). These trees, and identified individuals with DBH ≥ 10 cm, should be re-evaluated in future growing seasons for flower and fruit production.

There was not a clear association of woodland type or area with *C. dentata* growth habit, or the frequency of chestnut blight. All of the surveyed woodlands in the current study tended to be dominated by American beech (*Fagus grandifolia*), red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), and white ash (*Fraxinus americana*), but white oak (*Quercus alba*) and shagbark hickory (*Carya ovata*) were also typically present, and eastern hemlock (*Tsuga canadensis*) was also present in the southern sites in Steuben and Tompkins Counties. Paillet (1988) found that *C. dentata* was more commonly observed near the edges of remnant forest patches, woodlots, and hedgerows than within old-growth mesic forest in Connecticut and Massachusetts. Similarly, Tindall *et al.* (2004) found that extant *C. dentata* in southern Ontario was associated with deciduous forests with high canopy cover, but with well-drained sandy soils. Anecdotally, these associations appear to hold in the current study, suggesting that remnant *C. dentata* in western New York persists in association with older deciduous forests on well-drained soils. My surveys were not systematic, and given the patchy distribution of identified *C. dentata,* it is likely that future

efforts would prove fruitful in discovering additional small populations comprising reproductive trees in older woodlands and larger forest parcels of western New York.

The discovery of remnant *C. dentata* near its historical northern distributional limit helps clarify our understanding of the current ecological and phenotypic status of this once dominant species. These findings suggest that many remnant individuals persist in western New York, with reproductive trees escaping blight infection that may prove valuable for restoration efforts by the American Chestnut Foundation (www.acf.org) and the American Chestnut Research and Restoration Project (https://www.esf.edu/chestnut/). Yet, additional surveys in other parts of *C. dentata*'s historical range—including historical range margins—are essential to understand population dynamics and the potential genetic sources of adaptation or blight resistance (Van Drunen *et al*., 2017, 2018). Despite recent molecular evidence suggesting little genetic structure across the historical range (Huang *et al*., 1998; Kubisiak and Roberds, 2006; Dane, 2009; Shaw *et al*., 2012), local adaptation of key life history traits, such as cold hardiness, growth rate, and blight resistance, may be important for successful reintroduction of the species to certain parts of its historical range (Steiner and Carlson, 2006; Jacobs *et al*., 2013). The populations documented here may harbor unique genetic variation not represented by previously documented core distribution and range edge populations, and may enhance regional reintroduction efforts. Future efforts should investigate the current range of genetic and phenotypic variation present in remnant populations of *C. dentata* throughout the historical range by identifying these scattered persistent populations.

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Table 1. Locations and life-history status of *Castanea dentata* identified in woodlands of western New York. Asterisks (*) denote individuals for which voucher specimens were collected. Dates reported as DD/MM/YY. Reproductive status: N = non-reproductive, R = reproductive. Blight status: N = no visible signs of being afflicted by blight, B = visibly afflicted by blight or a dead trunk.

Plant ID	Date	Locality Name	County	Lat. (°N)	Long. (°W)	DBH (cm)	Height (m)	Status	Reprod. Status	Blight Status	Co-occurring Species
UR 1*	20/08/08	UR Woodlands	Monroe	43.1101	77.6396	21.6	15	live single stem	R?	N	*Fagus grandifolia*, *Acer saccharum*, *Acer rubrum*, *Fraxinus americana*, *Carya ovata*, *Quercus alba*, *Prunus serotina*, *Populus deltoides*, *Juglans nigra*, *Liriodendron tulipifera*, *Sassafras albidum*, *Ulmus* spp.
UR 2*	20/08/08	UR Woodlands	Monroe	43.1101	77.6396	12.7	15	live single stem	N	N	
UR 3*	20/08/08	UR Woodlands	Monroe	43.1099	77.6398	26.4	20	dead trunk, re-sprouts at base	N	B	
UR 4*	20/08/08	UR Woodlands	Monroe	43.1094	77.6397	7.1	12	live single stem	N	N	
UR 5*	20/08/08	UR Woodlands	Monroe	43.1093	77.6386	19.8	20	dead trunk, re-sprouts at base	N	B	
UR 6*	20/08/08	UR Woodlands	Monroe	43.1095	77.6393	8.5	15	live single stem	N	N	
LW 1	24/09/09	Lynch Woods Pk.	Monroe	43.1004	77.6390	20.0	15	live single stem	R	N	*Fagus grandifolia*, *Acer saccharum*, *Acer rubrum*, *Fraxinus americana*, *Carya ovata*, *Quercus alba*, *Prunus serotina*, *Populus deltoides*, *Juglans nigra*, *Liriodendron tulipifera*, *Sassafras albidum*, *Ulmus* spp.
LW 2	24/09/09	Lynch Woods Pk.	Monroe	43.1004	77.6388	12.0	10	live single stem	N	N	
EI 1*	05/10/09	East Irondequoit Pk.	Monroe	43.1913	77.5155	3.0	5	dead trunk, re-sprouts at base	N	B	*Quercus alba*, *Quercus rubra*, *Acer rubrum*, *Acer saccharum*, *Acer saccharinum*, *Carya ovata*, *Sassafras albidum*, *Liriodendron tulipifera*, *Fraxinus americana*
EI 2	05/10/09	East Irondequoit Pk.	Monroe	43.1918	77.5150	3.0	5	live single stem	N	N	
EI 3	05/10/09	East Irondequoit Pk.	Monroe	43.1918	77.5150	3.0	5	live single stem	N	N	
EI 4	05/10/09	East Irondequoit Pk.	Monroe	43.1918	77.5143	3.0	5	live single stem	N	N	
EI 5	05/10/09	East Irondequoit Pk.	Monroe	43.1912	77.5158	3.0	5	live single stem	N	N	

