CHAPTER 8.

Determining the Extent of the Invasive Nonnative *Ailanthus* Tree Using Helicopter Mapping within Appalachian Ohio Oak Forests

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JOANNE REBBECK
CHERYL COON
AARON KLOSS

INTRODUCTION

Concern is growing about future sustainability of oaks in the oak-hickory forests of the Eastern United States. Oaks serve as keystone species in forests by providing a community structure and an environment that maintains critical processes. Their hard mast is vital to wildlife; the wood is important for the forest products industry; and they are tolerant of environmental conditions such as drought often associated with future climate scenarios. Ohio's forests are currently at a crossroads. Historical fire regimes have been interrupted. The dominant oak systems are declining and gradually being replaced by more shade-tolerant and fire-sensitive trees (Hutchinson and others 2012). Forest health is being impacted by nonnative invasive plant and insect species. Without an ecosystem approach to restoration, forest composition will continue to shift away from oak-hickory, invasive species will occupy more of the landscape, biological diversity will continue to be lost, and forests will lose their resiliency and ability to respond to climate change (Johnson and others 2009).

Ailanthus altissima, an aggressive invasive tree, can invade and expand dramatically when forests are disturbed (Albright and others 2010). It invades disturbed habitat via abundant wind-dispersed seed and can persist and expand by clonal growth. The Wayne National Forest (WNF) identified sustaining oak forests as a primary objective in its Forest Management Plan. Oak forests of the Appalachians require fire disturbance to restore and maintain their ecological function; however, *Ailanthus* is present in many mixed oak forest landscapes. *Ailanthus* competes directly with oaks and represents a barrier to the reintroduction of fire since it may benefit from the disturbance. The U.S. Department of Agriculture (USDA) Forest Service, Northern Research Station (NRS); the Ohio Division of Forestry (ODOF); and the WNF initiated a project to aerially map the invasive tree, *Ailanthus*, in southern Ohio (Rebbeck 2012, Rebbeck and others 2014). Because invasive species do not recognize property boundaries, mapping across all ownerships within the proclamation boundaries of the WNF was initiated in 2011. *Ailanthus* is dioecious, with up to 350,000 seeds produced per tree annually (Kowarik and Saümel 2007). Because its seeds persist into winter months when there is no interfering leaf cover, the ideal time to conduct aerial surveys is early to middle winter (fig. 8.1). The technique used was based on aerial *Ailanthus* mapping the ODOF initiated in 2008 in partnership with the NRS on Ohio State forests. Seed-bearing *Ailanthus* were mapped utilizing a Digital Aerial Sketchmapping System (DASM) run on a laptop computer with a touch screen display and stylus; the system allows the manual recording of digitally sketched and georeferenced features onto a base map. DASM technology, developed by the USDA Forest Health Technology Enterprise Team and Remote Sensing Applications Center, is commonly used to conduct annual forest health surveys from fixed wing aircraft in many U.S. States (Schrader-Patton 2003).

The primary objective of the project was to identify and map seed-producing *Ailanthus* trees across large forested landscapes in southeast Ohio. These data would then be used to prioritize invasive control treatments in conjunction with oak restoration treatments such as prescribed fire and overstory thinning. Additional impact would be achieved by sharing these georeferenced maps of *Ailanthus* infestations with groups such as the ODOF and Natural Resources Conservation Service, who work with private landowners to control invasive plants.

