

# The Impact of ALB and Eradication Efforts in a Forested Conservation Area in Worcester, Massachusetts – A Preliminary Assessment

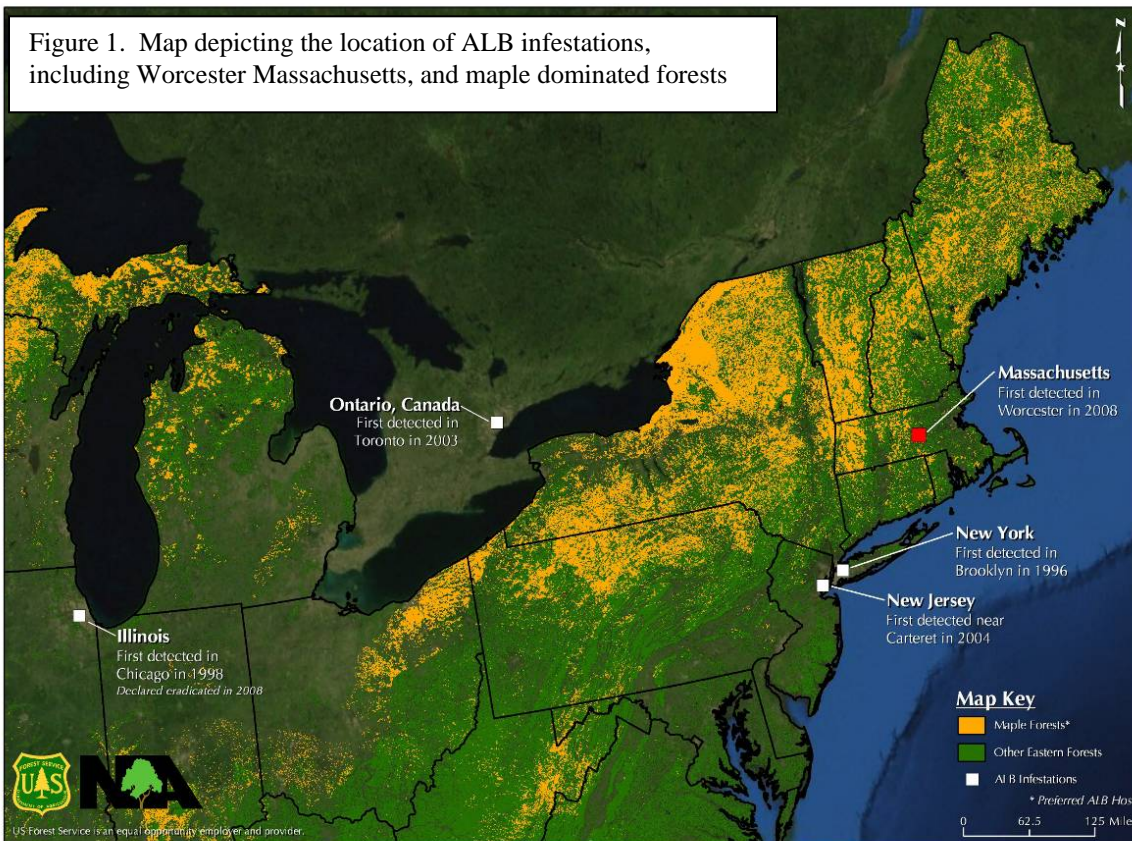
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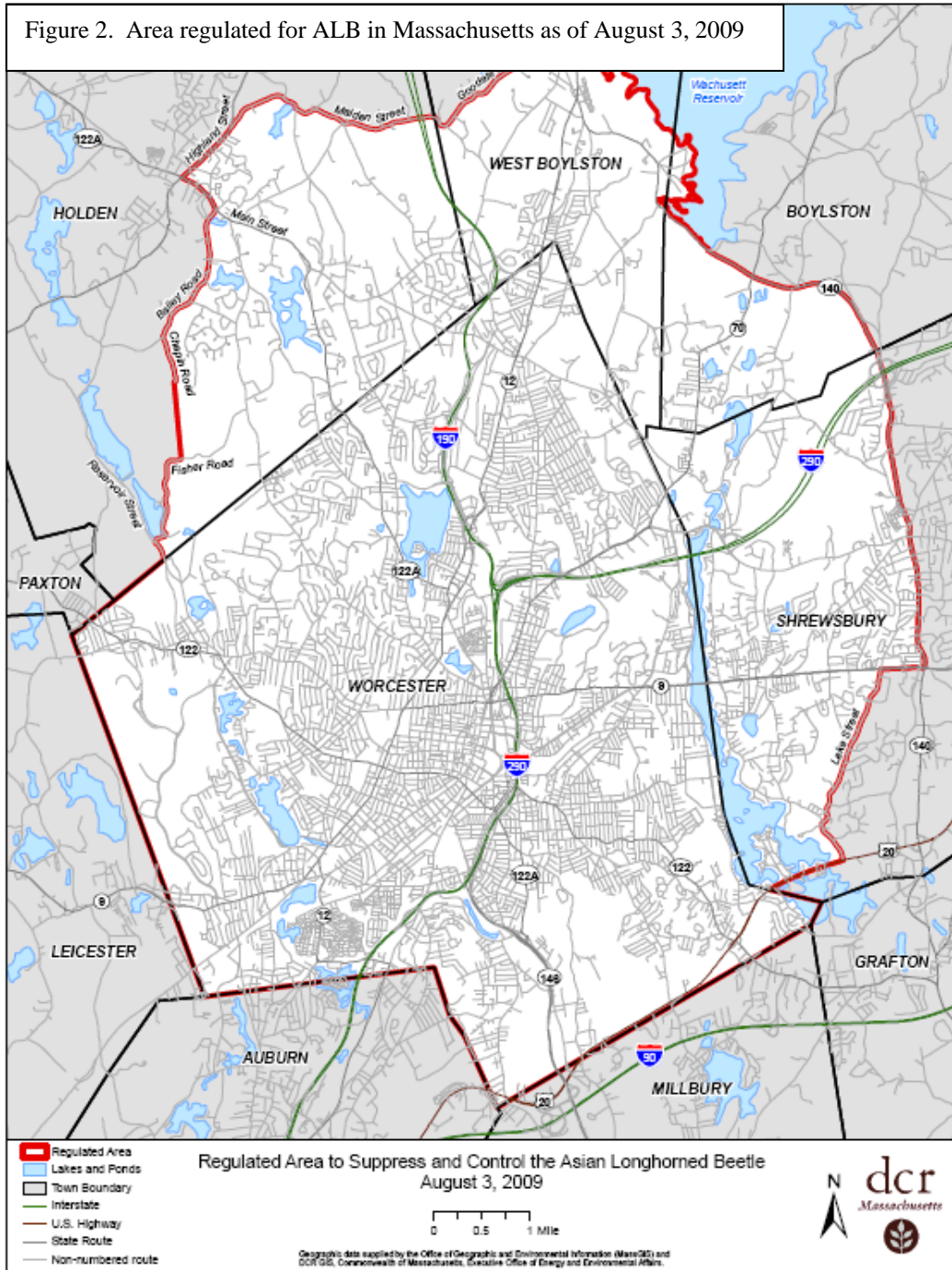
## Introduction

