New York's Battle with the Asian Long-Horned Beetle

By Robert A. Haack, Kenneth R. Law, Victor C. Mastro, H. Sharon Ossenbruggen, and Bernard J. Raimo

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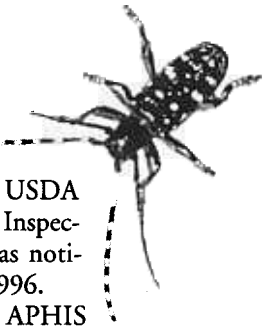
The Brooklyn resident who found the exotic beetles in August 1996 first thought that the holes in the maples on his street were the work of vandals with huge drills.

A wide variety of organisms are unintentionally transported from country to country each year, primarily as a result of world trade. Practically all classes of plants and animals can be stowaways. Aquatic organisms travel in the ballast water of ships; land organisms move with the cargo. Some organisms hitch rides inside the cargo, while others travel on or inside the crating, pallets, or other shipping materials.

Some 4,500 exotic organisms are now established in the United States (US Congress 1993), and of these more than 400 are insects that feed on trees and shrubs (Haack and Byler 1993; Mattson et al. 1994; Liebhold et al. 1995; Niemela and Mattson 1996). Although most tree-feeding exotics cause little apparent damage each year, some have greatly altered major forest ecosystems in the United States: consider the gypsy moth, the smaller European elm bark beetle, the hemlock woolly adelgid, and the beech scale. Some exotic insects reach pest status because they arrive without their normal suite of natural enemies or because their new host plants lack evolved natural defenses.

One of the latest stowaways to enter the United States is the Asian long-horned beetle, *Anoplophora glabripennis,* which was discovered in 1996 (Haack et al. 1996; Haack and Mastro 1997; USDA-FS 1997). On August 19, 1996, a Brooklyn resident notified the New York City Department of Parks and Recreation that all the Norway maple *(Acer platanoides)* trees lining the street in front of his house were riddled with large holes; he also reported seeing several large black-and-white beetles. The next day a New York City forester sent one of the beetles to Cornell University for identification. Additional specimens were soon collected and their identity was confirmed. The USDA Animal and Plant Health Inspection Service (APHIS) was notified in early September 1996.



In mid-September APHIS sent a team to the Greenpoint area in Brooklyn to determine the extent of the infestation. In October APHIS selected a multiagency project management team to survey for and contain the beetle. A science advisory panel, meanwhile, was charged with gathering all scientific knowledge about the beetle, evaluating the consequences of its establishment and potential spread, recommending survey and control methods, and identifying research needs that supported the control program. The USDA Forest Service, at the request of APHIS, conducted a risk assessment of the Asian long-horned beetle (Kucera 1996) and concluded that the overall risk to the United States was high.

Range and Life Cycle

Anoplophora glabripennis is found primarily in China but may occur in other parts of Asia (Peng and Liu 1992). In China it is considered a major pest throughout a wide range—21°N to 43°N latitude (Yan 1985), a band that in North America spans from southern Mexico to the Great Lakes. In Asia the primary host trees of *Anoplophora glabripennis* include species of maple *(Acer),* poplar *(Populus),* and willow *(Salix).* In fact, boxelder *(Acer negundo)* and sugar maple *(Acer saccharum)* are planted as trap trees in parts of China to protect more valuable hardwood trees (Sun et al. 1990; He and Huang 1993). Other occasional host trees in Asia include chinaberry *(Melia),* mulberry *(Morus),* plum *(Prunus),* pear *(Pyrus),* black locust *(Robinia pseudoacacia),* and elm *(Ulmus)* (Qin et al. 1985; Sun et al. 1990; Gao et al. 1993; He

Reprinted from the *Journal of Forestry,* Vol. 95, No. 12, December 1997.

and Huang 1993; Kucera 1996).

In New York the beetle has attacked primarily species of maple, including Norway maple, sugar maple, silver maple *(Acer saccharinum),* sycamore maple *(Acer pseudoplatanus),* and boxelder. Also in New York, this beetle has completed development on one or more species of birch *(Betula),* poplar, willow, horsechestnut *(Aesculus hippocastanum),* and elm.

