

EXHIBIT – B
FINAL REPORT FORM
COUNTY OF HAWAII
DEPARTMENT OF RESEARCH AND DEVELOPMENT


CONTRACT/AGREEMENT NO.: C.006362

Organization Name: University of Hawaii-Manoa
Project/Program Title: Prosapia Bicincta (Two Line Spittlebug) Detection and Control
Contact Name: Mark S. Thorne Title: Specialist, Range Management
Contact Telephone No.: 808-887-6183 Email: thornem@hawaii.edu
Contract/Agreement Term: June 29, 2017 To June 30, 2019
Effective Date End Date

Please submit this completed and signed Final Report Form and the completed and signed Final Financial Report form with a narrative report that addresses each of the following five (5) points. Use additional pages as needed.

1. Program description from your original proposal.
2. Discuss the results of your project/program in detail.
 - a. Compare your proposed project outcomes of your original proposal narrative with the actual outcomes or results.
 - b. Explain why you were able to reach your stated objective(s) and/or why you were unable to reach your stated objective(s).
3. Describe how this program could be improved.
4. Add any additional comments as desired and/or requested by the Department's program specialist.
5. Attach copies of all news articles, advertisements, flyers, brochures, promotional materials on this project that you have collected to date if applicable.

Submitted by:

	Specialist Range & Livestock Management	09/20/19
Signature	Title	Date

For R&D Staff Use Only			
	Final Report Accepted	Program Specialist's Initials	Date
Final Report Received in R&D		Director's Initials	Date
	Final Invoice Submitted	Program Specialist's Initials	Date
Date	Contract Closed	Director's Initials	Date

EXHIBIT – B
FINAL FINANCIAL REPORT FORM

COUNTY OF HAWAI'I DEPARTMENT OF RESEARCH AND DEVELOPMENT

FINAL FINANCIAL REPORT OF ACTUAL EXPENSES AND INCOME **CONTRACT NO.:** C.006362

EXPENSES	Budgeted Amounts	County Award	Other Cash Sources	In-Kind	TOTAL
Operating Costs					
Materials and supplies					
Travel					
Marketing Costs					
Administrative Costs					
Indirect Costs					
TOTAL EXPENSES					
INCOME SOURCES	Budgeted Amounts	County Award	Other Cash Sources	In-Kind	TOTAL
R&D Award					
Applicant Organization					
<i>Other</i>					
<i>sources</i>					
<i>and/or</i>					
<i>sponsors</i>					
TOTAL INCOME					

I hereby certify that this final report to the County of project expenses and income relating the Contract Number listed above is accurate and that County funds have been expended in accordance with the provisions set forth in this Contract, including the budget that was made a part of said Contract.

Signature	Title	Date Signed
Name of Organization/Contractor	Project Title	

Narrative

1. Program Description

Livestock ranching is a highly productive and extremely valuable industry on all major islands in the State of Hawaii. The current estimate of the number of beef cattle in the state is over 142,000 head (beef cows and calves), located on over 1,300 ranches. Hawaii ranchers manage over 1 million acres of land, or about 25% of the state land mass. The value of Hawaii-raised livestock (Cattle, sheep, etc...) is estimated to be more than \$38 million annually. Cattle raised on the Big Island of Hawaii are raised on some of the largest ranches in the United States. With livestock production still expanding on the Hawaiian Islands, this industry serves as an economic engine for the state. It also supports communities of diverse farm workers and the paniolo culture within the State. Now however, the Hawaiian livestock industry faces severe threats from exotic pests such as the newly introduced two-lined spittlebug (TLSB), *Prosapia bicincta*, and other exotic pests and weeds. The two-lined spittlebug was first identified in Kailua-Kona, on the Big Island of Hawaii in September of 2016 and since, has damaged nearly 2000 acres of pasture land. The pest is expanding its range and needs to be controlled.

In highly infested areas, the two-lined spittlebug has caused severe impacts to key pasture grasses. Two-lined spittlebug damage levels were found to be high in several areas and have the potential to spread throughout the islands and irreparably harm large areas of valuable cattle grazing land. There are currently no integrated pest management (IPM) protocols, nor are there any known natural enemies present in Hawaii. The geographic spread of the infestation is currently unknown, and very little is understood about how this new pest will perform in the Hawaiian environment. Additionally, there is a need to establish an information campaign for ranchers.

