THE ECONOMICS OF PIERCE'S DISEASE IN CALIFORNIA

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ABSTRACT
The goal of this research project is to estimate the medium to long-run economic impact to growers and consumers of California's diverse agricultural crops, and to taxpayers from the establishment of the glassy-winged sharpshooter (GWSS) in California, and to estimate how different public policy responses affect the costs and benefits to growers and consumers. The costs and benefits to consumers, producers and taxpayers will be estimated using market models that take into account changes in the costs of production, total production by newly infested growers in California and all other growers, trade, and consumer demand.

INTRODUCTION
In 1989, a pest new to California, the glassy-winged sharpshooter (GWSS), was collected in Irvine, CA. Since then the GWSS has spread throughout most of southern California and limited infestations of the GWSS are found as far north as the southern San Joaquin Valley counties of Kern and Fresno (CDFA 2008). Initially thought to mimic the feeding patterns of native California sharpshooters, by the late 1990s it became apparent that the GWSS was a more deadly vector of the bacterium *Xylella fastidiosa* (*Xf*) than native sharpshooters because of its wide host range and ability to feed on and transmit the pathogen to older grape wood. Pierce's disease (PD) has been endemic to California since the 19th century. However, because the GWSS is a more deadly vector of the bacterium, its establishment in southern counties has led to an increase in both the severity and incidence of the disease in infested regions. Initial infestations in the Temecula Valley caused large losses for growers due to vine death and the removal of vineyards. In 1999, losses to growers were estimated to be $46 million (Brown et al. 2002).

In 2000, soil applied imidacloprid (Admire®) was granted a Section 18 emergency use permit (Jetter et al. 2001) and has since proven to be the most effective chemical treatment of GWSS (Barry Hill, CDFA, 2008, personal communication; Jennifer Hashim-Buckey, UCCE, 2008, personal communication; Judy Leslie-Stewart, Consolidated Central Valley Table Grape Pest and Disease Control District, 2008, personal communication). In the Central Valley, the use of Admire® replaced the use of Provado®, a foliar formulation of imidacloprid that was less effective in controlling the GWSS. Consequently, one cost to the grape industry to treat GWSS is not the cost of Admire®, but the difference in cost between Admire® and Provado®. Manual controls include pulling out infected vines, or in some cases, vines that may be infected (Barry Hill, CDFA, 2007, personal communication) in order to remove the bacterium from the vineyard before it can be transmitted by GWSS or other vectors.

Public agencies, including research universities and governmental agencies, have also been conducting research on effective techniques to manage the GWSS. With regard to the management of GWSS and PD, universities have been engaged in research involving the use of biological control agents for the GWSS and developing hybrid varieties resistant to PD. For the biological control program, a number of egg parasitoids have been imported into California and released to reduce populations of GWSS. To date, these parasitoids appear to be most effective in citrus, and in the coastal and interior regions of southern California. With regard to plant breeding, research on a new variety of PD resistant wine grapes used in the production of blended wines is promising, but is still in the testing stage (Andrew Walker, UC Davis, 2008, personal communication).

Governmental agencies have been involved in two control programs to manage and contain the GWSS. One treatment involves the control of the GWSS on citrus before it can move into vineyards and transmit the 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 from a trapped vine. While some citrus growers may benefit from the control of the GWSS and other pests 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 have not 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 this 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).

Growers with GWSS and PD are affected economically though higher costs of production. Given the size of the grape industries in infested counties, higher costs of production will put upward pressure on market prices. With higher market prices newly infested growers are able to recoup a portion of their higher costs of production. Higher market prices will cause consumers to purchase less, however. With higher prices and lower consumption, consumers are also worse off from the establishment of GWSS. The higher prices will make growers in uninfested areas of California, and in the rest of the U.S. better off. These growers receive the higher market prices, but do not incur the higher costs of production. Additional costs accrue to taxpayers who bear the costs of the public management programs. An economic analysis needs to include all these effects.

OBJECTIVES

1. 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.
2. Estimate the costs and benefits of public policies to manage and contain the GWSS. The public control policies include public programs to treat the GWSS in citrus to prevent its spread into grape vineyards in the spring, and the associated containment program. An additional public policy to contain the spread of GWSS and, thus, the transmission of PD, is a state quarantine on the movement of nursery, citrus and other host crops out of infested regions.
3. Estimate the optimal check-off rate for the grape industries that benefit from the treatment of the GWSS on overwintering crops. The rate will take into account the costs and benefits to the grape growers in both infested areas and areas that benefit from the containment of the GWSS within infested areas, and the costs and benefits to growers of overwintering crops. The results of the first two objectives will be used as parameters in the model that estimates check-off rates.

Analytical Approach to Measuring the Economic Effects of Pierce's Disease in California

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 of the changes in the costs of production. 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.

