**I. PROJECT TITLE:** Are Natural Enemies Controlling Glassy-Winged Sharpshooter Populations in Southern California?

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## III. LIST OF OBJECTIVES AND DESCRIPTION OF ACTIVITIES CONDUCTED TO ACCOMPLISH EACH OBJECTIVE:

This proposal has **One** Objective: **(1)** To continue long-term monitoring of GWSS populations and associated egg parasitoids in organic citrus at UCR Ag. Ops. The purpose of these long-term surveys is to document the long-term population trends of GWSS and percentage parasitism of GWSS eggs at this study site. These data will be used to determine which factors are responsible for the year to year variations observed in GWSS densities.

## IV. SUMMARY OF MAJOR RESEARCH ACCOMPLISHMENTS AND RESULTS FOR EACH OBJECTIVE:

Data collected from bi-weekly monitoring over the last eight years from organic commercially-managed lemons in at Ag. Ops. UC Riverside indicates that glassy-winged sharpshooter (GWSS) populations have declined steadily since this project was initiated in March 2002 (Fig. 1.) It is uncertain whether parasitism of GWSS eggs by mymarid parasitoids is responsible for this downward population trend (Fig. 2). In California, there is a guild of natural enemies attacking GWSS eggs. The dominant parasitoid attacking GWSS in California is *G. ashmeadi* which was self-introduced into California. Other *Gonatocerus* parasitoids associated with GWSS eggs are *G. morrilli*, *G. walkerjonesi*, *G. novofasciatus*, *G. triguttatus* and *G. fasciatus.* The latter two, *G. triguttatus* and *G. fasciatus*, were imported from Texas and Louisiana, respectively. Widespread establishment of these two parasitoids appears doubtful and their impact on GWSS has been negligible. Trichogrammatid parasitoid species include, *Ufens* sp., and *Zagella* sp. which parasitize GWSS eggs infrequently in organic lemons at UCR Ag. Ops. Together, this guild of parasitoids provides an average of ~25% parasitism of GWSS eggs over the entire ~8 yrs that this study site has been monitored (Fig. 2). There are at least four possible reasons for low year-round parasitism levels in California: (1) competitive exclusion amongst members of the GWSS parasitoid guild reduces effective biological control. (2) A new and extremely aggressive and efficacious natural enemy that can outcompete the omnipresent *G. ashmeadi* and completely dominate the system year round to the almost total exclusion of all resident parasitoid species is needed, and it would have to exploit non-GWSS hosts during long periods of GWSS egg unavailability over fall, winter, and mid-late spring. (3) The absence of resource subsidies such as nectar provided by flowering plants in agroecosystems may limit parasitoid efficacy because longevity and fecundity is significantly reduced when parasitoids cannot access carbohydrates. Understorey management may be an important cultural strategy to benefit GWSS parasitoids if it can be demonstrated not to enhance GWSS and *Xylella* populations. (4) Climate, in particular, prolonged cool periods over winter which results in GWSS eggs being unavailable for prolonged periods (i.e., months) probably has a severe affect on parasitoid reproductive success and the ability of parasitoid populations to propagate through the winter. This last point, lack of GWSS eggs over winter most likely has the strongest influence on parasitoid densities and their subsequent ability to rebound when GWSS begin laying eggs as temperatures increase in late spring. Long-term phenology studies which generate data similar to the project reported on here can be used to tease out density-dependent (e.g., mortality caused by natural enemies) and density-independent (e.g., mortality caused by weather) factors affecting population dynamics. Such analyses can be used to elucidate which factors (e.g., egg parasitism) are important in regulating GWSS population growth in California.

