Semi-annual Project Report

Prosapia bicincta (Two-lined Spittlebug) Detection and Control in Hawaii Contract No. 68126

For the Period of October 1, 2020 – March 31, 2021

Submitted by: Mark S. Thorne, Ph.D. Extension Specialist in Range and Livestock Management University of Hawaii-Manoa Cooperative Extension Kamuela Extension Office 67-5189 Kamamalu Road, Kamuela, HI 96743

And

Mark G. Wright, Ph.D. Professor and Specialist in Entomology Plant & Environmental Projection Sciences University of Hawaii-Manoa 3050 Maile Way Rm. 310 Honolulu, HI 96822

Progress Report

This report covers the period from October 1, 2020 through March 31, 2021. The objectives of the work under this contract are to 1) provide rancher outreach and education; 2) conduct surveys to detect and monitor TLSB populations; 3) develop Integrated Pest Management (IPM) protocols (Pesticides, Grazing management, Forage replacement); 4) conduct biological control agent exploration; and 5) research the biology and ecology of Twolined spittlebug (TLSB). The work and deliverables of each of these objectives are discussed in the following sections. The attached appendix includes pictures of TLSB damaged pastures and example data output from the project.

Twolined spittlebug was first detected in Kailua-Kona, on the Big Island of Hawaii in September of 2016 where it had caused damage to nearly 2,000 acres of pastureland. Monthly pasture surveys that began in in November of 2017 have revealed that the pest has rapidly expanded its range and as of August of 2020 infests over 275 sq. miles or about 176,124 acres (Figure 1). In highly infested areas, the TLSB has resulted in nearly 100% die back of key pasture grasses including Kikuyu (Pennisetum clandestinum) and pangola (Digitaria eriantha) grasses. The loss of these important livestock forages provides entry for the establishment of many undesirable, and often invasive plants including Pamakani (Eupatorium adenophorum), wild blackberry (Rubus spp.), fireweed (Senecio madagascariensis), Hilo grass (Paspalum conjugatum), several other minor grasses of low forage quality, and other weeds. The weeds tend to replace the dead grasses permanently, reducing the quality and usability of the pasture for livestock production. The rate of spread of this pest combined with its devastating impacts on Hawaii's rangelands threatens the economic sustainability of the Hawaii livestock industry.



For more information, please contact Dr. Mark S. Thorne, Extension Specialist in Pasture and Range: thornem@hawaii.edu or (808) 887-6183

Figure 1. Map showing increase in the range of Twolined Spittlebug infestation from 2017-2020. Green dots are monthly survey sites. Yellow dots represent scouted TLSB populations.

Personnel

The current contract provided support for two TLSB research technicians, two graduate students and a partial support for a third Range Research Technician.

Outreach and Education

Due to the ongoing situation with COVID-19 and the University's restrictions on holding in person meetings, much of our planned outreach and education activities have been put on hold. We were able to provide several presentations via online webinars during this past period, several of which were recorded and are now available to view on the University of Hawaii-Manoa Livestock Extension You Tube channel.

Outreach and education activities for this reporting period include:

- Presentation (Graduate Student Paper) Entomology Annual Meeting November 11-25, 2020 (Virtual)
- Presentation Hawaii Cattlemen's Council, November 13, 2020 (online via zoom)
- Presentation Mauna Kea Watershed Alliance, December 15, 2020 (online via Zoom, presentation recorded and available to view on You Tube at: https://youtu.be/ZvTQ6z1ygzg)
- Presentation Three Mountain Alliance Meeting March 4, 2021
- Collaborating with USDA-NRCS to develop information videos on Twolined Spittlebug
 First of several videos available to view at: <u>https://vimeo.com/510897324</u>
- Work continued on the development of the Twolined Spittlebug Management Tool smartphone/computer application (See Appendix A)

Field Surveys – Detection and Surveillance

Monthly field surveys of established transects continue. Twolined spittlebug activity between October 1, 2020 and March 31, 2021 was low for most of the period as the pest was largely in diapause. The pest typically breaks diapause in April with increased activity through May and June. Adult populations peak, typically, in late June and late August, or early September. Monthly reports on the survey data from each location are available.

Integrated Pest Management Protocols

We continue to work on developing and refining IPM protocols for TLSB for ranchers and homeowners. We have derived a sampling protocol for producers/land managers needing to make decisions about implementing IPM protocols. These include:

- 1. Collecting data on nymph density
- 2. Collecting data on TLSB adult activity via sweep net counts
- 3. Monitoring protocols during and post treatment on nymph and adult activity

Using data collected on instar dimensions (length and width; Table 1) we derived three age classes to assist in the classification of nymph population density distributions that allow observers to project the approximate days to expected adult outbreaks (Table 2).