In response to the recent invasion and severe impact of the two-lined spittlebug to the Big Island of Hawaii, immediate actions to restrict its further spread and to prohibit establishment on the other non-infested Hawaiian Islands is necessary. Immediate action is thus suggested for consideration of Farm Bill 10007 funding to implement a multi-faceted plan to limit two-lined spittlebug spread and to further conduct detailed assessments to ensure that two-lined spittlebug and other pests do not obtain footholds on non-infested islands in the State. To accomplish these goals, the Hawaii Department of Agriculture (HDOA), in cooperation with the University of Hawaii, College of Tropical Agriculture and Human Resources (CTAHR) are organizing a comprehensive set of action plans to address two-lined spittlebug. This inter-institutional group is proposing to focus their efforts on the following strategies: 1) Rancher outreach and education; 2) Detection and surveillance; 3) Development of Integrated Pest Management (IPM) Protocols (Pesticides, Grazing management, Forage replacement); 4) Biological control agent exploration; 5) Research Biology and Ecology.

The activities supported by this specific funding through the County of Hawaii, Research and Development Dept. were objectives 1- 3: Rancher outreach and education; Detection and surveillance; and Development of Integrated Pest Management protocols.

Rancher Outreach and Education

In support of more generalized detection and control, targeted outreach and education campaigns in high-risk areas and a general educational campaign will be launched. The targeted Island wide outreach campaign will focus on ranchers and associated stakeholders. The educational components for this effort will focus on recognizing signs and symptoms of pest infestation, what to do if an infestation is detected, actions to take to mitigate these pests, and effective treatment methodologies for pest infestations. The general educational campaign will further focus on an expanded public awareness campaign educating the public about what TLSB is and what the public can do to help prevent the spread. As part of this campaign, people will be encouraged to call in suspect infestations to a service such as the State's Pest Hotline (643-PEST) and/or their local University of Hawaii Cooperative Extension Office. Outreach and education materials will be developed, printed and made available on the web, and lectures, seminars, and workshops will be conducted for interested stakeholders.

Detection and Surveillance of TLSB

- UH-CTAHR/HDOA will conduct surveys at high-risk ranches, natural areas, and nurseries that sell susceptible grass species using visual inspections for damage and presence of TLSB, and other activities in key uninfested areas.
- Follow-up investigations of suspect infestations statewide from referrals by the University of Hawaii diagnostic clinics, Cooperative Extension Services, other State and Federal agencies, private industry such as the Farm Bureau, Hawaii Agricultural Research Center, farms, ranches, and nurseries.
- Residential and commercial pest calls statewide.

Field surveys for TLSB will be conducted following high-risk pathways identified through data assessments and will use a combination of hired field scouts and ranch-based personnel. Data generated through field surveys will be used to refine target areas. Accurate identification of TLSB requires examination of suspect insects under a microscope. Screening and identification will be done by the State Entomologists and final determination will be done by the HDOA Insect Taxonomist.

Integrated Pest Management Protocol Development

To offer ranchers long-term control strategies, it is important to take a systems approach to pest management and provide them with IPM protocols. A major component of IPM in rangeland may be the use of pesticides, unfortunately there is no available information on the efficacy of pesticides used against TLSB over large areas in Hawaiian conditions. Several pesticides will need to be tested for efficacy and economic feasibility. Mechanical strategies such as intensive grazing and burning may be employed to control pest populations. In addition, resistant grass species will need to be located to provide alternative re-seeding options to ranchers for forage replacement in areas highly damaged by TLSB.

2. Results

Rancher Outreach and Education

Rancher outreach and education has included the publication of a TLSB pest alert, and an update distributed through the Hawaii Cattlemen's Council (HCC) meetings and at CTAHR extension

workshops. An educational workshop was held May 14, 2018 in Kona for cooperating producers, HDOA Plant Pest Control Branch personnel, and UH Faculty. Educational presentations were provided to ranchers across the state at the 2017 and 2018 HCC Annual meetings, and at the joint mid-year meeting of the HCC/Hawaii Cattlemen's Association meetings in June of 2017 and 2018. The TLSB team provided a field day/pasture walk training for USDA-NRCS field personnel on the identification and detection of TLSB in pastures. A poster on TLSB in Hawaii was presented at the 2019 Annual meeting of the Society for Range Management, and at the Ag Day at the Capital in February. Monthly reports of the survey data were compiled and provided to the cooperating ranches, and HDOA-Plant Pest Control Branch personnel.

Detection and Surveillance

In October/November of 2017 the project team established five Two-line Spittlebug (TLSB) transects on each of two ranches in the North Kona area where the bug had been reported along an elevational gradient transcending from 2,000 to 5,000 ft. Spittlebug larva and adults were documented and collected from the transects. With funding, a recruitment for a Research Technician and two graduate students was initiated in October. One Graduate Student position was filled in early January 2018 and the research technician position was filled on January 17, 2018. The second graduate student position was never successfully filled.

New transects were established on two additional ranches, one where spittlebug activity had been previously documented, and a second ranch further south, where no spittlebug activity was reported. Monthly surveys of all the transects on all four locations began in February 2018.