The results of the population monitoring study reported here and measures of percentage parasitism clearly indicate that GWSS densities have continued to decline steadily at the long-term monitoring plot (Fig. 1) and percentage parasitism has remained relatively constant over this time period (Fig. 2). Detection of density-dependent mortality from sequential census data such as that presented here is notoriously difficult. One of the major problems with these types of analyses is serial correlation, where densities at $N_t$ directly influence the population at $N_{t+1}$. Recent developments in analyses of time series data, such as those we are collecting for GWSS are now providing much more robust tests that overcome autocorrelation problems. Consequently, census data collected from GWSS monitoring will be subjected to appropriate statistical analyses once we have data for a minimum of 10 consecutive years to determine if density dependent (e.g., egg parasitism) or density independent (e.g., very cold winters, or unusually wet springs) feedback is responsible for observed fluctuations from generation to generation. Detection of density dependent mortality will indicate that populations are being regulated, and could suggest that natural enemy populations are responsible. Currently, our data set is too short to determine if parasitoid activity is providing density dependent mortality and is subsequently responsible for decreasing GWSS densities at the study site. To remedy this problem we are continuing with long-term population phenology monitoring studies on GWSS in organic citrus in southern California.

**Fig. 1.** Phenology of adult *Homalodisca vitripennis* in organic Eureka lemons. Data are total counts from timed five minute surveys made every two weeks of 10 mature lemon trees at Ag. Ops. University of California, Riverside.