In August 2008, Asian Longhorned beetle (ALB), *Anoplophora glabripennis* (Motschulsky), was located within the city limits of Worcester, Massachusetts. In terms of ALB detections in North America, Worcester represents a unique situation in regards to host tree density and proximity to susceptible natural forests (Figure 1). Large tracts of hardwood-dominated forests containing host trees like maple and birch surround Worcester, providing an easy pathway into natural and managed forests that contain a high density of hosts. Previous infestations have been largely urban and isolated from large tracts of natural forests.



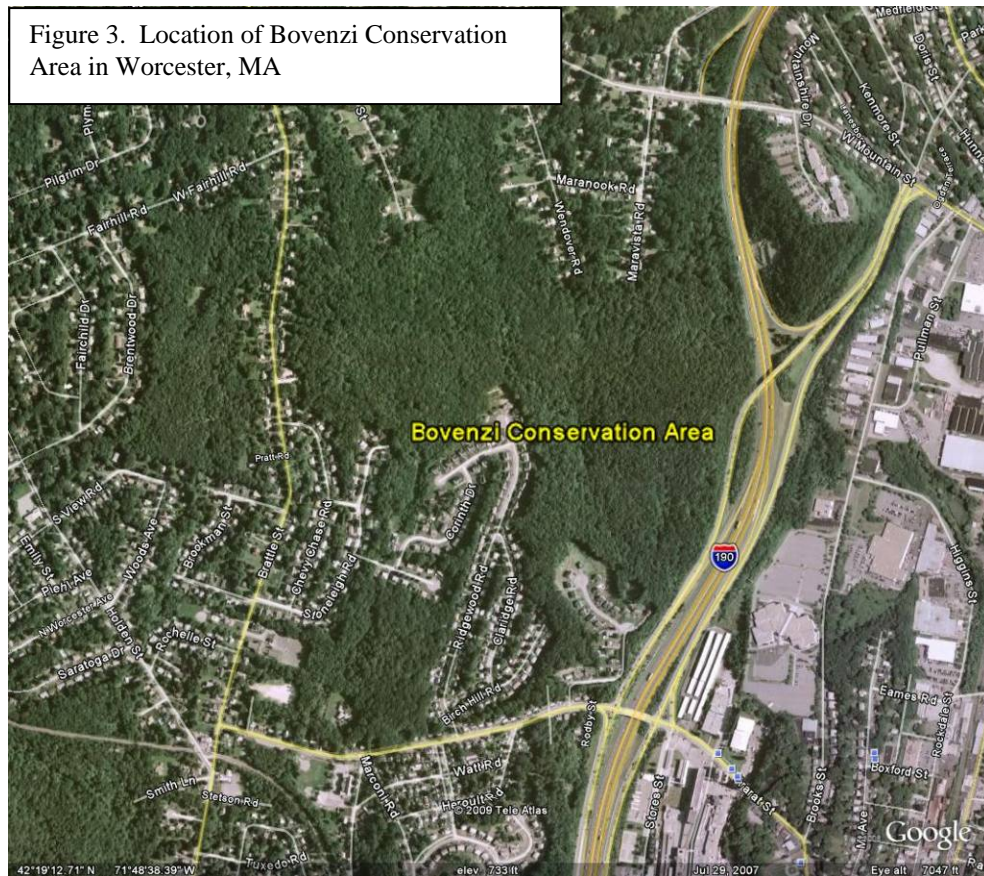
Survey and delimitation efforts led by the USDA and state agencies began almost immediately after ALB was detected in Worcester in 2008. As of August 2009, survey efforts have led to the detection of at least 13,000 infested trees and a regulated area of

approximately 66 square miles that incorporates Worcester and portions of Boylston, West Boylston, Holden, and Shrewsbury (Figure 2). Tree removal of infested trees and



high-risk host trees began during winter 2008 and is currently ongoing with over 25,000 trees removed thus far. Even with a large-scale survey effort underway, the Worcester infestation is assumed to be larger than currently defined.

ALB is now believed to have been introduced into the Worcester area at least ten years ago. Adjacent to the original detection point and likely introduction point is the Bovenzi Conservation Area (BCA). This ~ 40 ha forest preserve is managed by the Greater Worcester Land Trust and contains a mixed hardwood forest. The BCA is bounded by a major highway on the east and neighborhoods in all other directions (Figure 3).



Because ALB has been a pest in urban settings there is little currently known about how this insect will behave in forested ecosystems. The presence of ALB in BCA provided a unique opportunity to gather baseline data on the behavior and impacts this insect could have, through its colonization of host trees and/or through eradication efforts, on forests. The objectives of this study were to (1) describe the forest stand conditions present at BCA before eradication efforts commenced, (2) investigate ALB colonization behavior in a forested ecosystem, and (3) compare growth rates between trees with signs of ALB present and those without.

## Methods

### *Site description*

The ~40 acre BCA contains several forest types situated on and around a hill with elevations ranging from approximately 190 m to 245 m. At the base of the area a small

creek runs through a red maple-dominated swamp. Forest composition changes with elevation and includes a mix of hardwood species throughout the area.

In the fall of 2008, a volunteer-led survey of BCA located signs of ALB presence on maple trees throughout the area. Initial finds by the volunteer group were confirmed by APHIS personnel and tree climbers were brought in to survey the eastern half of the BCA. Climbers extensively examined potential host tree canopies and boles looking for oviposition sites or exit holes and marked every host tree as attacked or unattacked. Attacks were originally thought to be concentrated in the eastern half of the BCA, the location of our survey efforts (see Figure 3). From the approximately 40 ha that comprise BCA, we worked within a 10 ha section. During the summer of 2009, ALB was found in the remaining forested area of BCA.

#### *Vegetation plots*

Twenty fixed-radius (12 m) circular plots were placed along transects that ran in a north-south direction parallel to the primary slope of the study area to estimate tree and stand parameters and ALB activity at each site. Each plot was separated by at least 25 m. For every tree over 7.5 cm dbh in each plot, tree species, dbh, crown class, living/dead, and presence or absence of ALB were recorded. ALB presence was based on results from tree climbing surveys where tree boles and crowns were closely surveyed. Crown classes were differentiated based on exposure to light, including overtopped, intermediate, codominant, and dominant.