Table 1. continued

Plant ID	Date	Locality Name	County	Lat. (°N)	Long. (°W)	DBH (cm)	Height (m)	Status	Reprod. Status	Blight Status	Co-occurring Species
IW 1	30/06/11	Irondequoit Wetlands	Monroe	43.1666	77.5313	8.4	12	live stem, sapling 1m S	N	N	*Quercus alba*, *Quercus rubra*, *Acer rubrum*, *Acer saccharum*, *Acer saccharinum*, *Carya ovata*, *Sassafras albidum*, *Liriodendron tulipifera, Fraxinus americana, Populus deltoides*, *Ulmus* spp.
IW 2	30/06/11	Irondequoit Wetlands	Monroe	43.1666	77.5313	7.4	10	live single stem	N	N	
IW 3	30/06/11	Irondequoit Wetlands	Monroe	43.1666	77.5313	5.3	8	live single stem	N	N	
IW 4	30/06/11	Irondequoit Wetlands	Monroe	43.1668	77.5313	5.8	8	live single stem	N	N	
IW 5	30/06/11	Irondequoit Wetlands	Monroe	43.1668	77.5313	3.6	2.5	live single stem	N	N	
IW 6	30/06/11	Irondequoit Wetlands	Monroe	43.1668	77.5313	8.9	13	live stem, re-sprouts at base	N	N	
IW 7	30/06/11	Irondequoit Wetlands	Monroe	43.1668	77.5313	3.1	3	live single stem	N	N	
IW 8	30/06/11	Irondequoit Wetlands	Monroe	43.1669	77.5313	6.1	12	live stem, re-sprouts ~5m N, 1m S (3.8cm DBH)	N	N	
IW 9	30/06/11	Irondequoit Wetlands	Monroe	43.1666	77.5314	6.9	8	live single stem	N	N	
IW 10*	30/06/11	Irondequoit Wetlands	Monroe	43.1664	77.5321	2.5	1.5	dead trunk, re-sprouts at base	N	B	
IW 11	30/06/11	Irondequoit Wetlands	Monroe	43.1656	77.5301	5.3	3	live single stem	N	N	
IW 12	30/06/11	Irondequoit Wetlands	Monroe	43.1650	77.5289	5.3	0.5	2 dead trunks, re-sprouts at base	N	B	
IW 13	30/06/11	Irondequoit Wetlands	Monroe	43.1649	77.5288	5.3	7	2 trunks, re-sprouts 3m W & 2m S	N	N	

Table 1. continued

Plant ID	Date	Locality Name	County	Lat. (°N)	Long. (°W)	DBH (cm)	Height (m)	Status	Reprod. Status	Blight Status	Co-occurring Species
IW 14	30/06/11	Irondequoit Wetlands	Monroe	43.1649	77.5288	2.0	3	live single stem	N	N	
IW 15	30/06/11	Irondequoit Wetlands	Monroe	43.1650	77.5287	5.6	3	live single stem, re-sprout 1m N	N	N	
IW 16	30/06/11	Irondequoit Wetlands	Monroe	43.1649	77.5286	21.1	20	live single stem	R?	N	
IW 17	30/06/11	Irondequoit Wetlands	Monroe	43.1648	77.5284	1.3	2	live single stem	N	N	
IW 18	30/06/11	Irondequoit Wetlands	Monroe	43.1648	77.5284	2.3	2	live single stem	N	N	
IW 19	30/06/11	Irondequoit Wetlands	Monroe	43.1648	77.5284	6.9	4	live single stem	N	N	
IW 20	30/06/11	Irondequoit Wetlands	Monroe	43.1648	77.5284	6.4	7	live single stem	N	N	*Quercus alba*, *Quercus rubra*, *Acer rubrum*, *Acer saccharum*, *Acer saccharinum*, *Carya ovata*, *Sassafras albidum*, *Liriodendron tulipifera, Fraxinus americana*, *Populus deltoides*, *Ulmus* spp.
IW 21	30/06/11	Irondequoit Wetlands	Monroe	43.1649	77.5284	6.1	7	live single stem	N	N	
IW 22	30/06/11	Irondequoit Wetlands	Monroe	43.1648	77.5283	11.2	15	live stem, re-sprout 1m E	N	N	
IW 23	30/06/11	Irondequoit Wetlands	Monroe	43.1647	77.5283	10.9	15	live single stem	N	N	
IW 24	30/06/11	Irondequoit Wetlands	Monroe	43.1647	77.5283	6.4	8	live single stem	N	N	
IW 25	30/06/11	Irondequoit Wetlands	Monroe	43.1647	77.5282	9.1	10	live single stem	N	N	
IW 26	30/06/11	Irondequoit Wetlands	Monroe	43.1647	77.5283	4.3	5	dead trunk, re-sprouts at base	N	B	
IW 27	30/06/11	Irondequoit Wetlands	Monroe	43.1646	77.5281	10.9	12	2 trunks	N	N	
IW 28	30/06/11	Irondequoit Wetlands	Monroe	43.1647	77.5281	4.1	7	live single stem	N	N	
IW 29	30/06/11	Irondequoit Wetlands	Monroe	43.1647	77.5280	3.6	2	dead trunk, re-sprouts 5m E, 20 m E	N	B	