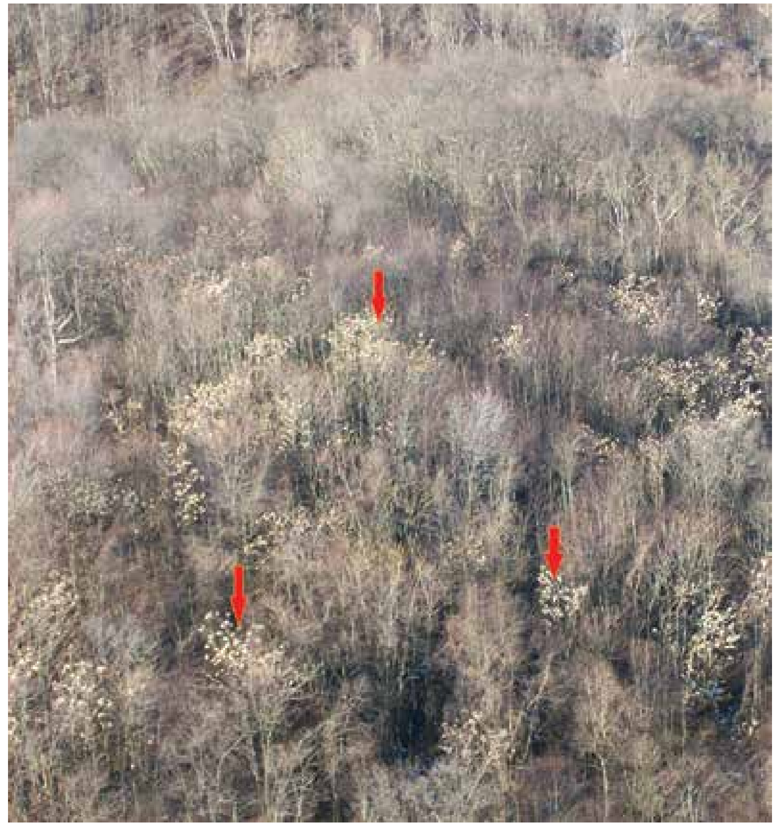

Figure 8.1—Aerial view of seed-bearing Ailanthus *trees in February 2011 on the Marietta Unit of the Wayne National Forest. Three representative seed clusters are identified with red arrows. (photo by Thomas Shuman, Ohio Department of Natural Resources)*

METHODS

Survey Areas

The Athens, Marietta, and Ironton Units of the WNF are located within the Unglaciated Allegheny Plateau where topography is highly dissected, consisting of sharp ridges, steep slopes, and narrow valleys. The forest spans portions of 12 southeastern Ohio counties. The WNF Proclamation Boundary covers 833,990 acres. However, 71 percent of the land within these boundaries is privately owned. It is a diverse landscape but is primarily represented by mixed oak-hickory forests. These units have a long history of past disturbance including clearcutting for farming, livestock grazing, and charcoal production as well as mineral, gas, oil, and coal extraction, which began in the early 1800s. Current disturbances include prescribed burning, timber harvesting, recreation trails, and oil/gas extraction.

Aerial Survey Methods

A Bell 206 B3 JetRanger helicopter owned and operated by the Ohio Department of Natural Resources (ODNR) Division of Wildlife was used for the aerial sketchmapping surveys. Just prior to each surveying session, sketchmappers reviewed mapping protocols, use of digital sketching software and hardware, and aerial photographs of seed-bearing *Ailanthus* trees. One sketchmapper sat in the co-pilot's seat and one in the rear on the opposite side of the aircraft. Each recorded the position of seed-bearing female *Ailanthus* on a tablet laptop computer that utilized a Holux M-241 GPS logger. Laptops were equipped with stylus-touchable screens, and loaded with GeoLink Powermap software (Michael Baker Jr., Inc., Jackson, MS). Reference base maps included U.S. Geological Survey 7.5-minute quadrangle maps (digital ortho quads [DOQs]) at a 1:24,000 scale and the survey boundaries. Laptops were linked to a Bluetooth-enabled EMTAC GPS receiver and an onboard Garmin™ 496 GPS unit. Survey altitudes were 373–600 feet above ground level at a speed of 5–80 miles per hour, depending on environmental conditions, forest density, and structure. Survey lines were spaced approximately 1,000 feet apart in a general north-south orientation. Both single and multipoints of individual seed-bearing *Ailanthus* trees were collected when one to several trees were spotted. If multipoints were not feasible (e.g., large areas with dense clusters of seed-bearing trees), a polygon was recorded instead, and the estimated percentage of cover of *Ailanthus* within the polygon was assigned a cover class of ≤25 percent, 26–50 percent, 51–75 percent, or 76–100 percent cover (Rebbeck and others 2015). At the beginning, midpoint, and end of each flight, both sketchmappers collected data on the same trees and prominent landscape features (large building structures, road intersections) to assess mapping accuracy. ESRI ArcGIS® (Version 10, Redlands, CA) software was utilized for postprocessing of data. Coordinates were downloaded to handheld GPS units (Garmin™ GPSmap 76CSx, Olathe, KS) so that mapping accuracy could be assessed on the ground. The handheld units included 2.0 GB microSD storage cards with a GPS accuracy of < 33 feet and a differential global positioning system (DGPS) accuracy of 10–16 feet. Ground-truthing was conducted several weeks after aerial surveys on a subset of the mapped *Ailanthus* (Rebbeck and others 2015).