Adult beetles are capable of flying several hundred meters in a single flight episode and, because they live more than 40 days, can cover considerable distances to find suitable host trees. Newly emerged adults first feed on the bark of twigs and then mate on the trunks and branches. It is possible that adult females produce a sex attractant, or pheromone; however, no pheromones have yet been identified (He and Huang 1993). For egg-laying, the female chews through the bark to the cambial region, then turns and usually lays one egg, 5–7 mm long Most females lay about 25 to 40 eggs in their lifetime. In New York, adult long-horned beetles were seen laying eggs from July to early November.

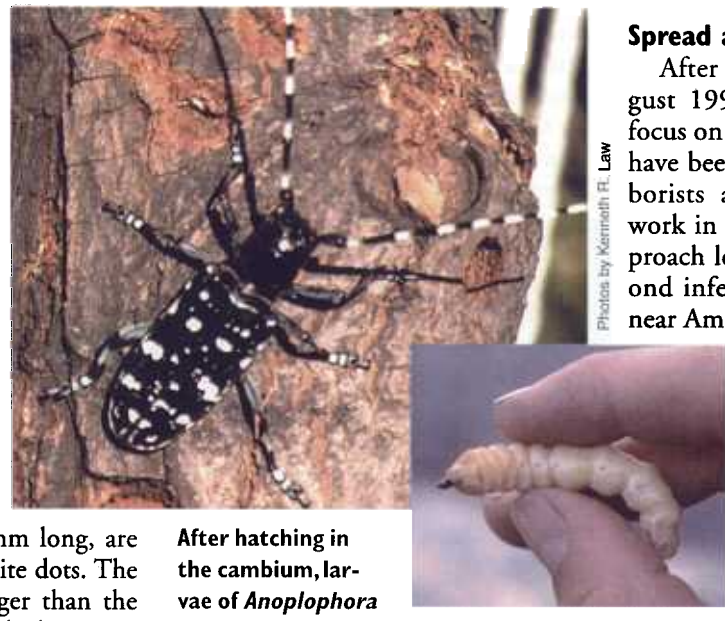
Eggs usually hatch in one to two weeks. The larvae first feed in the cambial region and later enter the wood, tunneling upward for 10 to 30 cm through both sapwood and heartwood. Full-grown larvae reach 50 mm in length. The larvae transform to pupae and then to adults inside the larval galleries, usually in summer. The new adults exit through 6- to 18-mm holes that they chew through the bark. Adults, 20 to 35 mm long, are shiny coal black, with white dots. The antennae, which are longer than the body, are banded black and white.

The Asian long-horned beetle attacks healthy trees, stressed trees, and recently cut logs (Peng and Liu 1992; Gao et al. 1993; He and Huang 1993). Both young and old trees are attacked.

Figure 1. **Brooklyn and Amityville, sites of the original *Anoplophora glabripennis* infestations on Long Island, New York. Because of its limited distribution but high potential threat to North American hardwood forests, state and federal officials imposed a quarantine on the infested areas in 1996 and initiated an aggressive eradication program in 1997.**

In New York everything from newly planted street trees to trees larger than 1.8 meters in diameter were infested *(table 1).* Adults typically lay eggs first in the upper trunk and along major branches where the bark tends to be smooth. Small branches, 3 to 4 cm in diameter, can be attacked. As the tree crown begins to die, adults lay eggs along the entire trunk and even on exposed roots.

Although adult beetles can cause twig mortality during their maturation feeding, larvae cause most of the damage as they tunnel through branches and boles. Individual branches or entire trees can die if larval densities are high or if infestation continues for several years. Before a tree dies, however, heavily mined branches and stems commonly break, especially during strong winds (Qin et al. 1985; Yan 1985; Gao et al. 1993; Haack and Mastro 1997). Larval feeding tunnels also reduce the quality of lumber, veneer, and wood fiber. In North America, the Asian long-horned beetle's preference for maple trees was considered a real threat to the Northeast's maple sugar industry, lumber industry, homeowner property values, and tourism (Kucera 1996).



