THE ECONOMICS OF PIERCE'S DISEASE IN CALIFORNIA

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ABSTRACT
The first goal of this research project is to estimate the medium to long-run economic impact to growers and consumers of California's grape and orange industries, and to taxpayers from the establishment of the glassy-winged sharpshooter (GWSS) in California. The public control program to date has managed to contain the GWSS in the southern part of the State. As part of the public program citrus growers are reimbursed their expenses for winter control of GWSS and a quarantine that regulates the movement of fresh citrus, fresh grapes, and nursery host crops to areas currently free of GWSS. In the southern San Joaquin County due to effective winter GWSS control in citrus, the cost for grape growers to treat GWSS using one soil application of imidacloprid a year ($50-$60 per acre) is offset by reductions in the use of other insecticides such as the foliar applications of imidacloprid and treatments for pests such as the grapeleaf skeletonizer. In the Temecula Valley; however, GWSS becomes active earlier, orchards and vineyards are generally smaller, and the orange/grape land interface is more complex causing growers in this area to incur additional costs. In addition to a soil application of imidacloprid, vineyards in the Temecula valley may also need an additional irrigation at $12.50 an acre at the time of the imidacloprid application, plus two additional spray treatments with Danitol at $35.50 an acre. Total costs for GWSS control in the Temecula Valley is $98 to $108 an acre. About $50-$60 of that cost is also offset by reductions in the use of insecticides needed to treat pests that are now controlled with the soil application of imidacloprid. The net increase in costs is about $48 an acre per year. The average number of acres cultivated in grapes from 2005 to 2007 in the Temecula Valley is about 200, making the total estimated annual losses to growers in the Temecula Valley about $9,600 a year. These losses could increase substantially if the public control program were discontinued as winter GWSS treatment in citrus would cease and, without a quarantine, GWSS would spread. Costs for grape growers would increase throughout grape growing regions due to higher control costs where GWSS is currently established, and the need to implement control measures in areas currently free of GWSS.

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INTRODUCTION
The establishment of newly introduced pests in California has resulted in significant costs to growers and consumers in California, and to consumers in the rest of the U.S. Infestations of the ash whitefly (*Siphonius phillyreae* (Haliday)) in the late 1980s and early 1990s caused aesthetic damages to ash and ornamental pear trees estimated between $324 million and $412 million before a biological control agent brought the infestation under control (Pickett et al., 2003). Losses to consumers and producers due to the establishment of the avocado thrips (*Scirtothrips perseae*) were estimated at $4.45 million a year (Hoddle et al., 2003). Losses from the establishment and potential spread of the red imported fire ant, first identified in California in 1997, were estimated to be about $900 million a year (Jetter et al., 2002). Should a newly introduced pest into California, the *Diaprepes* root weevil, become established throughout the state, the losses to consumers and producers of citrus and nursery crops from pest treatments and quarantines are estimated to be $100 million a year (Jetter 2007).

In 1989 a pest new to California, the glassy-winged sharpshooter (GWSS), was collected in Irvine, CA. Since then it has spread throughout southern California, into the southern San Joaquin Valley including Kern County and parts of southern Tulare County, and along the coastal counties of Santa Barbara and San Luis Obispo. Detections, mainly of egg masses on nursery shipments, have been found in many counties throughout the Central Valley as far north as Tehama County, in the Napa Valley, and in the Bay Area counties (CDFA 2007; http://max.cdfa.ca.gov/pdcp-gis/pdcp-gis.asp). The main hosts for the GWSS are citrus, grapes, almonds and alfalfa. The GWSS overwinters in citrus, avocados, in riparian vegetation and some ornamentals such as crape myrtle. As grape vines and almond trees leaf out in the springtime, the GWSS moves onto those hosts.