The addition of these two locations allowed us to bracket both the northern and southern extents of the Two-line spittlebug infestation by fall of 2018. Subsequent surveys, further north and south of our monitoring sites have not detected TLSB activity, nor have there been any reports of activity from ranchers outside of the current documented range of infestation. Thus, we believe that we now have both the northern and southern extents of the spittlebug population documented. However, without continued monitoring and specific steps to control the current infestation we expect the bug to continue to expand its range.

Ten 0.25 m² observation points are located at 10 m intervals along each 100 m transect at each of the four monitoring sites. Data collected in 0.25 m² observation points include a count and collection of TLSB nymphs and adults; identification and count of the number of plant species present; an estimate of canopy cover and height by growth form (grass, forb, shrub), and an estimate of damage (grass dieback) by grass species. This data has allowed us to gain an understanding of the biology and ecology of TLSB in Hawaii (objective 5) in terms of habitat selection, life cycle, along with the impacts of the bug on the composition of plant species in Hawaii rangelands.

Integrated Pest Management Protocols

Work on this objective is still underway. Through our field observations and literature reviews of TLSB behavior elsewhere we have compiled a short preliminary list of Integrated pest management strategies for ranchers and homeowners. These are being compiled and will be

published in extension documents in the future. Below is a summary of our preliminary IPM strategies for TLSB in pasture areas and for homeowners:

For ranchers with extensive areas infested grazing management strategies are the most cost effective, while reserving high dollar strategies for targeting critical areas or new (small) infestations. Grazing strategies include heavy grazing at the earliest detection to reduce suitable habitat for both the nymphs and adults followed by extended rest to allow for recovery of the forages. These intense grazing bouts may need to be repeated two or three times during the summer months (peak TLSB activity) until the bug goes into diapause (usually October/November). Pesticides are available for spittlebug control in pastures. Many are restricted use, but several are not. Due the cost and potential collateral damage of pesticides it is recommended that ranchers use pesticides strategically to target key use areas and/or where there new, small outbreaks of TLSB. Heavily damaged pastures should be seeded with one or more resistant varieties of forage grasses as soon as possible to help suppress competing weeds and recover forage quality of the pasture.

For home owners it is recommended to reduce watering as this will help dry out the underlying soil-bed reducing the suitability of the habitat of nymph survival. Additionally, the lawn should be kept short as this will reduce nymph and adult habitat. Non-restricted use pesticides can be used to spot treat observed nymph infestations.

3. Program Improvement

The two-line spittlebug infestation in the Kona area is poised to become a major threat to the Hawaii livestock industry. In fact, this pest is likely the most significant and potentially damaging pest for pasture systems ever introduced into Hawaii. At the time of this report the pest has extended its range outside of the Kona area and is now found in the Puuwaawaa area at its northern extent and has also expanded its range in the south. It is likely that within five years the pest will have invaded pastures throughout the Big Island. Yet there is so much we do not understand about the ecology and biology of this pest in Hawaii. Several more years of research and monitoring of the pest's behavior will be necessary to develop a powerful set of integrated pest management strategies that will reduce the impacts on Hawaii rangelands. Raising awareness has been an issue and we are now taking steps to increase the publics exposure to the Two-line Spittlebug problem through social media and other platforms.

4. Additional Comments

See appendix;

Pictures of Two-line Spittlebug, nymphs, damage, and maps of population densities and distribution.

5. Attachments

Two-Line Spittlebug Alert (sent out to ranching community in 2017)

Two-Line Spittlebug update (made available to ranching community in 2018)