#### *Increment cores from infested and non-infested trees*

Red maple was the dominant tree present at BCA and was the focus of dendroecological efforts. Red maple of similar diameters with and without ALB attacks were cored in each stand for age determinations and radial growth analyses. One increment core from each tree was taken at breast height (approximately 1.4 m). Whenever possible, cores were taken from trees within the 12 m fixed radius vegetation plots. All increment cores were air dried, sanded, and will be aged with a dissecting microscope, and annual rings will be measured to the nearest 0.01mm using a Velmex measuring system (Velmex, East Bloomfield, NY, USA). Tree age will be considered as the number of rings measured, with no additional estimation for cores that missed the pith. Current and past radial growth patterns will be examined in all cores to examine the impact of ALB on tree growth and whether tree growth influenced ALB preference.

#### *Spatial location of infested and non-infested host trees*

Sub-meter GPS locations were recorded using Trimble handheld units for every infested and non-infested host tree found in our survey area. Data points were downloaded and used to spatially depict host trees in BCA.

## Results and Discussion

Locating ALB in BCA provided a unique opportunity to investigate how this insect behaves in a forested ecosystem and what impacts they may have on tree growth. Previous ALB infestations were located in urban forests with dramatically different characteristics than the closed canopy natural forest present at BCA. While further studies are necessary to determine behavior of ALB in natural forests, the current study provides a glimpse into what natural resource professionals may encounter if or when ALB becomes naturalized in northeastern hardwood forests or through eradication efforts by regulatory agencies.

### *Vegetation present before eradication*

In the sampled area of BCA, 14 species of trees over 7.5 cm dbh were recorded. Red maple (*Acer rubrum* L.), black oak (*Quercus velutina* Lam.), red oak (*Quercus rubra* L.), and pignut hickory [*Carya glabra* (Mill.)] were the dominant overstory tree species present (Table 1). There were 500 stems/ha and 27.2 m<sup>2</sup>/ha of basal area in the surveyed area at BCA. Red maple, an ALB preferred host tree, had the highest importance value (31.8), followed by black oak (20.2), red oak (14.0) and pignut hickory (11.8). Red maple or oak species dominated every size class (Figure 4). Oak species, red maple, hickory species and white ash (*Fraxinus americana* L.) were the only trees found in the larger size classes (> 40 cm dbh), while these species and elm (*Ulmus* spp), black birch (*Betula lenta* L.), and eastern hophornbeam [*Ostrya virginiana* (Mill.) K. Koch] were also found in smaller size classes (< 20 cm dbh). The largest tree was a red maple over 100 cm dbh.

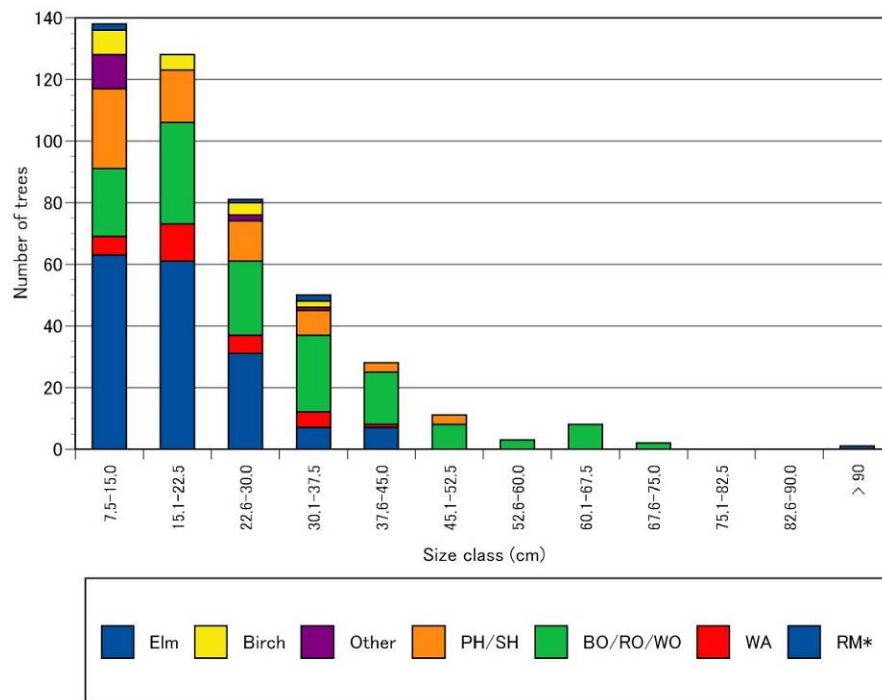


Figure 4. Size class distribution of trees at Bovenzi Conservation area prior to detection of ALB and eradication efforts. \* includes one sugar maple

Table 1. Basal area, density, and importance values for overstory tree species (stems > 7.5 cm dbh) at BCA