Table 1. continued

Plant ID	Date	Locality Name	County	Lat. (°N)	Long. (°W)	DBH (cm)	Height (m)	Status	Reprod. Status	Blight Status	Co-occurring Species
IW 30	30/06/11	Irondequoit Wetlands	Monroe	43.1649	77.5279	15.2	25	live single stem	N	N	*Quercus alba*, *Quercus rubra*, *Acer rubrum*, *Acer saccharum*, *Acer saccharinum*, *Carya ovata*, *Sassafras albidum*, *Liriodendron tulipifera, Fraxinus americana*, *Populus deltoides*, *Ulmus* spp.
IW 31	30/06/11	Irondequoit Wetlands	Monroe	43.1650	77.5279	18.8	30	dead trunk, re-sprouts 2m N, 3m E, 1 m N	N	B	
IW 32	30/06/11	Irondequoit Wetlands	Monroe	43.1655	77.5279	3.6	3	dead trunk, re-sprouts 5m W, 10 m W, 2 m N	N	B	
DE 1*	05/06/11	Durand Eastman Pk.	Monroe	43.2282	77.5638	5.0	10	live single stem	N	N	*Fagus grandifolia*, *Acer saccharum*, *Acer rubrum*, *Tsuga canadensis*
SB 1*	19/10/08	Stony Brook SP	Steuben	42.5148	77.6926	4.0	10	live single stem	N	N	*Quercus alba*, *Tsuga canadensis*, *Acer saccharum*, *Fraxinus americana*
SB 2	19/10/08	Stony Brook SP	Steuben	42.5148	77.6926	5.0	10	live single stem	N	N	
SB 3*	19/10/08	Stony Brook SP	Steuben	42.5147	77.6918	2.0	5	dead trunk, re-sprouts at base	N	B	
SB 4	19/10/08	Stony Brook SP	Steuben	42.5147	77.6918	3.0	5	live trunk, re-sprouts at base	N	B	
SB 5	19/10/08	Stony Brook SP	Steuben	42.5147	77.6918	4.0	10	live single stem	N	N	
SB 6	19/10/08	Stony Brook SP	Steuben	42.5147	77.6918	2.0	5	dead trunk, re-sprouts at base	N	B	
SB 7	19/10/08	Stony Brook SP	Steuben	42.5147	77.6918	5.0	10	live single stem	N	N	
SB 8	19/10/08	Stony Brook SP	Steuben	42.5147	77.6918	4.0	10	live single stem	N	N	
SB 9	19/10/08	Stony Brook SP	Steuben	42.5147	77.6918	3.0	8	live trunk, re-sprouts at base	N	B	
SB 10	19/10/08	Stony Brook SP	Steuben	42.5147	77.6918	10.0	20	live single stem	R?	N	

Table 1. continued

Plant ID	Date	Locality Name	County	Lat. (°N)	Long. (°W)	DBH (cm)	Height (m)	Status	Reprod. Status	Blight Status	Co-occurring Species
T 1*	27/06/09	Taughannock SP	Tompkins	42.5381	77.6091	4.0	10	live single stem	N	N	*Quercus alba*, *Acer saccharum*, *Acer rubrum*, *Tsuga canadensis*, *Fraxinus americana*
T 2	27/06/09	Taughannock SP	Tompkins	42.5381	77.6091	4.0	10	live single stem	N	N	
T 3	27/06/09	Taughannock SP	Tompkins	42.5392	77.6058	4.0	10	live single stem	N	N	
T 4	27/06/09	Taughannock SP	Tompkins	42.5392	77.6058	20.0	15	live single stem	N	N	
T 5	27/06/09	Taughannock SP	Tompkins	42.5392	77.6058	20.0	15	live single stem	R	N	