Interim Progress Report for CDFA Agreement Number: CDFA 15-0453-SA

Title of report:
Evaluating Potential Shifts in Pierce's Disease epidemiology

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Reporting Period: The results reported here are from work conducted between March 2017 and July 2017.

Introduction

Pierce's disease of grapevine (PD) has reemerged in Napa and Sonoma counties, where disease incidence has been much higher than usual and the distribution of sick vines within vineyards often does not fall within expectations. These field observations taken together with the very high number of vineyards affected in the region indicate that a PD epidemic is emerging. The goal of this proposal is to determine what factors are driving this epidemic, so that ecology-based disease management strategies can be devised and immediately implemented, as was successfully done in the past when disease drivers appear to have been different. This report summarizes activities associated with vector ecology (part of Objective 1) and *X. fastidiosa* population genomics research that was recommended by reviewers. We present Results and Discussion sections together addressing each original objective. Furthermore, we note that limited amount of data analyses has been done, primarily because efforts have focused on collecting data, and not spending time generating/interpreting preliminary results.

List of Objectives

Objective 1. Vector, pathogen, and host community surveys to inform the development of a quantitative model to assess future Pierce's disease risk and develop integrated management strategies.
Objective 2. *Xylella fastidiosa* colonization of grapevines and the role of overwinter recovery in Pierce's disease epidemiology.
Objective 3. Determine the role of spittlebug insects as vectors of *Xylella fastidiosa*.
Objective 4. Data mine and disseminate existing information on vector ecology, vegetation management, and efficacy of pruning.
Objective 5. Develop a larger extension and outreach footprint with additional seminars, extended interviews made available on the web, and an update to the *Xylella fastidiosa* website, the main online resource for PD information.

Description of activities

One of the main objectives of the project is to relate vector pressure to Pierce's disease dynamics. Therefore, we have been monitoring for sharpshooters and other vector populations in more than 30 vineyard blocks in Napa and Sonoma Counties. These ongoing monitoring activities involve a combination of methods, including yellow sticky traps, sweep-net sampling of the vineyard canopy, and sweep-net sampling of the vineyard floor. The last two methods were initiated this season and data is still being collected, but we now have more than a year of sticky trap monitoring at the sites.

Sticky trap monitoring includes traps placed throughout the vineyard as well as outside of the vineyard blocks in nearby vegetation that may serve as source habitat for certain vector populations. We are deploying traps and checking them every two weeks for most of the year, then monthly over the winter. All vectors collected from the traps are removed and preserved in alcohol, for later testing of whether they are infectious for *Xylella fastidiosa*. Here we report the results of vector counts on the sticky traps thus far in the project.

A total of more than 10,000 traps have been deployed and checked in Napa and Sonoma sites between March 2016 and June 2016. Thus far, we have collected over 400 BGSS at Napa sites and more than 800 in Sonoma. Trap catch has been as high as 17 on an individual trap, but with season-wide averages of approximately 0.1 BGSS per trap in Napa and 0.15 in Sonoma. Analyses of these data with zero-inflated Poisson mixed–effects models have shown significant effects of seasonality (i.e. census date), site type (i.e. with or without nearby riparian habitat), and distance from nearby putative vector source habitat (i.e. riparian, ornamental plantings, other native vegetation).