RESULTS

Between 2011 and 2013, approximately 163,256 acres were sketchmapped in a total of 45 flight hours (3,600 acres per hour) (table 8.1). On the Marietta Unit, more than 1,300 *Ailanthus* infested areas were mapped, representing a total of 6,388 acres (8 percent of the surveyed land) (fig. 8.2). However, because only polygon data were collected during the 2011 Marietta survey flights, the actual number of female *Ailanthus* trees is unknown. On the Ironton Unit, only 65.2 acres (0.08 percent of the surveyed 83,522 acres) were mapped as infested with *Ailanthus*. The vast difference between infested acres on the Marietta and Ironton Units created uncertainty as to whether the Ironton Unit truly had such low levels, or whether the late

Table 8.1—Summary of *Ailanthus* aerial surveys conducted on the Wayne National Forest between 2011 and 2013

Survey unit	Survey year-month	Number of days/hours of mapping	Total area surveyed	Mapped infested area	Number of mapped female *Ailanthus*	Female tree d.b.h.		Number of mapped polygons	Size of mapped polygons	
						Range	Mean		Range	Mean
			acres	*acres*		--------- *inches* ------------			-------- *acres* ---------	
Athens	2013-January	2/10	87,307	41	259	3.6–20.5	8.2 (± 7.2)	23	0.3–7.8	1.8 (± 1.88)
Ironton	2011-February	2/12	83,522	65	18	—	—	20	0.3–10.2	3.6 (± 3.28)
	2013-January	2/10	112,832	4	39	—	—	3	0.9–1.6	1.3 (± 0.47)
Marietta	2011-January, February	6/18	79,734	6,388	N/A	3.5–10.2	6.9 (± 2.2)	1,356	0. 1–71.6	4.7 (± 7.16)

— = Trees were not measured at the Ironton survey unit.
d.b.h. = diameter at breast height.

