The Benefits and Costs of Alternative Policies for the Management of Pierce's Disease: A Case Study of Pierce's Disease and the Blue-Green Sharpshooter in the Napa Valley

Kate B. Fuller, Julian M. Alston and James N. Sanchirico*

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Pierce's Disease (PD) was first reported in California in the 1880s. Originally known as California Vine Disease or Anaheim Disease, it was later re-named after plant pathologist Newton Pierce, who conducted early studies of the disease. PD is caused by a strain of the bacterium *Xylella fastidiosa (Xf)*, which typically kills grapevines over a span of one to three years by clogging the *xylem* and thus limiting water transport from the soil into the plant. Grapes are not the only plants affected by *Xf*; different strains of this bacterium cause damage to a wide range of plants including citrus, almonds, and oleanders. In many plants, however, the bacteria can exist without producing symptoms. Today, Pierce's Disease has been identified in grapevines in 28 California counties (CDFA 2009). Additionally, strains of *Xylella fastidiosa* have been noted in Brazil, Taiwan, Mexico and other countries in Central America.

In this study, we aim to gain insight into the economics of Pierce's Disease in California as a whole by studying PD as vectored by the Blue-Green Sharpshooter (BGSS, *Graphocephala atropunctata*) in the Napa Valley. The main habitat of the BGSS in the Napa Valley is near rivers and in landscaped areas that are irrigated and therefore provide a stock of host plants that exhibit the kind of lush new growth that is attractive to the BGSS. The disease and the BGSS vector have been endemic for a long time in the Napa Valley, but even though it has been the subject of research for many years, knowledge of the etiology of the disease and its vector is still limited.

In the Napa region, methods of control include riparian revegetation, green fencing, and pesticide application. Riparian revegetation is relatively new because, in years prior to 2000, it was illegal to remove plants in the riparian zone in the Napa Valley. While some remarkable claims have been made regarding its effectiveness, revegetation requires a great deal of paperwork for approval in addition to large direct costs of BGSS host plant removal, native non-host replanting, and maintenance. Green fencing is somewhat promising, but is not widely practiced. Pesticide application is problematic because it is illegal in the riparian zone, the primary habitat of the BGSS. Perhaps because of these challenges, some growers have chosen to simply abandon land adjacent to riparian areas.

Some studies suggest that benefits from both revegetation and green fencing exceed the costs. However not all vineyards opt to use these controls, suggesting that previous studies may have failed to capture all aspects of the problem. One such aspect is that of interaction between neighbors because, as the BGSS has the ability to migrate from one property to the next, one property owner's decision not to control could have detrimental effects on neighbors nearby. To address these issues, we have created a model that incorporates insect population distributed over space as a result of different landowners' decisions regarding PD/BGSS management and control. Several examples of similar papers that look at the spread of a pest or disease over space include Bicknell, Wilen and Howitt (1999), Brown Lynch and Zilberman (2002) and Bhat and Huffaker (2007). Specifically, we examine how neighboring vineyard owners affect each other through their control choices. To show this interaction effect, we created a model based on individual grower profit, subject to PD damage that depends on neighbors' control choices. Optimal control techniques are used to determine parameterized Pareto-optimal pest control strategies and the corresponding insect population and damage rates. We then compare the optimal values from this model to those under a cooperative scheme. We find that in the noncooperative case, individuals will under-invest in PD controls relative to the case of maximizing collective benefits.

We will calibrate the model using information to be gleaned from interviews with vineyard managers during the coming months. We will conduct interviews with a process called "participatory mapping." Using a set of aerial images of a manager's vineyard blocks, respondents will be asked to sketch onto the maps where and how they manage PD and the associated costs over the space of the block. Each interviewee will be presented with two images; one will be a block that is adjacent to a riparian area, and the other will be similar in grape variety and clone, but relatively far away from the riparian zone. By comparing the methods of control and their associated costs over space within and between the two different blocks, we hope to gain better understanding of the effects of PD over space, and how vineyard managers work to counteract it. Interviewing growers will allow us to parameterize, test, and extend the bioeconomic model, which will be used to understand and predict grower behavior under different scenarios, such as the introduction of a better-performing control technique, a dramatic increase in PD, or PD spread by other vectors with different characteristics.

A specific and particularly interesting outcome of these interviews will be to explore the sub-case of land abandonment. Talking to vineyard managers will help us gain insight into how much land has been abandoned due to PD in the Napa Valley, and how growers make decisions about whether to abandon portions of their land. Vineyard managers must weigh the potential benefits from planting vines on that land against the possibility that they will die before they turn a profit. Since the incidence of Pierce's Disease can vary greatly from year to year, managers must make these decisions based on highly imperfect information. The decision to abandon land can also be affected by neighbors' decisions regarding whether to control, as abandoning land can be thought of as a specific case of "no control."

This paper will add to the economic literature examining potential benefits from cooperation versus noncooperation in resource management, pest and disease control in agriculture, and will also potentially aid in modeling other pest and disease problems of grapes in the Napa Valley and beyond.

*Julian Alston is a professor in the Department of Agricultural and Resource Economics and Director of the Robert Mondavi Institute Center for Wine Economics at the University of California, Davis, and a member of the Giannini Foundation of Agricultural Economics. Kate Fuller is a PhD candidate in the Department of Agricultural and Resource Economics at the University of California, Davis. James Sanchirico is a professor in the Department of Environmental Science and Policy at the University of California, Davis, and a nonresident fellow at Resources for the Future.

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