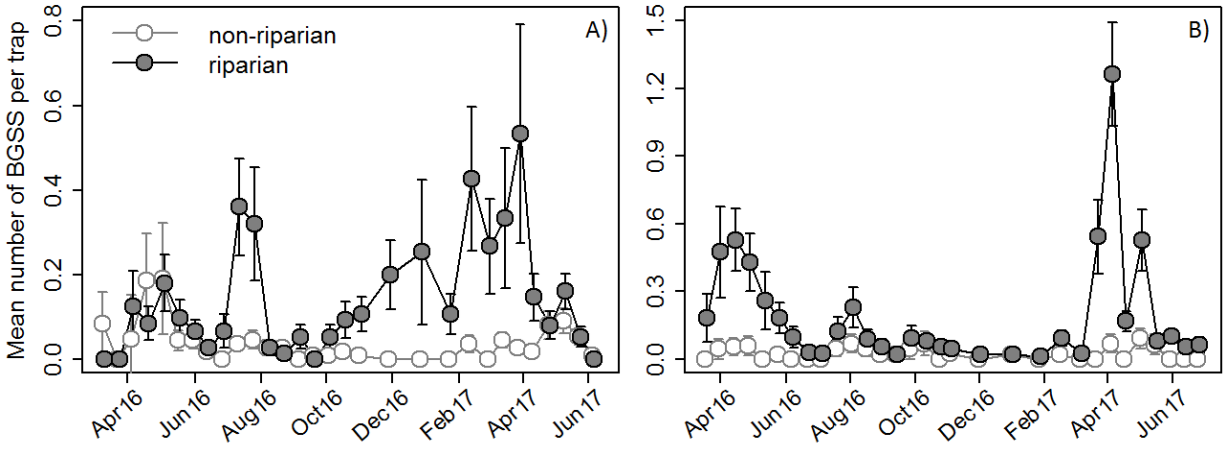


Figure 1. Seasonal counts of the mean (±SE) number of *Graphocephala atropunctata* per trap among all traps at all sites in A) Napa and B) Sonoma County. Note scale of y-axes varies between panels.

BGSS trap catch varied substantially over the season in both Napa and Sonoma sites (Fig. 1). Both areas show peaks in the Spring and mid-Summer of 2016 (to varying degrees), and more substantial peaks in the Spring of 2017. Differences based on site type are also apparent, with between 5 and 6-fold higher overall BGSS catch and more substantial peak counts at those sites where there was clear riparian habitat near the vineyard. These patterns generally reinforce what has been described prior regarding BGSS population dynamics in the North Coast – namely, substantial seasonal and interannual variability.

There was also a clear effect of distance from potential vector source habitat (Fig. 2). Overall, BGSS counts were high in the nearby vegetation plot traps and along the edge of the vineyard block, then declined on average at greater distances. However, a handful of traps at substantial distances from the edge of blocks (up to 300m distant) standout for having higher BGSS counts. Those traps that standout appear to be a bit more common at riparian versus non-riparian sites. Notably, this effect of trap distance holds even if the vegetation plot traps are excluded.

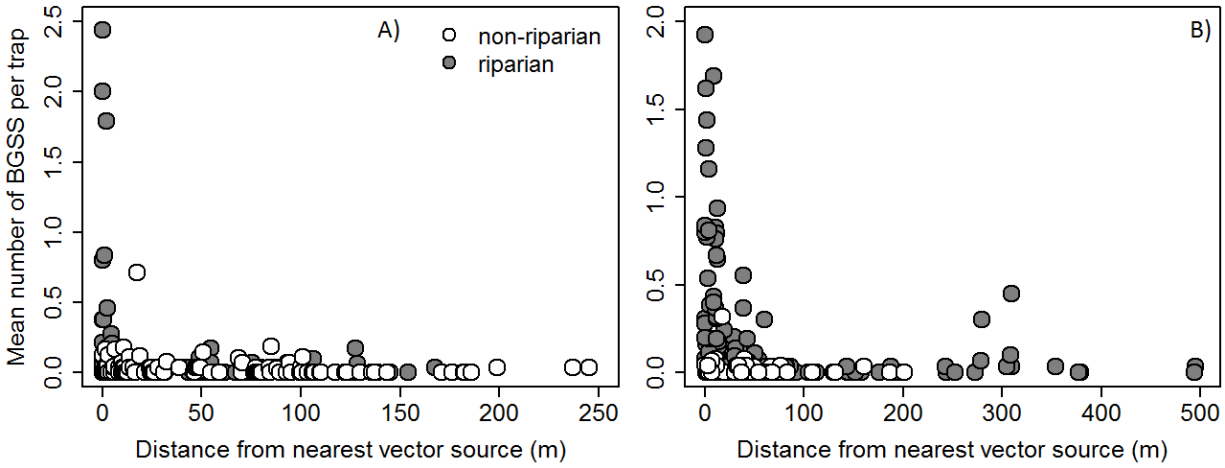


Figure 2. Mean number of *Graphocephala atropunctata* over the season per trap across sites in A) Napa and B) Sonoma County. Note scale of axes varies between panels.

Finally, we qualitatively analyzed the counts of spittlebugs collected on the sticky traps, for which two or three species were lumped. Compared to BGSS, spittlebugs were less common on traps, with just 4 total collected at Napa sites and approximately 100 at Sonoma sites. There is a clear difference in spittlebug counts between Napa and Sonoma, but season differences and patterns with respect to distance to outside vector habitat aren't robust (Fig. 3). These modest spittlebug counts make it difficult to understand how important a role they are playing in PD spread compared to BGSS, but sweep net sampling within the vineyard may help to clarify.