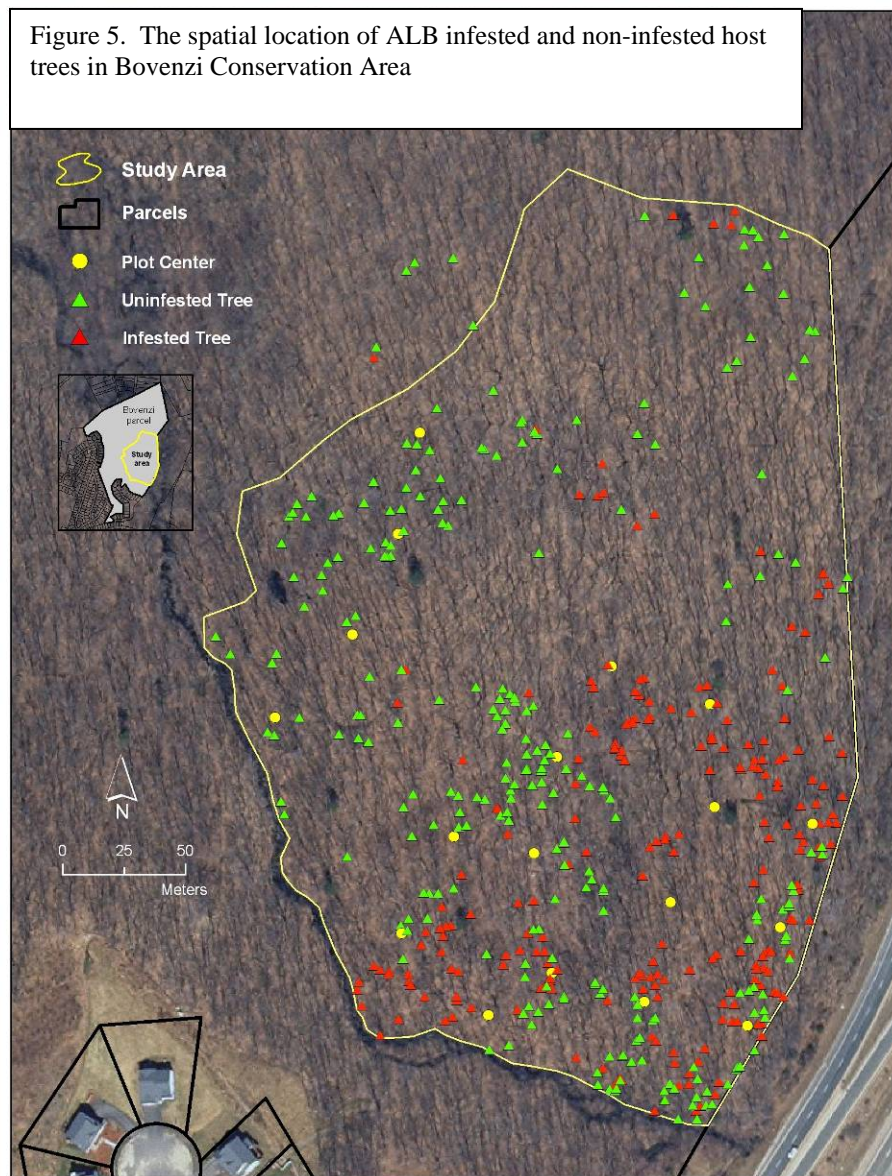
Species	Avg. $\pm$ SE dbh (cm)	Total BA	Density of stems	Relative BA (%)	Relative Density (%)	Importance Value
<b>Host Trees</b>						
RM	19.1 $\pm$ 0.83	6.4	169	26.1	37.6	31.8
ASH	22.5 $\pm$ 1.54	1.4	30	5.6	6.7	6.1
BB	17.5 $\pm$ 1.96	0.6	19	2.3	4.2	3.3
ELM	22.6 $\pm$ 4.71	0.2	5	0.9	1.1	1.0
SM	26.4 $\pm$ 0.00	0.05	1	0.2	0.2	0.2
<b>Non-host Trees</b>						
BO	37.0 $\pm$ 2.08	6.9	55	28.3	12.2	20.2
RO	28.6 $\pm$ 2.00	4.1	51	16.7	11.3	14.0
PH	20.7 $\pm$ 1.47	2.6	59	10.5	13.1	11.8
WO	21.0 $\pm$ 1.49	1.5	36	6.0	8.0	7.0
SH	23.6 $\pm$ 3.41	0.6	11	2.4	2.4	2.4
Hop hornbeam	11.7 $\pm$ 1.52	0.1	9	0.4	2.0	1.2
BT Aspen	31.8 $\pm$ 0.00	0.08	1	0.3	0.2	0.3
WP	26.5 $\pm$ 0.00	0.06	1	0.2	0.2	0.2
WH	8.4 $\pm$ 1.44	0.02	3	0.1	0.7	0.4
Total hosts		8.6	224			
Per hectare hosts		9.5	249			
Total non-hosts		24.5	450			
Per hectare non-hosts		27.2	500			