Photos by Kenneth R. Law

After hatching in the cambium, larvae of *Anoplophora glabripennis* chew their way into the sapwood and heartwood, tunneling as much as 30 cm before pupating and exiting as adults. If it doesn't kill the tree outright, such damage exposes large limbs to breakage.

Spread and Containment

After the initial discovery in August 1996, survey teams began to focus on areas where the beetle could have been moved accidentally by arborists and firewood dealers who work in the Brooklyn area. This approach led to the discovery of a second infestation in September 1996 near Amityville, New York, about 50 km east *(fig. 1).* The Brooklyn beetles probably came from Asia on infested wooden packing materials entering sometime in the 1980s or early 1990s. In contrast, the Amityville infestation may have originated in the transport of infested tree sections from Brooklyn to Amityville for final disposal or sale as firewood. As of October 31, 1997, a total of 1,559 infested trees had been detected: 963 trees in Brooklyn and

596 in Amityville, more than 80 percent of them maples.

Since September 1996, city, state, and federal inspectors have been conducting street-by-street surveys for the Asian long-horned beetle, looking for characteristic beetle damage—exit holes, oviposition pits and associated bark staining, and extruded frass. In Brooklyn alone an estimated 500,000 trees grow along streets and in parks, and an additional 100,000 are in private yards (Kucera 1996). More than one third of these trees are potential hosts of *Anoplophora glabripennis.* In December 1996, New York State quarantined the two infested areas of Long Island, restricting the movement of potential host material, including firewood. A similar federal quarantine was imposed by APHIS in March 1997.

Because of the potential long-term ecological and economic damage, the science advisory panel recommended that the infestations be eradicated. The panel also concluded that the only practical way to eradicate the beetle was to locate, cut, and chip all infested trees. Other control options were considered, including systemic insecticides. However, because of the lengthy egg-laying period, the larval feeding habits deep within the tree, and lack of any significant biological control agents, tree removal was chosen as the best strategy. Tree removal began in February 1997, and as of late October 1997, 1,450 infested trees had been cut, chipped, and burned.

Public Outcry and Support

Before starting the eradication program, however, it was necessary to obtain the support of local officials, environmental groups, and private citizens. Members of the project management team met with the local community board, city officials, and residents. Questions raised during these discussions were referred to the science advisory panel. New York State officials also received numerous phone calls from officials in neighboring states as well as professional associations representing maple syrup, lumber, and tourism interests. The need for quick action was made more urgent when windstorms caused many infested branches to break and fall.

Local residents and community leaders had to be assured that tree removal would be followed by tree replacement. Educational efforts helped garner support for the eradication and replanting programs. The Asian long-horned beetle was covered by local television, radio, and newspapers. Public meetings were held to inform local residents about the problem, listen to their concerns, and discuss control options. Because of the ethnic diversity of the infested areas, information was published in English, Italian, Polish, Russian, and Spanish. Workshops for local teachers were held, and the teachers in turn held discussions with students.

Once the eradication effort was approved, tree removal contracts had to be awarded. The agreed-on payment schedule stipulated uniform prices for each 6-inch-diameter class for trees up to 4 feet dbh, above which the cost was negotiated on an individual tree basis. The set payment covered the costs of tree felling, stump grinding, chipping, cleanup, and burning.

Overall, the tree removal went smoothly, in large part because of the well-coordinated efforts of several city, state, and federal agencies. Aerial photos revealed many trees growing in enclosed courtyards in Brooklyn, and homeowners had to be persuaded to allow tree removal crews to enter their homes not only to cut the trees but also to carry out the cut branches and trunks. Community cooperation was generally excellent, though problems with absentee homeowners and liability concerns had to be addressed.

Restoration Activities

Coordination of all the restoration activities continues to be challenging. Federal, state, and community officials are involved, as well as civic and environmental groups and individual private citizens. A community committee was established in Brooklyn to plan restoration activities, to involve "greening" partners, and to educate the public. Handouts describing the beetle, tree care, and urban forestry were developed in several languages. Several educational activities were conducted in Brooklyn, including establishing an informational display at the local library and holding a contest for schoolchildren to enter letters, poems, and pictures that illustrated their concern for the lost trees.