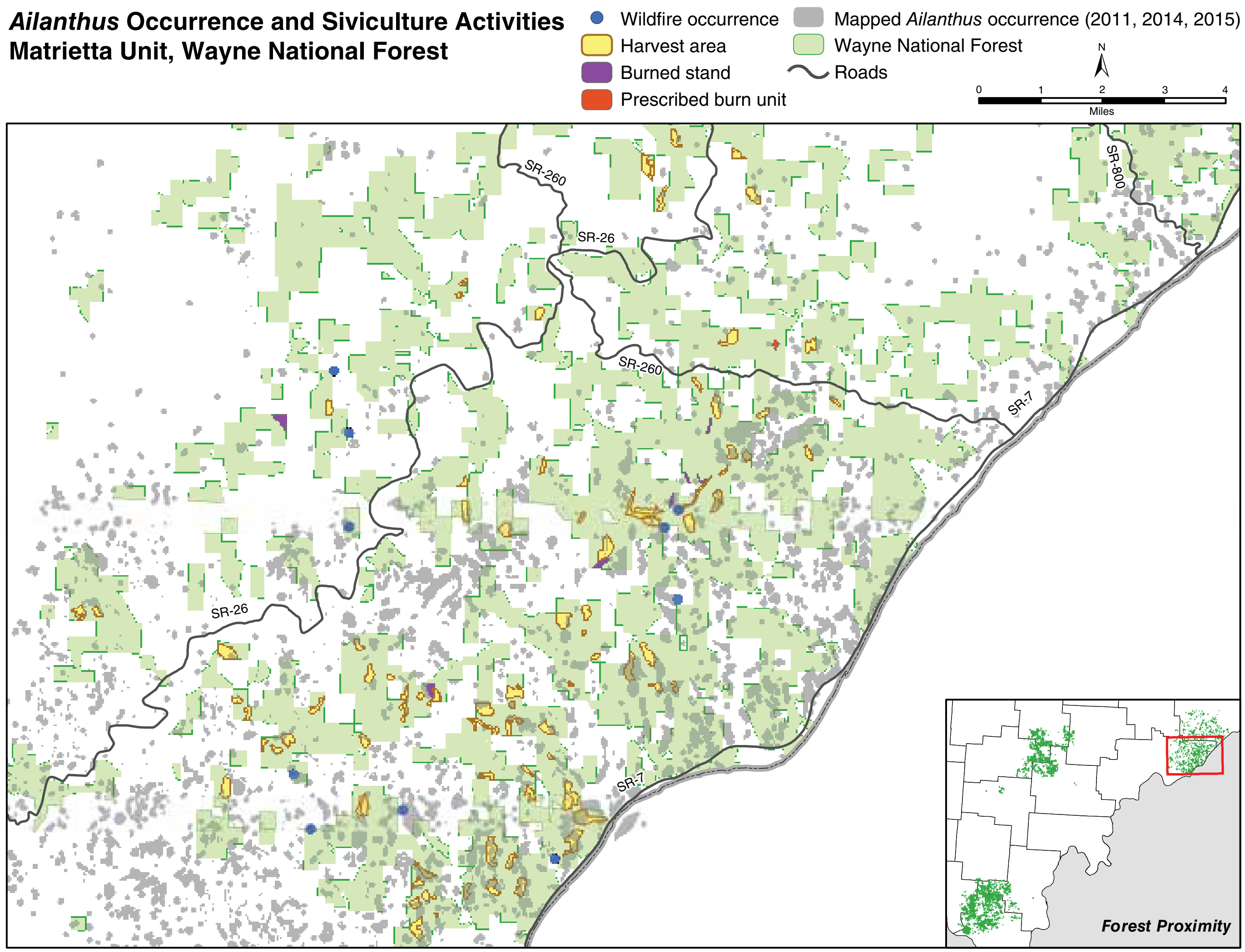

Figure 8.2—Map of the Marietta Unit of the Wayne National Forest. Note the high density of private inholdings and the high density of Ailanthus*-infested areas shown as brown polygons mapped in early 2011.*

(March) aerial surveys failed to detect areas of infestation because the seed clusters had dropped. To determine this, the entire Ironton Unit (112,832 acres) was surveyed in January 2013. The mapped data confirmed that, indeed, few seed-bearing females were present on that landscape. Within the Athens Unit survey area, 259 female seed-bearing *Ailanthus* female trees and 23 polygons were mapped. Of the 23 polygons, 6 had a cover of ≤ 25 percent, 8 had 26–50 percent cover, 3 had *Ailanthus* cover of 51–75 percent recorded, and 3 had no assigned *Ailanthus* cover attribute. Ground-truthing surveys were conducted in summer 2013 covering approximately 4,400 acres and 50 miles of roads. Within the ground-truthed area, 62 of the 70 aerially mapped females were relocated. The relocation distance of the ground-mapped female *Ailanthus* trees ranged from 3 to 492 feet. During ground surveys, male (non-seed bearing) trees were identified as individuals or in clumps (8 percent of total ground mapped), but most were mixed with females (33 percent of total ground-mapped *Ailanthus*) (Rebbeck and others 2015).