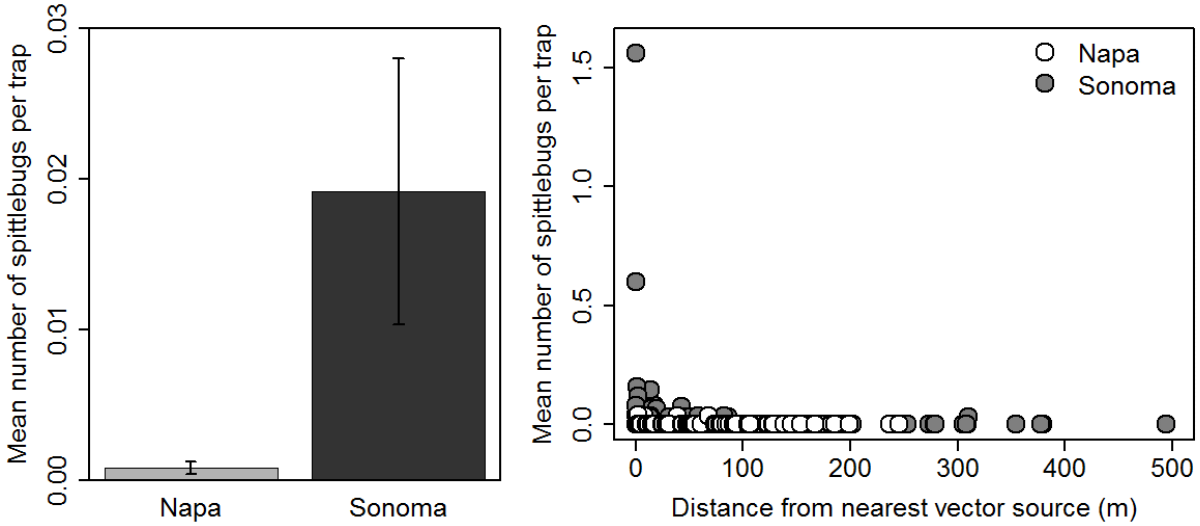
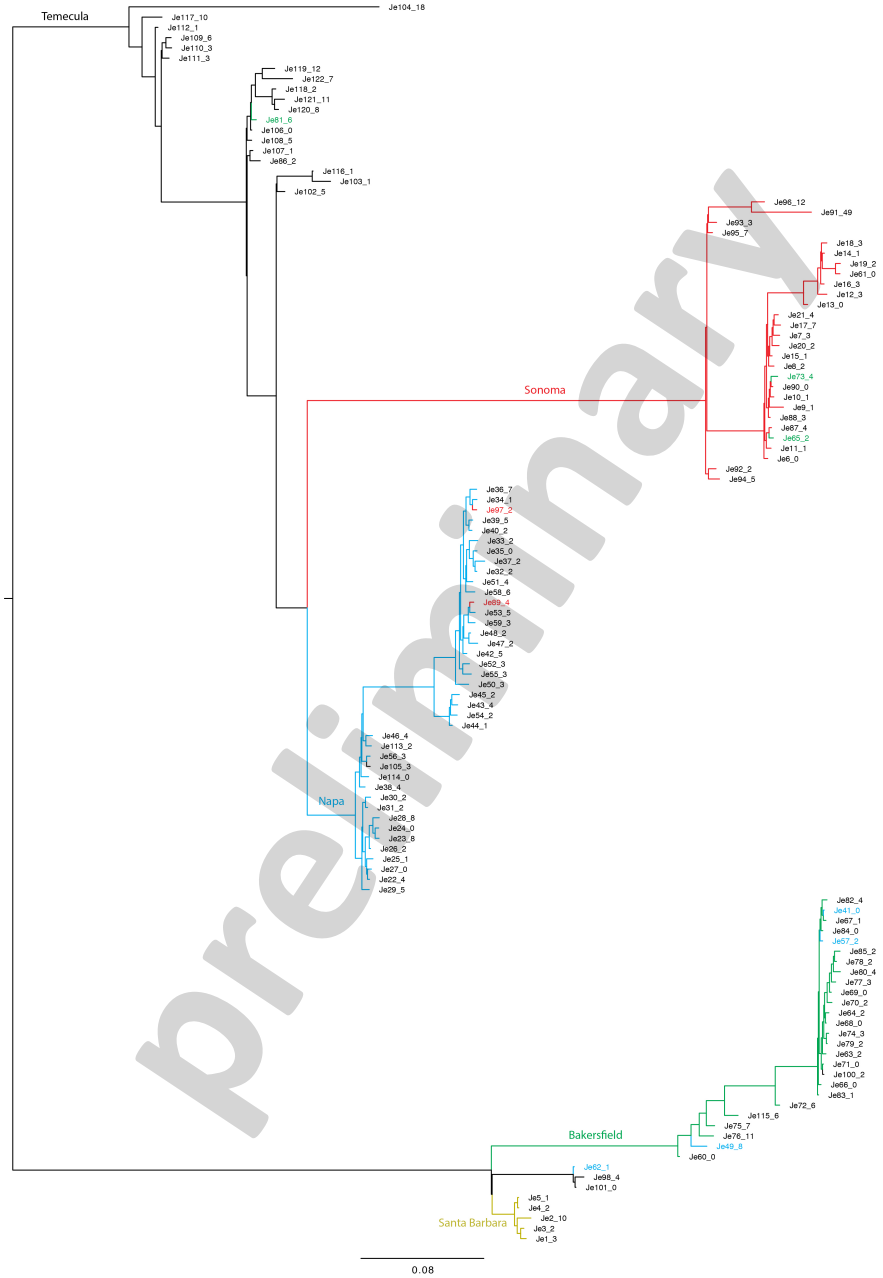


