A Cost/Benefit Analysis of the Ash Whitefly Biological Control Program in California

by

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Previous research has shown that healthy street trees significantly contribute to the aesthetic beauty of our urban areas. Not surprisingly, people will demand pest control to protect the aesthetic beauty of street trees with levels of defoliation as small as 5%. Therefore, the preservation of a tree's aesthetic beauty by controlling pest infestations can result in substantial benefits to the community. In addition, healthy trees contribute significantly to property values, whereas defoliated trees cause property values to decrease.

The ash whitefly, *Siphoninus phillyreae*, was first identified in Los Angeles County during the summer of 1988. By 1990, it had spread throughout much of California and caused severe defoliation to its primary hosts, ash (*Fraxinus species*) and ornamental pear (*Pyrus species*) trees. Feeding by whitefly nymphs and adults resulted in chlorosis, or yellowing, of leaves. Also, a honeydew excreted by the whitefly caused sooty black mold to form on the leaves. The chlorosis and sooty black mold together led to substantial defoliation of the host trees although in general, the infestation had not led to tree mortality. Chemical insecticides were not a cost effective control of this pest because the whitefly multiplies rapidly during warm summer months.

During 1989 scientists with the California Department of Food and Agriculture (CDFA) and researchers at the University of California, Riverside (UCR) obtained a small stingless parasitic wasp, *Encarsia inaron (= partenopea)* from researchers in Israel and Italy. The wasp was reared in CDFA and UCR greenhouses and released throughout neighborhoods in California starting in 1990. Two years after the parasite was released, ash whitefly densities were reduced to numbers difficult to detect even with rigorous monitoring efforts. Since 1992, no further releases of the parasitic wasp have been made and ash whitefly populations remain at undetectable levels. The control of the ash whitefly resulted in the preservation of the aesthetic beauty of ash and ornamental pear trees in urban landscapes. This article estimates the economic benefits and costs of preserving the aesthetic beauty of urban street trees from the ash whitefly biological control program.

Photo courtesy of UC Statewide IPM Project

Ash Whitefly (Siphoninus phillyreae)
adult and nymphs, feeding on leaf surface.

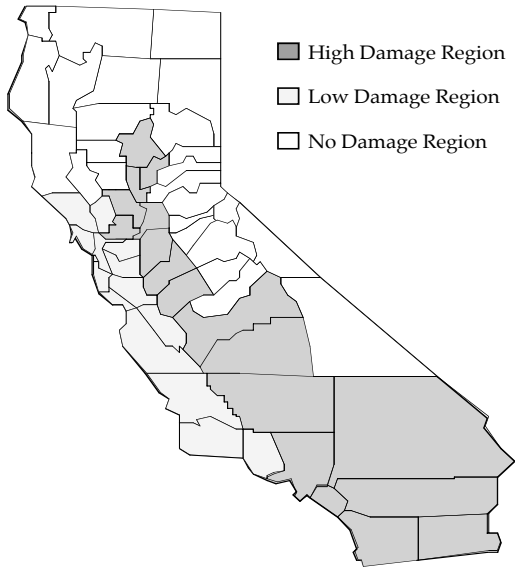
The Program

The primary benefit from the ash whitefly biological control program was in the preservation of the aesthetic beauty of the urban forest. The estimation of the tree's appraised value was based on the Trunk Formula Method, a widely used tree appraisal technique, developed by the Council of Landscape and Tree Appraisers, used when appraising landscape trees too large to be replaced with nursery stock. The formula calculates the value per square inch of the cross-section of the largest available transplantable tree at a height of one foot, and then multiplies this value times the trunk area of the tree being appraised. This maximum value was then adjusted by factors for the tree species, location within the landscape (street, yard, park, etc.) and the condition of the tree. For this analysis, the only difference between the appraised values of damaged and undamaged trees of the same species was the condition factor. Pear trees have a much smaller cross-section area than ash trees and a higher species factor. The average benefit per host tree was equal to its change in appraised value (CAV) due to ash whitefly damage.

This change was equal to the difference in the hosts' average appraised value as a healthy tree less the average appraised value after ash whitefly defoliation. This benefit was calculated as a onetime change at the

WHITEFLY—*continued on pages 6 and 7*

Whitefly*—continued from page 5*



level of defoliation that occurred when the ash whitefly populations were at their greatest.

The extent of urban tree damage caused by ash whitefly infestations varied geographically. Consequently, the state was divided into three regions for the analysis: high damage, low damage and no damage (see map on following page). The high damage region included counties in California with relatively cool winters and hot summers.

Defoliation of ash and ornamental pear trees in the high damage region reached 70% - 90% during peak infestations. Counties in the low damage region had lower temperature variations, with milder winters and cooler summers than in the high damage region. The ash whitefly caused 40-50% defoliation of susceptible trees in this region. The remaining counties in California had climates too cold to support the ash whitefly and consequently suffered no damage. The total benefits were equal to the average benefit per host tree, times the number of host trees in both the high and low damage regions.