*Increment cores from infested and non-infested trees*

All increment cores have been mounted and sanded for measurement at Harvard Forest. A cooperative agreement between Harvard Forest and the Durham Field Office is in place to provide funding for this work. We anticipate having this data complete by January 2010.

*Spatial location of host trees*

The locations of infested and non-infested host trees were mapped to examine the spatial pattern of ALB colonization in BCA (Figure 5). This data set has been provided to NRS scientists for preliminary analysis and determination if further analyses can be conducted.



### *ALB host trees*

There were five recorded ALB host species located in BCA (red and sugar maple, elm, birch), including white ash, a species not considered to be a common host (USDA APHIS, 2008). Host trees comprised 249 stems/ha and 9.5 m<sup>2</sup>/ha of basal area in BCA (Table 1). The most abundant host species and tree in the stand was red maple, which contributed the most basal area and number of stems. White ash, black birch, and elm had low importance values in the stands, with values of 6.1, 3.3, and 1.0 respectively. In all, ALB host species comprised 34% of the BA present in the stand. There was only one potential host tree over 50 cm dbh found in the stand (Figure 6)

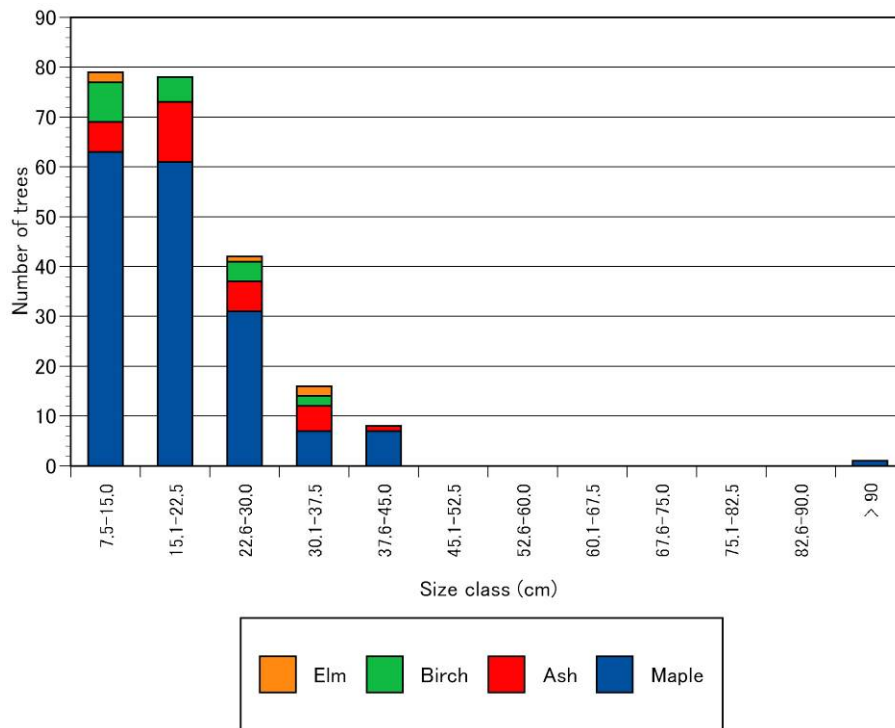


Figure 6. Size class distribution of host trees present in the BCA.

### *ALB infested trees*

Host trees in BCA were surveyed by trained tree climbers looking for signs of ALB presence (oviposition sites, exit holes). Surveys conducted by tree climbers are more reliable than ground based surveys, but even this technique can result in false negatives (i.e., trees considered uninfested that truly are). While false positives (i.e., trees considered infested that are not actually infested) could also occur, these types of errors would seem less common or frequent than the false negatives. Consequently, it could be possible that ALB was present in more host trees in BCA but not detected. Estimates of ALB presence, therefore, might be low for this stand.

While there were several potential ALB host species present in BCA, oviposition scars or exit holes were only found on maple (Figure 7). Of the maple present in BCA, 32% had signs of ALB attacks and these were distributed throughout available size classes (Figure 8). Larger size classes had a higher percentage of trees attacked by ALB than smaller size classes. Only one host tree over 50 cm was sampled in BCA (a 108 cm red maple) and this tree had signs of ALB present.