Governmental agencies have been involved in two control programs to manage and contain the GWSS. One program involves the control of the GWSS on citrus before it can move into vineyards and transmit the Pierce's disease (PD) bacterium. This program overcomes the divide created between the citrus growers who are not typically affected by GWSS and would not typically treat for GWSS, and grape growers who are negatively affected by large populations of GWSS migrating from citrus to grapes. Currently any citrus grove within ¼ mile of a trapped vine (i.e. a trap placed in a vineyard contains a GWSS) is treated, unless the grove is located along the northern boundary of the infestation, in which case the barrier is ½ mile of a trapped vine. While some citrus growers may benefit from the control of the GWSS in their groves, chemical treatments may also disrupt IPM pest control practices, imposing additional costs on the citrus industry. All these effects are important to include in any economic analysis of PD in California.

Finally, there is a state quarantine in place to limit the spread of the GWSS into uninfested grape growing areas of California. The quarantine consists of on-site sanitation practices, inspections and surveys, and spraying plant leaves with a chemical such a methomyl (Lannate®) to treat difficult to detect egg masses not caught by inspectors. As a result, management of PD in California includes a bundle of methods that have economic impacts on the wine, table and raisin grape, citrus, and nurseries industries. These different methods to control GWSS and PD have significantly improved the situation, and damages today are not as severe as initially anticipated. Even though better methods have been developed to manage GWSS, the costs of production for each industry may not have returned to pre-GWSS infestation levels.

Due to the size of the industries affected by the control of GWSS and PD in California, even small changes in the costs of production can have a major impact on the benefits and costs to producers, consumers and taxpayers. The grape industry is a major agricultural producer in California. With average annual revenues (2004-2006) to the wine, table and raisin grape industries totaling $3 billion, grape production is the largest fruit industry in California (USDA 2006a). When revenues from the citrus and nursery industries are combined with the revenues from the grape industry, their total revenues of $20.8 billion make it the second largest agricultural sector in the U.S. behind corn ($26.8 billion) and before soybeans ($18.3 billion) (USDA 2006a; USDA 2006b; Jetter 2007).

OBJECTIVES

The first objective of this study is to estimate the costs and benefits to wine grape, table grape and raisin growers, consumers and taxpayers from changes in the costs of grape production due to the establishment of the GWSS. The changes in production costs will be based on current best practices and will include chemical treatments, removal of infested vines, quarantine restrictions and public control programs. The increase costs of production affect newly infested producers directly because they bear the burden of paying the increased costs of production; however, consumers and producers are also affected through the market effects due the changes in the costs of production.

The remaining objectives are to address the following: 1) estimate the benefits and costs of the public program, and 2) to use those results to estimate check-off rates to the different industries that are protected by the public program. To determine the benefit of the public program the industry costs with respect to GWSS management need to be determine. A two-step process is currently being done to obtain these data and includes 1) a survey of growers to determine the economic impacts before Admire was recommended to treat GWSS and 2) using that information to discuss control alternatives for grape growers that would be most likely now. Surveys of grape, orange, and nursery producers are currently being developed.

Objective 1 will be completed through the use of economic market models. Market models are used to estimate the losses to both producers and consumers when changes in the costs to grow and market a crop are significant enough to affect market prices, production and supply. These effects can be shown graphically. **Figure 1** presents the market effects of the increased incidence of PD due to the establishment of the GWSS on the market for grapes (here defined as wine, table and raisin grapes) and the development of effective GWSS control methods. The market contains suppliers, who are willing to supply grapes and initially represented by supply curve S*. The supply curve is upward sloping because as prices increase growers will grow more grapes and supply more grapes to the market. The market also contains consumers who purchase grapes and are represented by the demand curve D. The curve is downward sloping because as prices decrease, consumers will want more grapes. The market is in equilibrium at point d. At point d, price is equal to P* and the quantity demanded by consumers, Q*, is exactly equal to the quantity supplied by producers.