Figure 3. Mean (±SE) number of spittlebugs A) between Napa and Sonoma sites and B) as a function of distance from adjacent potential vector habitat.

The second component of this report is associated with our effort to address one question: was the current epidemic due to the emergence of a new *X. fastidiosa* genotype? To answer this question we collected isolates from grapevines with Pierce's disease symptoms from 5 regions in 2016; Napa, Sonoma, Bakersfield, Temecula, and Santa Barbara. Over 100 *X. fastidiosa* genomes were cultured from plants, triple-cloned in the laboratory, and had their genomes sequenced. Preliminary analyses indicate that isolates from each region sampled clustered together, with a few exceptions, providing no evidence to the hypothesis of an emerging genotype of *X. fastidiosa* causing Pierce's disease. The exceptions suggest within-state movement of plant material (grapevines or ornamentals), although those introductions do not appear to lead to genetic sweeps. Analyses are ongoing to better understand factors affecting the structuring of populations in California.



Publications Produced

Cornara, D., Sicard, A., Zeilinger, A.R., Porcelli, F., Purcell, A.H. and Almeida, R.P.P. 2016. Transmission of *Xylella fastidiosa* to grapevine by the meadow spittlebug. Phytopathology 106: 1285-1290.

Research Relevance Statement

Extensive BGSS trapping in Napa and Sonoma during 2016 and 2017 has indicated that populations are currently low, and follow spatial and temporal patterns somewhat expected based on previous surveys. Insects occur more frequently near source habitats such as riparian zones. However, the data showed significant differences in trends between Napa and Sonoma valleys. In addition, due to the observation of PD hotspots away from BGSS habitat, we have initiate surveillance efforts targeting spittlebugs. This work was initiated in 2017, so there is limited data for any conclusion. One question raised by reviewers of this project was associated with the possibility of a novel PD genotype/strain being responsible for the recent epidemic on the North Coast and elsewhere. We collected and sequenced over 100 *X. fastidiosa* isolates from five grape-growing regions in California. The results show clustering of isolates based on region, indicating absence of a sweep through the State. These data were just obtained, so the analysis presented here is preliminary.

Layperson Summary

A PD epidemic is emerging in Napa and Sonoma counties. Very high PD prevalence is being reported throughout the region, with a large number of stakeholders reaching out to UCCE Farm Advisors. In summer 2015, the project team held a series of joint meetings/field visits with the Farm Advisors. Two observations have been made that raised our concern about the problem. First, high prevalence of PD in the North Coast is usually below 1-2% per vineyard; several vineyards visited had over 25% of vines symptomatic. Second, historically PD is closely associated with riparian zones in the North Coast; we have visited several vineyards where PD does not appear to be associated with riparian zones. We have observed these greater rates of disease incidence and dissociation with riparian areas throughout Napa and Sonoma counties—they are not district specific. The goal of this proposal is to determine what factors are driving this epidemic, so that ecology-based disease management strategies can be devised and immediately implemented, as was successfully done in the past when disease drivers appear to have been different.

Status of Funds

Funds are being used as proposed.

Summary and Status of IP

Not applicable.

Literature Cited

None.

Funding Agencies

Funding for this project was provided by the California Department of Food and Agriculture Pierce's Disease / Glassy-winged sharpshooter Research Program.