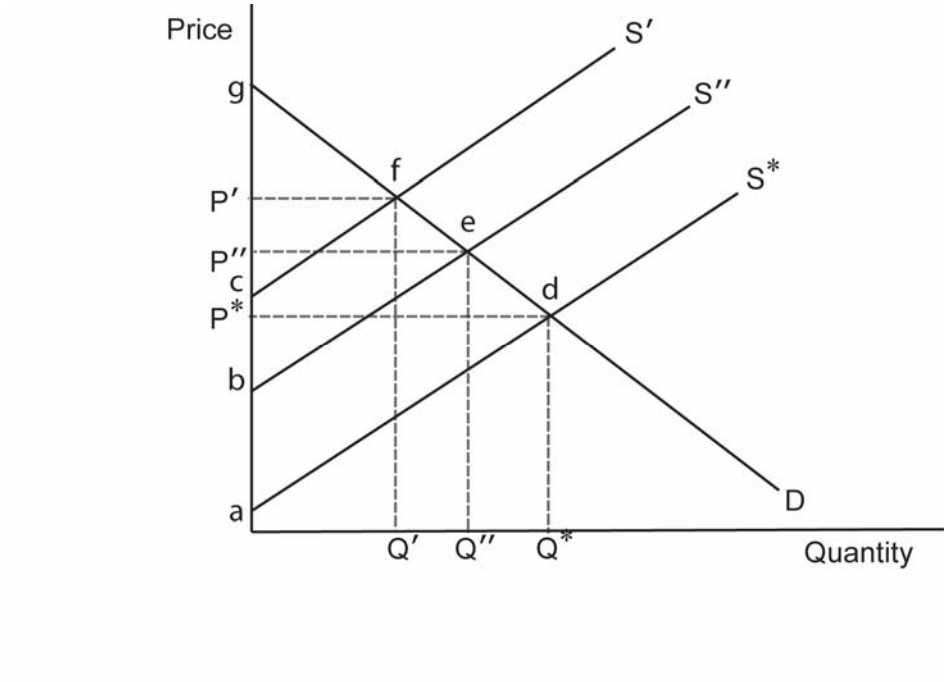

Figure 1. Market effects for grapes produced in GWSS infested counties.

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®.

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.

Once all costs and benefits of the establishment of the GWSS are estimated, and the costs and benefits of the public program to treat GWSS in citrus are estimated, the check-off rates that growers would need to pay in order to take over the citrus GWSS control program will be determined. Because research and the most effective means to complete the public control program is still being conducted, there is still a vital role public agencies have in reducing the short-term effects on producers and, especially, consumers, of commodities affected by *Xf* and GWSS. In the long-run though, taxpayer financed control of

the GWSS will probably not continue. Even though public funding will continue for the foreseeable future, this research project will put the economic evaluation tools into place if budgetary shortfalls at the state or federal level put pressure on policy makers to downsize the public program, and the industries affected by GWSS need to respond quickly.

RESULTS

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 tax payers. A majority of grape growers apply imidacloprid annually to control GWSS and prevent the vine-to-vine transmission of PD. Applications are typically at the maximum rate of 14 fl oz an acre (4.6 lb ai/gal formulation) through the irrigation system. While there is a low incidence of PD in Kern and Fresno counties, the incidence can rapidly increase should GWSS not be controlled. The treatments with imidacloprid also provide some benefits to the control of variegated leafhopper and are a suppressant of the grape and vine mealybug. No quarantine costs are incurred by grape growers as mature fruit destined for the fresh market is hand harvested and field packed.

Citrus growers are affected by the public control program and quarantines against moving citrus out of infested areas. With the public control program, citrus growers are reimbursed for their treatments of GWSS. Participation in the public program is currently voluntary for the citrus grower. 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 once every three years unless monitoring indicates an increase in GWSS populations. The treatments with imidacloprid may provide minor benefits to control of other pests. 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 butoxidor). Turbocide has also been mentioned as a material that can be used as a fumigant. Taxpayers bear the costs of the public program and the state quarantine. These costs include the payments to citrus growers, management costs of the program, and inspection and monitoring cots.

The remaining areas that will be included in this study are the southern California grape growing areas that also treat for GWSS, but where the public program is less widespread, the northern San Joaquin Valley grape growing area that is currently free of GWSS, but has a higher incidence of PD, and the major wine grape growing areas of northern California that are also currently free of GWSS. Growers in the areas free of GWSS do not incur any direct costs due to the presence of GWSS. They are also beneficiaries of the quarantine program to contain GWSS in the southern San Joaquin Valley. Thus, their benefits need to be included in the analysis of Objective 3.

CONCLUSIONS

The containment of GWSS affects both the grape and citrus industries, especially in the southern San Joaquin Valley counties. Even though grapes are treated annually and citrus once every three years, citrus receives treatments with two pesticide applications and a greater amount of imidacloprid. Thus, even though GWSS is a minor pest of citrus, the per acre costs of control are similar to the costs being born by the grape growers. While the per acre costs are similar, because the treatments in citrus are being born by the taxpayer there are no market effects with respect to changes in market prices or production. In comparison, treatments by grape growers are partially passed through to consumers, making consumers worse off. The complete economic analysis will take all these effects into account.

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