At a more regional level, dozens of presentations were made and thousands of beetle fact sheets (USDA-FS 1997) were distributed to professionals throughout the Northeast, including arborists, landscapers, nursery managers, foresters, garden clubs, and extension specialists. In addition, several

Table 1. Size class distribution of the first 1,410 infested trees to be cut in Amityville and Brooklyn, New York, by 6-inch-diameter increments, with the total number of trees cut in each diameter class. The long-horned beetle attacks trees in all size classes.

dbh	Amityville	Brooklyn	Total trees
0–6″	290	231	521
6–12	104	250	354
12–18	60	178	238
18–24	46	117	163
24–30	24	40	64
30–36	25	16	41
36–42	8	2	10
42–48	7	1	8
48–54	5	—	5
54–60	4	—	4
>60	2	—	2
Totals	575	835	1,410

Replanting the Urban Forest

I grew up in the woods of Wisconsin, 20 miles from a town of 1,500 people, and urban forestry did not come naturally to me. Where I come from, we had two career choices: we could brave the mosquitoes, gnats, and no-see-ums and work as loggers, or we could become fishing guides. I chose the latter.

So I remember very clearly when I first truly understood the importance of urban forests to people. I was visiting Greenpoint, New York, whose urban forest had been devastated by an outbreak of the Asian long-horned beetle. I was there to explain that even though we were going to remove many of the trees that lined the streets and shaded the yards, the Forest Service was committed to regreening Greenpoint. After a community meeting, an elderly woman took my arm and walked me outside. She pointed down the street, where trees were scheduled for removal, and with tears explained, "This is my street. I appreciate your help, but how can you possibly replace the tree I planted the day I learned my son was killed in Vietnam?"

William Fragment, USDA Forest Service

This infrared aerial photograph of McCarren Park in the Greenpoint section of Brooklyn was taken in September 1996, before more than 120 infested trees were removed from the park.

So today, when people ask me why as chief of the Forest Service I emphasize the importance of urban forest stewardship, I tell them about Greenpoint.

For most Americans, *urban* conservation and stewardship *are* conservation and stewardship. Eighty percent of Americans live in towns and cities. These people are a critical support base for conservation in America, and they very clearly understand how human impacts on the land affect environmental services, such as clean air and water and quality of life. The fact that so many Americans are living in such concentration has caused erosion and sedimentation problems, polluted runoff and flooding, loss of open space and wetlands, loss of fish and wildlife habitats, and elevated air temperatures in developed areas. Equally important, increased urbanization disconnects people from the land that sustains them, with profound social, economic, and ecological effects.

These are complicated issues, but quite often their answer can be as simple as planting a tree. As I learned at Greenpoint, trees not only yield environmental and social benefits, they also affirm our optimism for the future. The Forest Service *must* be a leader in promoting urban forestry and conservation.

From Mike Dombeck's remarks to the Eighth Urban Forestry Conference, Atlanta, September 18, 1997. Mike Dombeck (e-mail: dombeckmike/wo@fs.fed.us) is chief, USDA Forest Service, PO Box 96090, Washington, DC 20090-6090.

Internet Web sites were created to provide up-to-date information.

Replanting the affected areas began in spring 1997, using tree species that are not known hosts of the Asian long-horned beetle: London plane tree *(Platanus acerifolia),* honeylocust *(Gleditsia triacanthos),* sweetgum *(Liquidambar styraciflua),* tuliptree *(Liriodendron tulipifera),* oak *(Quercus),* linden *(Tilia),* and dawn redwood *(Metasequoia glyptostroboides).* In Brooklyn the community committee, with input from the City of New York and the USDA Forest Service, developed a restoration plan that guides the regreening efforts for the next three years. Updated planting specifications will be used to enhance tree survival. Several residents received special training in tree care, and they will help maintain the newly planted trees. In addition, a street tree survey is being conducted by volunteers in Brooklyn, and all planting efforts will be recorded using a geographic information system.

The eradication program, encompassing both tree removal and restoration, was paid for with public funds. APHIS, New York State, and New York City have paid more than $800,000 toward tree removal costs. In addition, more than $2,800,000 was pledged by the USDA Forest Service, New York State, and New York City for tree restoration and educational activities.