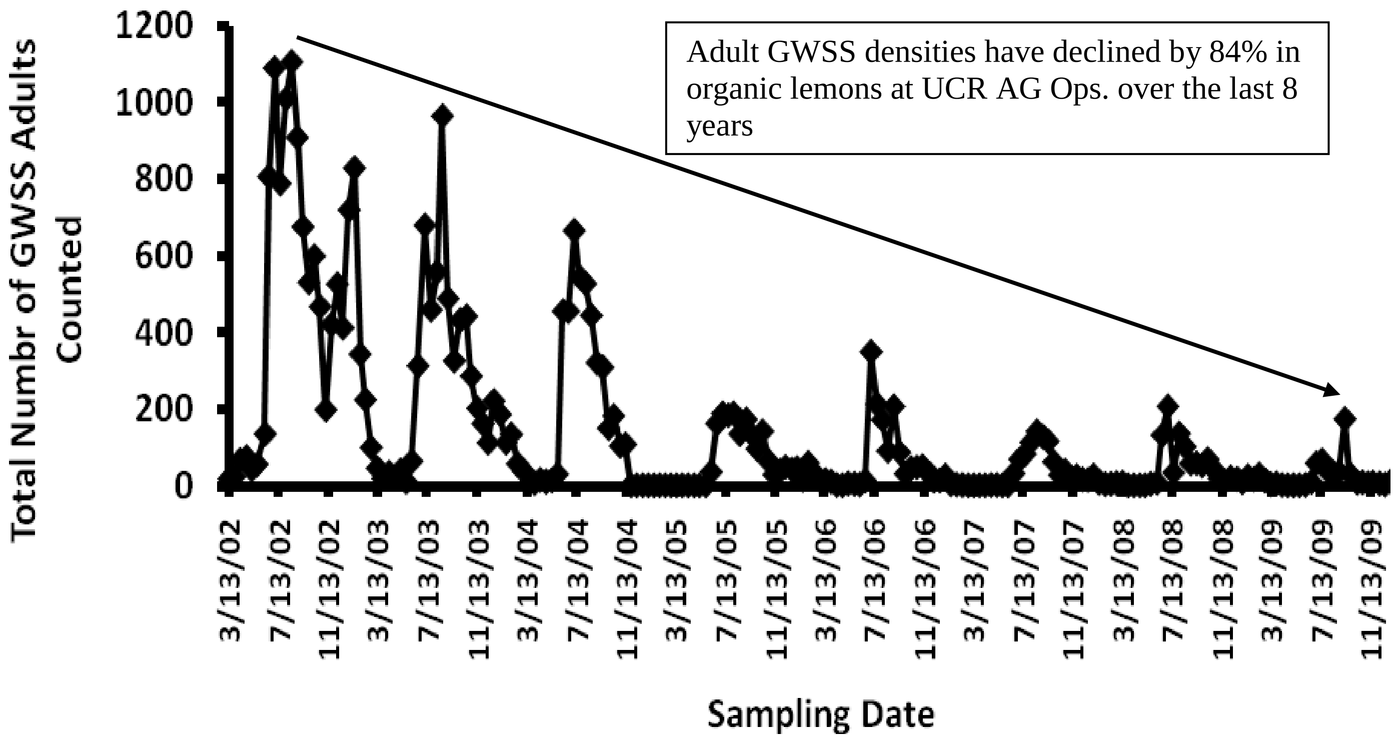
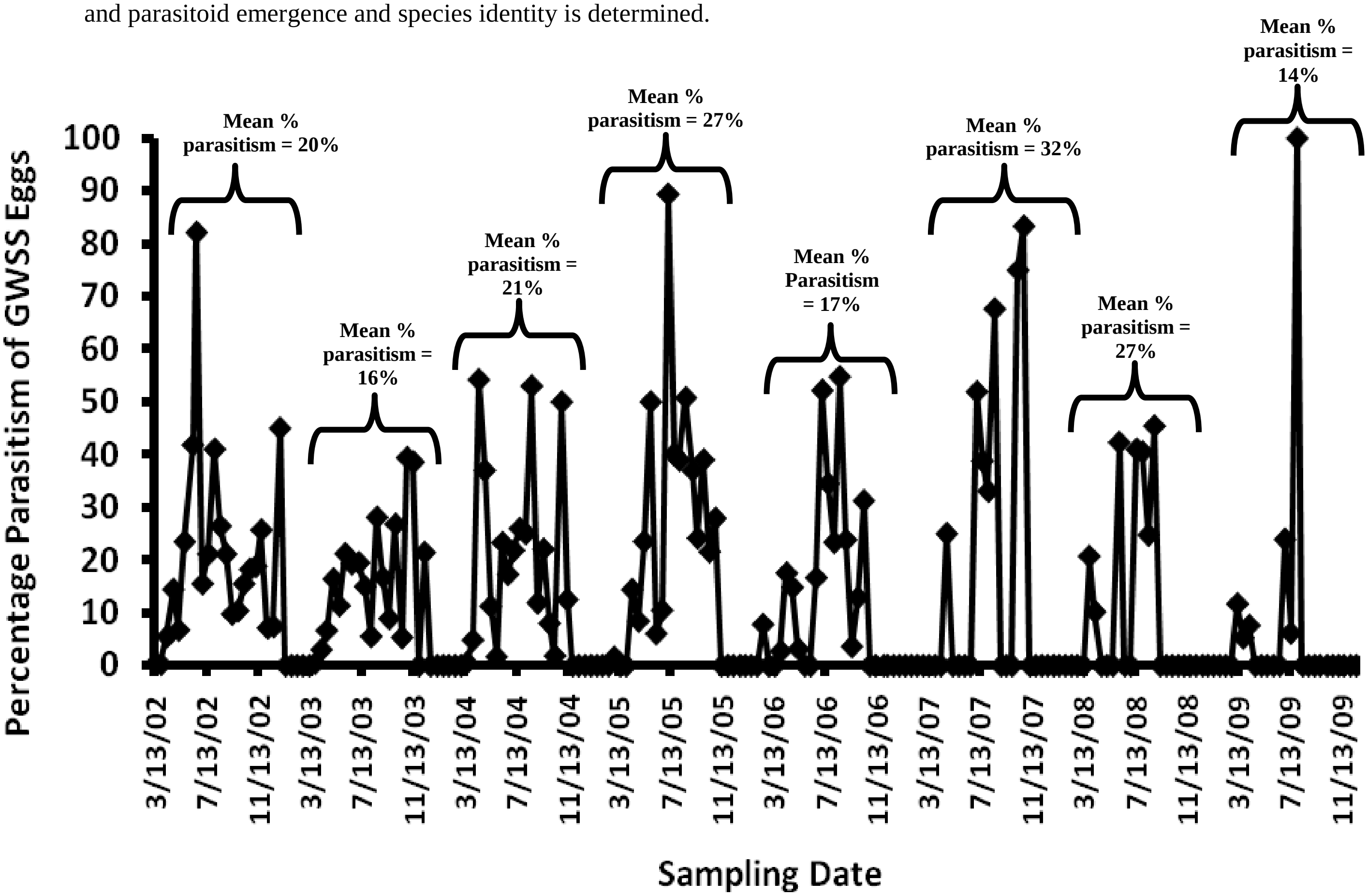