These aerial mapping data were used to prioritize *Ailanthus* control treatments in conjunction with oak restoration treatments. Since 2011, the National Wild Turkey Federation (NWTF) has partnered with the Wayne National Forest to maintain open land wildlife habitat by controlling *Ailanthus* within the WNF. Maintenance of these open habitats within oak-hickory forests benefits many regionally important wildlife species. Between 2011 and 2014, approximately 835 acres were treated with herbicides for *Ailanthus* control. In 2015, 747 acres are planned to be treated utilizing stem injection herbicide treatments (fig. 8.3).

DISCUSSION

This project demonstrated that helicopter digital sketchmapping technology can be used to economically and efficiently map *Ailanthus* in forested landscapes during the dormant season and utilize data to prioritize and develop control treatment plans. We estimated survey costs at $0.40 per acre, based on a commercial rate of $960 per hour for helicopter rental, pilot’s time, and two sketchmappers for an average 8-hour day. Although rates for fixed-wing aircraft hourly costs are considerably lower, fixed wing does not provide the required lower speed, maneuverability, and visibility needed. Traveling at speeds of 55–80 miles per hour in a helicopter compared with those of about 130 miles per hour in a fixed-wing aircraft improves the likelihood that infestations will be accurately located, sketched, and assigned correct attribute features. Estimates of coverage ranged from