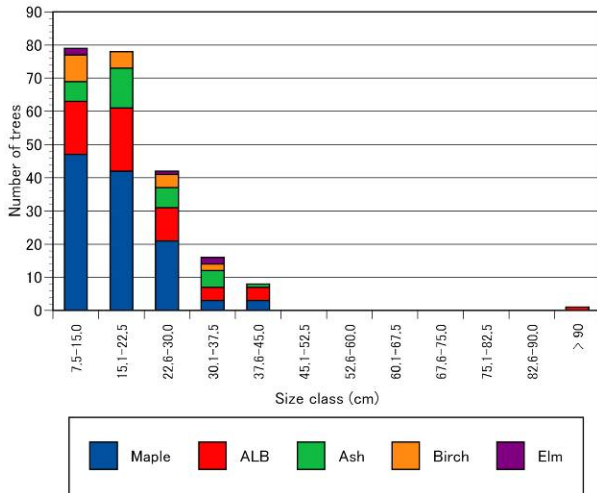


Figure 7. Size class distribution of host trees and ALB activity present at BCA

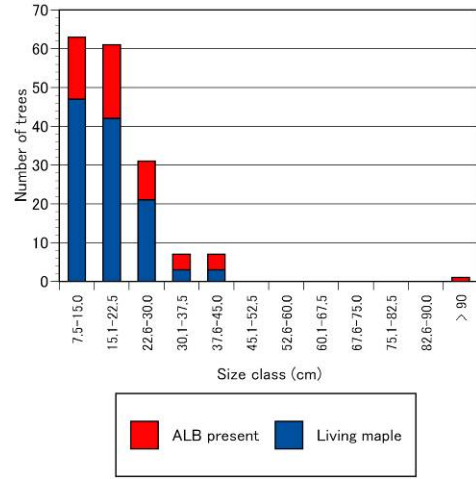


Figure 8. Diameter distribution of maple and ALB infested trees at BCA

### Estimated remaining forest

Estimating the remaining forest after the eradication efforts from pre-eradication data is difficult for several reasons. First, non-host trees may have been removed during the eradication efforts in the construction of skidder trails or were damaged during cutting. Second, not all potential host trees were removed from BCA and this makes estimating the remaining forest particularly challenging. Maple, elm, and paper birch were removed, but some black birch and white ash were left in the stand. To simplify analysis and provide information on what ALB could do in a forest or conditions that would result from a complete host tree removal it was assumed all host trees were removed for this analysis.

While we found no paper birch during our survey, black birch and ash were found throughout the stand and comprised 11% of the stems present at BCA before host removals. Assuming total removal of all ALB host trees, BCA is now dominated by oak and hickory (Table 2). Black oak (34%), red oak (24%), and pignut hickory (21%) are the most important species on the site and together comprise 85% of the living remaining basal area. The size class distribution of trees left after removals maintained the same shape as the pre-removal distribution (Figure 9). Thirty-five percent of the basal area per hectare was removed and 50% of the stems were lost (Figure 10).

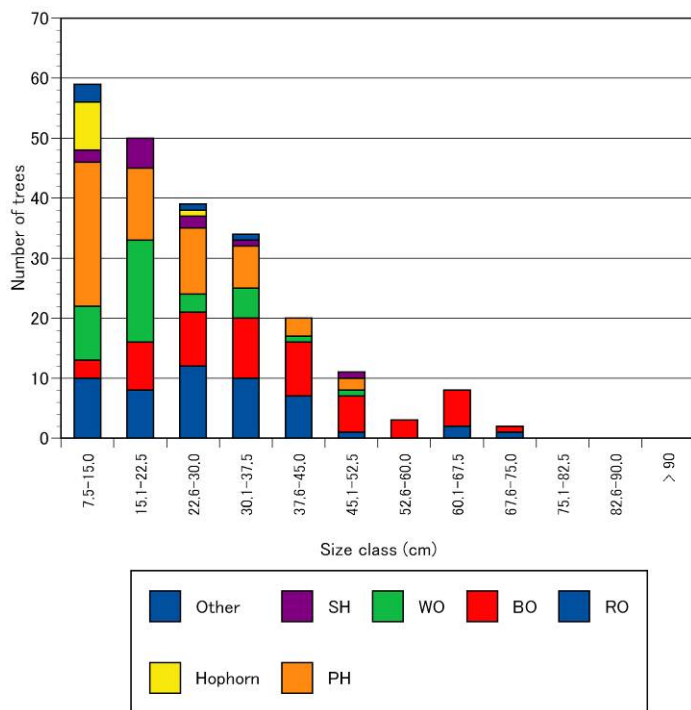


Figure 9. Estimated size class distribution of residual trees at BCA after the completion of eradication efforts