Appendix



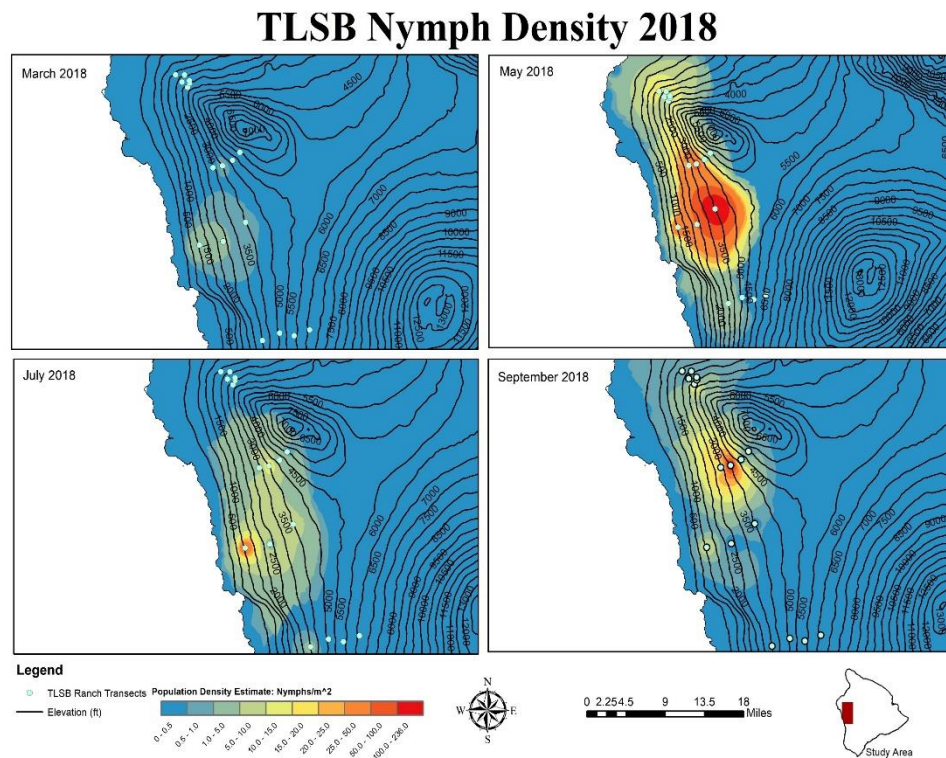
Figure 1. Two-line Spittle Bug adult (top) and nymphs in spittle mass found along grass roots just below the soil surface. Both the adult and nymph feed on the xylem (nymphs) and phloem (Adults) of the plant. Adults inject amylase into the plant that interferes with photosynthesis resulting in leaf die-back and in severe cases, plant death.



Figure 2. Rangeland damaged by Two-Line Spittlebug in the mauka lands of Kailua-Kona. Two-line Spittlebug densities greater than 50 nymphs/m² consistently resulted in the dieback of Kikuyu and Pangola grasses (top) leading to the invasion of weeds such as Pamakani, fireweed, blackberry and many others (bottom).



Figure 3. Progression of a TLSB infestation from initial attack (left, June 2018) on healthy range grasses involving a small patch to all visible range infested (right, January 2019) with dieback of grasses and increasing weed infestation. Applications of pesticides and intensive grazing in the early stage of an infestation may reduce the degree of TLSB damage observed on the right.



Acreage of Infected Area

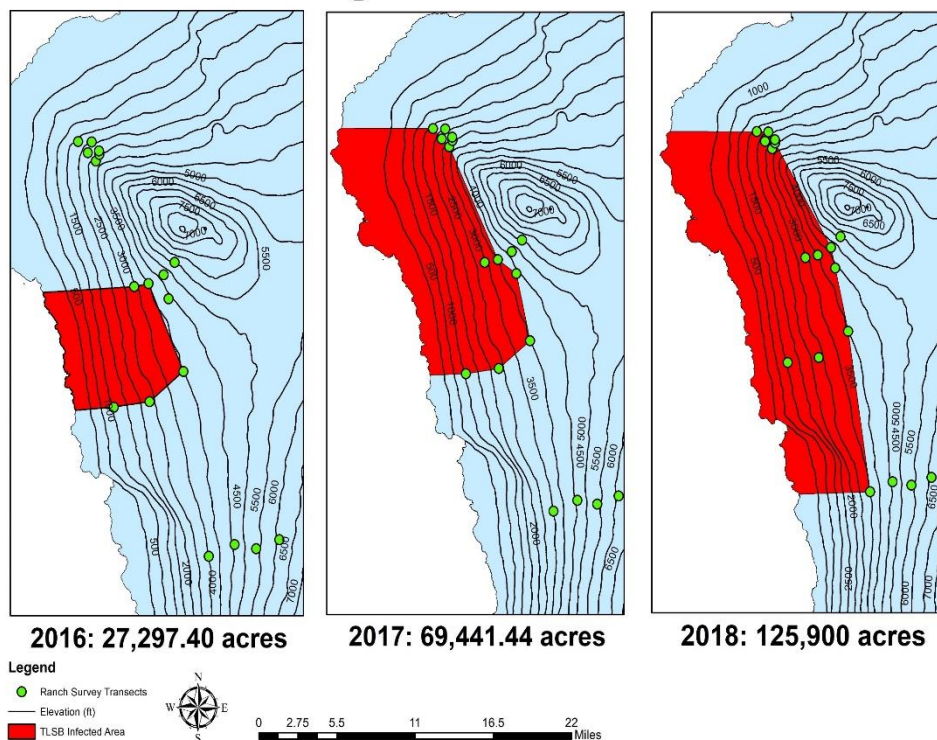


Figure 5. Map series depicting the expansion of Two-Line Spittle Bug in the Kailua-Kona region of Hawaii County between 2016, when it was first identified, and December of 2018.