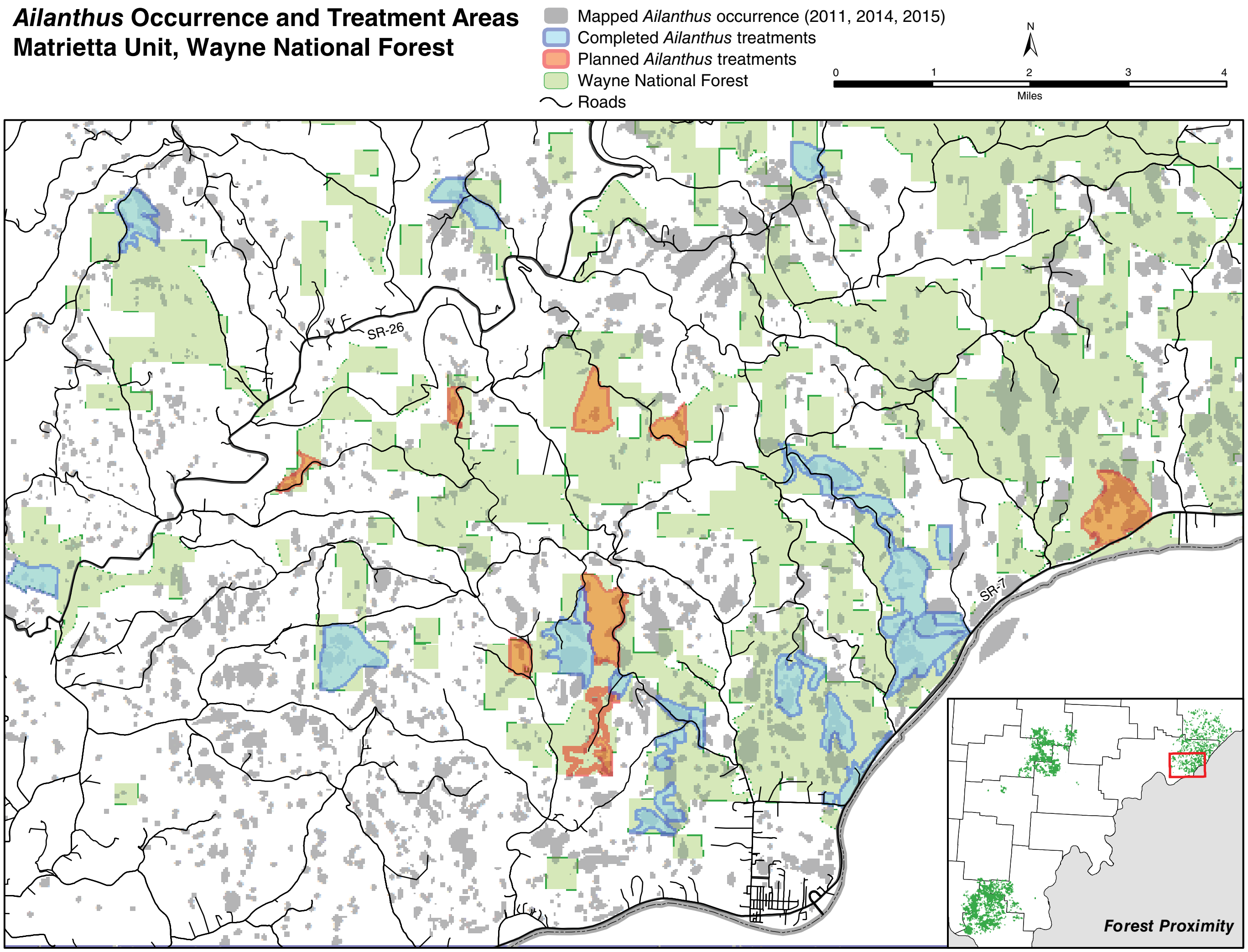

Figure 8.3—Distribution of Ailanthus *populations from aerial surveys and herbicide treatment areas on the Marietta Unit of the Wayne National Forest between 2011 and 2015.*

2,000 to 7,000 acres per hour, depending on the level of *Ailanthus* infestation and flight altitude. If more *Ailanthus* was present, then more time per acre was required for mapping. For example, the rate of mapping for the lightly infested WNF Ironton Unit was 6,960 acres per hour compared with 2,215 acres per hour for the heavily infested Marietta Unit. Another advantage of this mapping tool is quick access to the data. Very little post-flight processing is needed to generate georeferenced maps and/or downloadable point data onto GIS devices. It should be noted that downloading polygon data onto handheld units requires more storage capacity compared to waypoint data. The greatest limitation of this technology is the accuracy of the sketchmapping. This is a highly subjective skill that combines both art and science. Standardization of methods is critical and sketchmapper performance improves with experience. During all flights, sketchmappers should periodically record known land features such as road intersections, bridges, or prominent structures as spatial accuracy checks. Implementation of the aerial survey standards and quality assurance and quality control guidelines, developed by the U.S. Forest Service Forest Health Technology Enterprise Team, are available at http://www.fs.fed.us/foresthealth/technology/ads_standards.shtml.

This same approach could also be used to aerially map another invasive nonnative woody species, princess tree (*Paulownia tomentosa*). Sketchmappers were able to distinguish and map its prominent seed clusters, which were clearly visible and distinctive from *Ailanthus* during leaf-off surveys. Early indications show great promise for detection of this problematic nonnative as well. Unfortunately, not all invasive species can be mapped at the same time because of differences in their phenology. For successful mapping, timing of surveys must be linked to a prominent and distinctive feature of the target species. In the case of *Ailanthus* and *Paulownia*, winter leaf-off surveys are the most appropriate time.

CONCLUSIONS

This technology provides forest managers with readily available and affordable, landscape-level data of seed-producing *Ailanthus* populations. Since the mapping focuses on identifying seed-bearing trees, it underrepresents the magnitude of infestations. Maps from aerial data allowed managers to develop and implement control plans to treat *Ailanthus* on over 1,600 acres on the Marietta Unit of the WNF. Proactive control of invasive plants in advance of silvicultural treatments such as timber harvest or prescribed fire provides a huge advantage for managers to minimize the impacts and spread of invasive woody species such as *Ailanthus*.

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CONTACT INFORMATION

Joanne Rebbeck: jrebbeck@fs.fed.us.

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