The change in aesthetic values (CAV) is:

$$CAV_{ijp} = \text{Appraised Value without defoliation} - \text{Appraised Value with defoliation}$$

where:

i is equal to the geographical region
j is equal to ash or ornamental pear tree
p is equal to the wholesale price or retail price of the respective replacement tree.

Benefits were calculated at both wholesale and retail prices because cities could pay either price depending on the number of trees purchased and source of the trees. The wholesale cost represents a lower bound to the estimated benefits and the retail costs are an upper bound.

Results

The costs of the ash whitefly biological control program were provided by CDFA and UCR. The costs included salaries of employees hired for the ash whitefly project as well as costs for permanent employees of both institutions who worked on the project, travel expenses to collect and import the parasitic wasp, materials to rear the wasp in greenhouses, and travel expenses to release the wasp at selected sites and monitor its spread (Table 1).

The appraised value of an ash tree with no ash whitefly damage was between $1,279 dollars at wholesale prices and $1,607 at retail prices, and $922 and $1,238, respectively, for an ornamental pear.

In the high damage region, the appraised value of an ash tree decreased by $261 at wholesale prices and $328 at retail prices due to ash whitefly defoliation. The appraised value of pear trees decreased by about $75 less than for ash trees, due to the lower base value of the pear trees. As expected, in the low damage region the decrease in the appraised value of the susceptible hosts was much lower than in the high damage region.

The change in appraised value per tree per region was multiplied by the number of trees to estimate the total benefits of the ash whitefly biological control program. The total benefits from the biological control program from preserving the aesthetic value of street trees were between $255 million at wholesale and $320 million at retail prices for ash trees, and between $50 million and $66 million for ornamental pear trees in the high damage region (Table 2). In the low damage region, the total benefits ranged from $13 million to

Table 1: Ash Whitefly Biological Control Program Costs

Item	Costs ($)
Salary	772,492
Collection/Importation of Parasite	4,000
Rearing and Monitoring Costs	457,850
Total Costs	**1,224,352**

Table 2: Summary of Benefits

		Average CAV per Tree ($)		Total Benefits in Dollars [a]	
	No. of Trees	Wholesale	Retail	Wholesale	Retail
High Damage Region					
Ash Trees	974,848	261	328	254,541,345	319,994,833
Pear Trees	262,894	188	253	49,511,617	66,487,029
Total Trees	1,237,742	246	312	304,052,962	386,481,862
Low Damage Region					
Ash Trees	101,914	126	158	12,846,573	16,149,978
Pear Trees	79,987	91	122	7,272,353	9,765,732
Total Trees	181,901	111	142	20,118,926	25,915,709
Total Regions					
Ash Trees	1,076,762	248	312	267,387,918	336,144,811
Pear Trees	342,881	166	222	56,783,971	76,252,760
Total Trees	1,419,643	228	290	324,171,888	412,397,571

[a] *Sum of regions may not equal total due to rounding.*

$16 million for ash trees and $7 million to $10 million for ornamental pear trees.

As stated earlier, these benefits represented a one-time change in the aesthetic beauty of the host trees that was achieved when the ash whitefly populations were at their greatest in early fall. Defoliation levels might have been lower during earlier parts of the year. Also, this did not reflect that over time the defoliation could have led to tree death and the need to remove and replant new trees. If the long-term effects were also included, the estimated benefits would have been greater.

The direct costs of the ash whitefly biological control program totaled $1,224,324. The net benefits (total benefits less total costs) were thus $322,947,536 at wholesale values and $411,173,219 at retail values. The rate of return for each dollar spent to import, rear, release and monitor the parasitic wasp was between $265 and $337. If the overhead costs of the biological control program and the long-term research costs were also included, total costs would be higher and the rate of return would be lower.

Photo courtesy of UC Statewide IPM Project

*Wasp parasite (*Encarsia inaron = partenopea*)*

Conclusions

Successful introduction of a natural enemy, *Encarsia inaron (= partenopea)*, resulted in permanent control of the ash whitefly and protection of the aesthetic beauty of urban trees. The economic benefits from avoiding aesthetic damage to ash and ornamental pear trees planted as street trees in urban areas of California were between $323 million and $411 million. The respective benefit to cost ratios were 265:1 and 337:1. It should be emphasized that these benefits are for street trees only. Due to data limitations, aesthetic benefits for trees on other public areas (golf courses, parks, freeways, etc.) and private property were not included. Consequently, the economic benefits presented here may be regarded as minimum values that would increase with inclusion of additional trees.

This analysis demonstrated that significant economic benefits can be realized from successful biological control programs aimed at preserving the aesthetic beauty of the urban forest. Perhaps more important, the ash whitefly biological pest control program is permanently preserving the aesthetic beauty of these valuable host trees.

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