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REPORT: PROSAPIA BICINCTA (TWO LINED SPITTLEBUG DECTION AND CONTROL IN HAWAII

Table 1. Twolined Spittlebug Nymph instar stage, proposed age class distribution and expected days to adulthood by instar and age class, dimensions by age class based on TLSB nymph body length data analyses 12/08/20 (data sheet available on TLSB Google Drive).

			<u>Exp</u> size/dimen	<u>bected</u> nsions (mm)	
		Approximate			
Instar		Expected Days to			Range in Length
Stage	Age Class	Adult	Width	Length	(+/- SD)
1	Age Class 1	50 days	0.13	0.43	0
2	Age Class 1	40 days	0.61	1.80	2.05-1.55
3	Age Class 2	30 days	0.97	2.77	3.46-2.07
4	Age Class 2	20 days	1.43	4.57	5.19-3.95
5	Age Class 3	10 days	2.06	7.63	8.98-6.28

Table 2. Summary Twolined Spittlebug Age Classes (1, 2, or 3) with din	nensions and expected
days to adulthood. To be used in the TLSB mobile application .	

Age	Age class dimensions (mm)		Approximate Days Expected to
Class	Width	Length	Adult
1	< 0.6 mm	< 2.1 mm	More than 35 days
2	1.0 -1.4 mm	2.1-5.2 mm	Between 15 and 35 days
3	>1.5 mm	> 5.3 mm	Within 15 days

Note: Approximate Days Expected to Adult assumes an average 50 days from egg hatch to adult and an even development rate of 10 days between instar stage and selected to be the half-way point between classes in days.

Based on these age class distributions and the approximate threshold of significant damage for Kikuyu grass pasture at more than 60 nymphs/m² we derived three potential damage levels (Table 3) that relate to a series of recommended IPM strategies (Recommended Management Actions, see below).

Table 3. Age Class distribution and Expected Days to Adult by Nymph Density estimates in relation to Potential Future Damage. Yellow (damage level 1) light to moderate forage loss; Orange (damage level 2) moderate to heavy forage loss; Red (damage level 3) heavy to catastrophic forage loss.

	Nymph De	Expected Days		
Age Class	< 10/ m2	11-59/m2	>60/m2	to Adult
1	1	2	3	More than 35
2	1	2	3	15-35
3	2	3	3	Within 15

Management Actions by "Potential Future Damage Level":

Damage Level 1:

- 1. Intensive grazing
 - a. Objective: reduce suitability of pasture conditions for nymph and adult habitat.
 - b. Grazing should reduce forage biomass by more than 65% within one week and be followed by at least 40 days, but no more than 50 days of rest. (Estimated cost \$10/acre)
- 2. Monitoring of TLSB nymph and adult activity
 - a. Objective: determine effectiveness of intensive grazing and continued need
 - b. repeat grazing bouts as needed every 40-50 days as precipitation/forage production allows until detection of nymph/adult activity is zero.

Damage Level 2 (step 1 is essential, step 2 weighed against economic/environmental costs):

- 1. Intensive grazing
 - a. Objective: reduce suitability of pasture conditions for nymph and adult habitat.
 - b. Grazing should reduce forage biomass by more than 65% within one week and be followed by at least 40 days, but no more than 50 days of rest.
 - c. Estimated cost \$10/acre
- 2. Strategic pesticide application (one or the other product, but not both)
 - a. Contact pesticide (for example Carbaryl)
 - i. Objective: control adults
 - ii. Estimated Cost \$40/acre/application)
 - b. Systemic Pesticide (lambda-cyhalothirin/Chlorantraniliprole)
 - i. Objective: Control nymphs and adults
 - ii. Must have Restricted Use Pesticide Permit
 - iii. Estimated Cost \$45/acre/application
 - c. Pesticide applications must be applied post grazing and animal withdrawal periods considered; follow all product label requirements.
- 3. Monitoring of TLSB nymph and adult activity
 - a. Objective: determine effectiveness of intensive grazing and strategic pesticide applications
 - b. repeat grazing bouts as needed every 40-50 days as precipitation/forage production allows until detection of nymph/adult activity is zero.
 - c. Repeat pesticide applications according to label instructions

Damage Level 3:

- 1. Intensive grazing
 - a. Objective: reduce suitability of pasture conditions for nymph and adult habitat.
 - b. Grazing should reduce forage biomass by more than 65% within one week and be followed by at least 40 days, but no more than 50 days of rest.
 - c. Estimated cost \$10/acre
- 2. Strategic pesticide application (one or the other product, but not both)
 - a. Contact pesticide (for example Carbaryl)
 - i. Objective: control adults