The Outlook

Intensive surveys are planned for five years after the last infested tree is found in the Amityville and Brooklyn areas. In addition, in 1997 and 1998 systematic but less intensive surveys will be conducted throughout Long Island, Manhattan Island, and surrounding portions of New York State, Connecticut, and New Jersey. If researchers isolate a pheromone for *Anoplophora glabripennis,* that compound will be added to traps and used in New York for delimiting surveys and as a check on the eradication program. Such pheromone traps would also be used throughout the United States at ports of entry and at other locations where infested cargo may unintentionally be shipped.

During the first round of tree surveys, which ended in early June 1997, inspectors located 1,215 infested trees. From June through October 1997, another 344 infested trees were found. Undoubtedly, more infested trees will be identified, especially those that are only lightly infested. Nevertheless, given the intensive surveys now planned for the next several years, the eradication program may someday soon be complete.

Although the Asian long-horned bee-

tle infestation in New York appears under control, there remains a real threat that this beetle could enter elsewhere in the country. Before August 1996 there were only two other reported interceptions of *Anoplophora glabripennis* in North America: one on crating in Loudenville, Ohio, in 1992, and one on dunnage (wood braces) in Vancouver, British Columbia, in 1992. In both cases the infested wood was associated with products from China. Surveys at these two interception sites in 1996 and 1997 found no evidence that the Asian long-horned beetle was established.

In the year since the discovery of *Anoplophora glabripennis* in August 1996, five additional interceptions have been made at US ports. Three shipments arrived in California, one in Washington State, and one in South Carolina; all five were from China, one involving infested crating and four involving infested pallets. The infested crating, which arrived in California in May 1997, was not recognized as infested until June. By then, portions of the original shipment had been sent to Colorado, Illinois, Michigan, Missouri, New Jersey, New Mexico, Pennsylvania, and Wisconsin. State and federal plant health officers tracked down each shipment and have attempted to find, inspect, and destroy all the crating material.

The expansion of world trade is dramatically escalating the risk of introducing new exotic pests. At US ports of entry from 1985 through 1996, APHIS intercepted insects on various wood products on nearly 5,900 occasions. Most of these interceptions were associated with crating (49 percent), dunnage (36 percent), and pallets (6 percent). Since 1985, there has been a steady increase in the number of insect interceptions on wood products from China at US ports, likely reflecting the growing volume of Chinese imports *(table 2)*. The volume of commodities imported annually from China with associated wood crating or pallets is estimated to be in the millions of shipments.

Because of the many exotic pests associated with unprocessed wood packing materials used in international trade, such material should perhaps be prohibited or at least be chemically treated, kiln dried, or somehow processed to render it unsuitable for insects. Introductions of new pests are likely to continue until the movement of unprocessed wood is dramatically reduced.

If exotic pests are detected relatively early, aggressive eradication programs can prevent large-scale infestations. Only through rigorous inspections, regulations, surveys, and management can the risk these exotics pose be minimized. If we are not prepared to expend the effort to safeguard our economy and ecosystems, North America will be poorer in terms of resources and biological diversity. Short-term savings gained by allowing unprocessed wood in the form of packing and dunnage to enter North America will in the long term cost significantly more for control and restoration. JOF

Table 2. Growth of US imports and insect interceptions on wood products from China.

	Percent of total US imports from China	Percent of total insect interceptions
1985	1.1%	1.2%
1986	1.3	1.2
1987	1.6	0.7
1988	1.9	1.5
1989	2.5	0.6
1990	3.1	1.2
1991	3.9	0.6
1992	4.8	4.4
1993	5.4	7.3
1994	5.8	8.3
1995	6.1	11.2
1996	6.4	21.2

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JOURNAL OF
FORESTRY
December 1997 Volume 95, Number 12

COVER

Yellow-cedar, normally a long-lived species, is dying in all age classes throughout much of southeast Alaska. If inability to adapt to climate change is the root cause, then yellow-cedar decline may be an excellent example of the devastating effect of a moderate climate shift on a forest ecosystem.