At the initial equilibrium point there are some consumers who are willing to pay more than P* and some producers who could offer their products at a market price less than P* and still make a profit. The consumers who are willing to pay more may have more income than other consumers, or just a greater preference for grapes and grape products. The maximum amount that each consumer would be willing to pay for grapes is represented by the demand curve. The difference between what consumers are willing to pay and the actual price that they do pay is called consumer welfare. In **Figure 1**, consumer welfare is equal to area P*gd.

The producers who could profitably accept less than the market price are producing grapes at a lower cost than other producers. The minimum amount at which each producer would supply grapes to the market is represented by the supply curve. The difference between the price at which producers would offer their goods to market and the actual price they receive is called producer welfare. In **Figure 1**, producer welfare is equal to area P*ad.

The establishment of the GWSS in select counties in California initially causes the supply curve to shift up from S* to S'. For supply curve S' the new equilibrium point is f. At point f, the equilibrium price is P', and the equilibrium quantity is Q'. For example, this shift could represent the losses in the Temecula Valley as PD spread with the GWSS and diseased vines were removed. Over time, management of the GWSS improves and losses decrease. This causes the supply curve to shift from S' to S''. Thus, supply curve S'' represents the current situation with respect to the management of GWSS and PD. For supply curve S'', the new equilibrium point is e, price is P'' and market supply is Q''. For example, over time growers in the Temecula Valley learned that treating a vineyard with the Admire® formulation of imidacloprid can effectively reduce GWSS populations and the incidence of PD. While vineyards can now be replanted, the cost to produce grapes has increased above the pre-GWSS environment because growers must now incur the additional expense of applying Admire®.

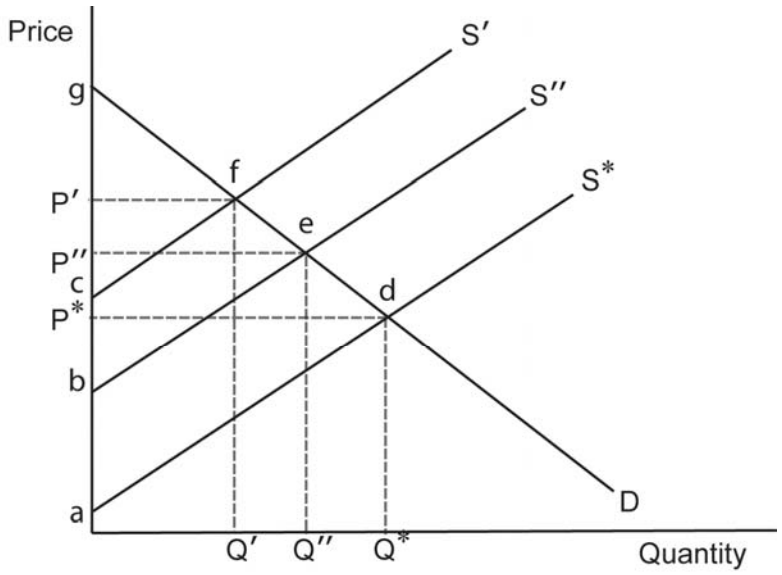

Figure 1. Market effects for grapes produced in GWSS infested counties.

For Objective 1, the losses to the different grape industries in California will be estimated assuming a shift in the supply curve from S to S''. The estimated losses to consumers and producers will be equal to area beda. For Objectives 2 and 3, the initial market equilibrium will reflect the current situation and practices in California. In **Figure 1**, this is at point e, where the demand curve, D, and supply curve, S'', intersect. It is assumed that should the public management of GWSS be discontinued, the supply curve would shift upward again. As an example, assume that the supply curve S'' shifts back up to S' if the public programs are discontinued. The estimated losses to producers and consumers would then be equal to area cfeb.

The graphical analysis above illustrates the situation in which all grape production in a specific region is affected. Within that region all growers are worse off due to higher costs, but losses to some degree are minimized through higher market prices. Consumers are worse off due to higher prices, and lower consumption. With regard to the case of PD in California, growers located in regions free of the GWSS, and growers in other states where the GWSS is native, will be better off due to

the establishment and spread of GWSS in select counties of California. Growers without GWSS receive higher prices, but do not incur higher management costs due to control of GWSS. Additional costs accrue to taxpayers who bear the costs of the public management programs. An economic analysis needs to include all these effects. Due to the relative newness of the establishment of the GWSS, the scenarios estimated will include a sensitivity analysis that reflects the best estimates of the range of possible effects by scientists researching and managing the GWSS.