**Fig. 2.** Percentage parasitism estimates of *Homalodisca vitripennis* eggs in Eureka lemons. GWSS egg masses are collected from timed five minute surveys made every two weeks of 10 mature lemon trees at Ag. Ops. University of California, Riverside. Harvested leaves are returned to the laboratory, the number of eggs per egg mass are counted and parasitoid emergence and species identity is determined.




Percentage parasitism of GWSS eggs across all years has averaged ~ 25%

**V. PUBLICATIONS OR REPORTS RESULTING FROM THE PROJECT:** No publications have as yet resulted from this work as this project is incomplete.

**VI. PRESENTATIONS ON RESEARCH:** One presentation has been made on this work, a summary of results similar to those presented here was presented at the CDFA Pierce's Disease Symposium.


Hoddle, M. S. 2008. Are glassy-winged sharpshooter populations regulated in California? Long-term phenological studies for GWSS in an organic lemon orchard. Symposium Proceedings of the Pierce's Disease Research Symposium, December 15-17 2008, The Westin Gaslamp Quarter Hotel, San Diego. California Department of Food and Agriculture, pp. 63-65.

**VII. RESEARCH RELEVANCE STATEMENT:** Considerable effort and expense has been invested in biological control of GWSS with natural enemies, in particular, mymarid parasitoids that attack the eggs of GWSS. However, no comprehensive long term studies have been under taken to ascertain why GWSS populations have declined by ~84% over the last eight years. To possible causes for GWSS population declines are either natural enemies or weather. We have documented that natural enemies provide on average year round around parasitism of ~25%. Is this sufficient mortality to cause GWSS populations to decline? Alternatively, is there high overwintering mortality caused by colder-drier than normal winters, of excessively heavy rain for short periods of time that can kill large numbers of overwintering adult GWSS? Long-term population monitoring studies such as those being conducted here may provide deep insight into what factors (density dependent [i.e., natural enemies] or density independent factors [i.e., weather]) cause GWSS populations to fluctuate from year to year.

**VIII. LAY SUMMARY OF CURRENT YEAR'S RESULTS:** GWSS populations have declined dramatically in southern California over the last six years or so. In 2009, average peak population densities of GWSS were only ~16% of what was measured in 2002, indicating that pest populations have declined by around 84%. The major question that needs to be answered here is **WHY** has this population decline occurred? If we can figure out the underlying mechanism causing GWSS populations to decrease then we will better understand how stable GWSS populations are likely to be in southern California over the long-term, and perhaps, be able to predict factors and conditions that could lead to GWSS outbreaks. Consequently, the results from these simple surveys could be of immense value to managing GWSS in southern California and this could greatly help agricultural producers that experience problems with this pest (e.g., grape growers).

**IX. STATUS OF FUNDS:** Year 1 = $18,570 [2008] and funding for year 2 = $19,349 [2009] have been fully expended. Funding for year 3 = $20,167 [2010].

**X. SUMMARY AND STATUS OF INTELLECTUAL PROPERTY PRODUCED DURING THIS RESEARCH PROJECT:** No intellectual property has resulted from this work.