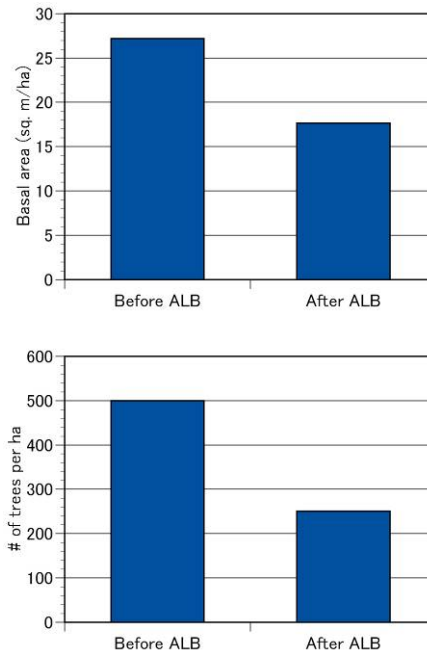


Figure 10. Before and after eradication estimates for basal area and number of stems per hectare estimates at BCA

To accurately estimate the residual forest remaining after eradication efforts in BCA it may be necessary to re-sample the area. While much can be gained from the data analysis as carried out, a more accurate estimate would result from revisiting the site. However, from the data used for these analyses the impact of ALB or eradication efforts in BCA can be clearly seen. Red maple was the dominant tree present in the surveyed area and its and other host trees removals have changed forest conditions in BCA. The surveyed area in BCA covered an elevation gradient with red maple more common in the lower areas of the site. As elevation increased, oak and hickory became more important species and dominated those areas. Consequently, not all areas of BCA suffered the same level of impacts from ALB or eradication efforts.

In many ways BCA represented a best-case scenario for management of ALB in a forested ecosystem. While much of the forest may have been dominated by maple, other non-host tree species were present in most size classes allowing for a closed canopy forest to still exist on the site even after host tree removal. Forests further north or in areas with higher moisture levels will likely have a higher component of maple species present and removal of these trees will be more detrimental to ecosystems present on a site.

This survey of an ALB infested forest is a first step at gathering information on the potential impacts this invasive beetle could have on native forests in North America.

This project provided a snapshot of ALB activity in BCA over the past several years. However, it is important to note that there is no way of knowing what the real impact of ALB would have been on forest trees over time. Because forest conditions are different from urban settings, it is unknown if ALB will be as successful colonizing trees and integrating in native ecosystems as it has been in urban areas.

There were no estimates of attack intensity on trees in BCA, but from ground based surveys little damage was observed on living trees and no dead trees were present with obvious signs of ALB presence. It appears that ALB has dispersed throughout the stand and is currently causing little damage in trees. Attacks do not appear to be concentrated on only a few host trees, instead many trees had small levels of ALB activity on them. However, with no knowledge on how long ALB has been present in the stand it is difficult to place observations from this data into context. If the observations from BCA are typical of how ALB behaves in forested ecosystems, this may be beneficial and allow trees to better defend themselves over time.

Table 2. Basal area, density, and importance values for overstory tree species (stems > 7.5 cm dbh) present in BCA after ALB eradication efforts.

<b>Species</b>	<b>Avg. dbh</b>	<b>Total BA</b>	<b>Density of stems</b>	<b>Relative BA</b>	<b>Relative Density</b>	<b>Importance Value</b>
BO	37.0 ± 2.08	6.92	55	43.6	24.3	34.0
RO	28.6 ± 2.00	4.08	51	25.7	22.6	24.1
PH	20.7 ± 1.47	2.56	59	16.1	26.1	21.1
WO	21.0 ± 1.49	1.47	36	9.3	15.9	12.6
SH	23.6 ± 3.41	0.58	11	3.7	4.9	4.3
Hop hornbeam	11.7 ± 1.52	0.11	9	0.7	4.0	2.3
BT Aspen	31.8 ± 0.00	0.08	1	0.5	0.4	0.5
WP	26.5 ± 0.00	0.06	1	0.4	0.4	0.4
WH	8.4 ± 1.44	0.02	3	0.1	1.3	0.7
TOTAL		15.88	226			
Per Hectare		17.62	251			

## **Acknowledgements**

Many people from the Durham Field Office contributed to this project including Mike Bohne, Bob Cooke, Garret Dubois, Tom Luther, Tom Rawinski, and Dennis Souto.