RESULTS

Changes in treatment costs due to the establishment of the GWSS and the public control program.

For Objective 1 data are needed on the changes in the costs of production for affected growers due to the establishment of the GWSS in California. For Objective 1 data are also needed on grape, citrus and nursery production, prices, revenues and trade data from 1998 through 2007 (the last year for which data are available); current costs of production; and elasticities (elasticities measure the percentage change in a quantity variable for a one percent change in a price variable – for example it could measure the percentage change in production for a one percent change in the farm price.)

How the GWSS affects current production was determined through meetings held with UCCE farm advisors and growers to discuss how the establishment of the GWSS affected their pest control programs for grapes. The meetings were held in November and December 2008 in the southern San Joaquin Valley in November and December 2008. The results of these meetings were compared to University of California Cooperative Extension Budgets to determine how all pest control treatments changed as a result of the treatments required for GWSS (Hashim-Buckley 2007; Peacock et al. 2007; Peacock et al. 2007b; Vasquez et al. 2007). Production and price data for grapes were collected from the National Agricultural Statistics Service.

Economic Effects in the Southern San Joaquin Valley

A meeting was held with grape growers, and public agencies involved with the public control program to determine how the establishment of GWSS has affected different groups in this area. Three groups are affected by control of the GWSS in the southern San Joaquin Valley, grape growers, citrus growers and taxpayers. While there is currently a low incidence of PD in Kern and Fresno counties, the incidence can rapidly increase should GWSS not be controlled.

The first line of defense against the spread of PD by the GWSS is the public control program whereby citrus is treated during the winter months to prevent the build up of GWSS populations. To control for GWSS in citrus an application of Assail is made in the fall followed by an application of imidacloprid in the spring. Imidacloprid is applied at a rate of 32 fl oz an acre (2 lb ai/gal formulation) through the irrigation system. The control program is conducted on an area-wide basis to achieve longer-term reductions in GWSS populations. The control in citrus occurs about once every three years based on monitoring of GWSS populations. Under the public program citrus growers are reimbursed for their treatments of GWSS and participation in the public program is currently voluntary for the citrus grower.

The second line of defense against the spread of PD is to treat grape vines for GWSS. A majority of grape growers apply imidacloprid once annually to control GWSS and prevent the transmission of PD. Applications of Admire Pro are typically at the maximum rate of 14 fl oz an acre (4.6 lb ai/gal formulation) through the irrigation system. The cost of applying Admire Pro is currently about $50-$60 an acre. The patent for Admire expired in 2005. As a result the initial cost to control the GWSS was higher. Growers from the southern San Joaquin Valley will provide the costs for earlier treatments with Admire.

The treatments with imidacloprid also provide some cost savings as the GWSS also controls the variegated grape leafhopper, grape skeletonizer, and is a suppressant of the grape vine mealybug. The cost savings by growers is $62 an acre based on UCCE budgets, or about the same amount as the current costs to apply Admire Pro. No quarantine costs are incurred by grape growers, as mature fruit destined for the fresh market is hand harvested and field packed.

Total costs of production for citrus growers are also affected by the public control program and quarantines against moving citrus out of infested areas. Treatments with imidacloprid may help suppress nematodes, citrus peelminer and California red scale. Better control of these insects can be achieved by applying an additional amount of imidacloprid when treating for GWSS; however, the grower is responsible for those costs. The citrus industry is affected by the interior quarantine and fruit from infested areas needs to be inspected and treated before leaving a quarantine area. Quarantine treatments involve fumigation using EverGreen (pyrethrum + piperonyl butoxide). Turbocide has also been mentioned as a material that can be used as a fumigant. If GWSS are found in a grower's orange shipments, the grower bears the cost of treating for GWSS in his or her grove if the grower did not participate in the area wide program. This aspect of the public control program is believed to encourage greater participation by citrus growers in the control of GWSS.

Economic Effects in the Temecula Valley

In the Temecula Valley there is also a public program to control GWSS. In contrast to the program in the southern San Joaquin Valley, individual groves are treated following identification of an outbreak. Area wide coordination of treatments has been more difficult in the Temecula Valley. Many groves are being carved up into rural homesteads and cultural

procedures are completed by farm management companies instead of a grower/owner. With a lower proportion of groves being treated in the Temecula Valley than in the southern San Joaquin Valley, GWSS pest pressure in greater in the Temecula Valley.

Private treatment of GWSS in the Temecula Valley also consists of an annual treatment of Admire. However, because there is greater GWSS pest pressure, higher costs of production for grape growers in the Temecula Valley are being realized as the application of Admire is being supplemented with annual sprays of Danitol in some areas. For vineyards located near citrus groves about two applications of Danitol are needed a year. Growers in the Temecula Valley would also no longer be required to treat for the grapeleaf skeletonizer. There is no problem with leafhoppers in this area.

The Temecula Valley has a drier climate than the San Joaquin Valley. In order for growers to apply Admire when it can do the most good, a separate irrigation may be required. Farm managers with whom meetings were held estimate that half the time they need to complete a separate irrigation in order to apply Admire. The extra irrigation costs are estimated to be $12.50 on average. Danitol is applied at a rate of 11 oz per acre, with the cost per ounce equal to $1.62. With two treatments a year the cost to treat GWSS with Danitol is $35.86. The total additional cost to grape growers to treat GWSS in the Temecula Valley is about $48 a year when rounded.

Market effects of GWSS control and PD to date.
Grape growers in the southern San Joaquin Valley produce about 87% of all grapes in California while growers in the Temecula Valley account for only 3.4%. Given the low share of production in California that would be affected by higher costs of production due to the GWSS, there is no shift up in the supply curve and no market effects. Consequently, market prices would not be affected and growers in the Temecula Valley incur all losses due to the additional treatments for GWSS.

DISCUSSION
The public control program to date has managed to contain the GWSS in the southern part of the State. Due to the effective control of GWSS in citrus in the southern San Joaquin Valley, the cost to grape growers of GWSS control has been offset by cost reductions in the use of other insecticides. The area with a net increase in the costs of production for grape production, the Temecula Valley contributes a very small share to California, and U.S. production of grapes (2.8% of U.S. production). Given the low percentage of grape production in the area with the increase in costs and no net change in costs in the areas with the greatest percentage of U.S. production, there is no shift up of the U.S. grape supply curve due to GWSS control in the southern San Joaquin Valley. Market prices do not change and market demand is unaffected.

One implication of the success of the public program with regards to the absence of widescale changes in the costs of production is that consumers to date have been unaffected by the spread of the GWSS and the increase in the incidence of PD that would have happened had the program not been successful. Based on NHANES data, grapes are the fourth most widely consumed fruit in the U.S. after oranges, apples and bananas. Because grapes are so widely consumed, even small changes in price (say less than 10%), would result in large losses due to the number of people who consume grapes.

While the public GWSS control program has managed to keep the change in the costs of production to levels that do not affect market demand, the consequence for growers in the Temecula Valley is that their extra treatment costs are not partially offset by changes in market prices. The increase in changes in the costs of production then result in a decrease in profits for a grower.

If the public control program were discontinued winter GWSS treatment in citrus would cease and, without a quarantine, GWSS would spread. Costs for grape growers would increase throughout grape growing regions due to higher control costs where GWSS is currently established, and the need to implement control measures in areas currently free of GWSS. The net effect would be an increase in market prices and lower market supply, making consumers worse off in additional to producers.

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