- ii. Estimated Cost \$40/acre/application)
- b. Systemic Pesticide (lambda-cyhalothirin/Chlorantraniliprole)
 - i. Objective: Control nymphs and adults
 - ii. Must have Restricted Use Pesticide Permit
 - iii. Estimated Cost \$45/acre/application
- c. Monitor and repeat applications according to product label
- d. Pesticide applications must be applied post grazing and animal withdrawal periods considered; follow all product label requirements.
- 3. Monitoring of TLSB nymph and adult activity
 - a. Objective: determine effectiveness of intensive grazing and strategic pesticide applications
 - b. repeat grazing bouts as needed every 40-50 days as precipitation/forage production allows until detection of nymph/adult activity is zero.
 - c. Repeat pesticide applications according to label instructions
- 4. Herbicide applications
 - a. Objective: reduce weed cover followed by repeat applications as needed
 - b. Estimated cost \$50/acre/application.
- 5. Seed damaged patches/pastures
 - a. Objective: Reestablish pasture forage productivity and ecological condition
 - b. Reseed with a grass/legume combination suitable for the elevation/soil conditions of the pasture (See UH- Cooperative Extension for recommendations) following initial intensive grazing activity.
 - c. Estimated cost \$30/acre.
 - d. Rest from grazing during establishment phase (3-6 months).
 - e. Once new pasture is established, manage grazing, monitor TLSB activity.

These will be compiled and published via extension publications and other media including the Twolined Spittlebug Management Tool, later this year.

Biological Control Agent Exploration

We are working, locally, on potential biological control agents. Though we have not made any new progress on the indigenous insect-pathogenic nematode, it remains an interesting line of research. A pathogenic fungus was observed to cause mortality of adult *P. bicincta*, and samples were collected for submission to the USDA insect pathogen lab in Ithaca, NY.

Greenhouse pesticide screening trials were initiated last fall at the end of the TLSB season. To determine whether *Beauveria bassiana* (formulated as Botanigard[®]) is potentially effective against twolined spittle, trials were conducted in Petri dishes (dipped adult TLSB, Botanigard compared with controls), and in caged trials (adults). Two dose rates of Botanigard[®] were applied: the label rate (1x), and a 4x dose. An untreated control was included in the trials, and a labelled pesticide, Sevin[®] was included as a standard treatment in the cage trials. Four replicates of five adult TLSB were used for each treatment. Morality was assessed daily for seven days following treatment. Data were analyzed using Kaplan-Meir curves in Prism (GraphPad) to determine probability of survival of TLSB in each treatment, median survival, and to compare the survival curves with logrank tests.

The insects treated in Petri dishes died quickly after treatment in the 4x Botanigard treatment, and died at a slightly slower rate in the 1x treatment, confirming their susceptibility to *B*. *bassiana*. The caged trials produced median survival of 7 days for the controls; 5 days for Botanigard 1x; 4 days for Botanigard 4x; and 1 day for Sevin. The survival curves are shown in Figure 2. Isolates were collected and grown on PDA plates in the lab to confirm that *B. bassiana* was the causal agent in TLSB that died and had signs of mycosis.



Figure 2. Kaplan-Meir survival curves for TLSB exposed to 3 pesticide treatments and a control. The curves were significantly different (logrank test, P < 0.05).

These results suggest that while TLSB are susceptible to Botanigard, treatment at the label rate produced slow mortality, not different from the control. The 4x Botanigard treatment resulted in death of all treated TLSB by the fifth day following treatment. These early trials suggest that while TLSB adults are susceptible to the fungal strain in BotaniGuard, spraying at the recommended rate (4X) may not be economically efficient at the field scale. Additional trials will be conducted this summer to further assess the effectiveness of BotaniGuard on TLSB adults. This will include controlled experiments in the greenhouse and filed plot trials.

Exploration of potential biological agents in the home range of TLSB have been put on hold because of the COVID-19 crisis.

Twolined Spittlebug Biology and Ecology

In addition to the data collected during the monthly surveys that revel important aspects of the biology and ecology of TLSB, several controlled experiments are underway. These include host-plant specificity trials and adult density threshold (economic injury level) trials.

Last reporting period we provided a summary of results from these trials on six varieties of grass tested. Based on this established protocol we will be trials on 12 varieties of grasses, including two experimental varieties developed in Brazil to be spittlebug resistant, one variety developed

in Columbia for spittlebug resistance, along with Mulato II, a *Brachiaria* spp. hybrid developed for spittlebug resistance, Gatton panic, Bahia Tifton 9, Mirandu (*Brachiaria brizantha*), Rhodes grass, and four other naturalized grasses commonly found in Hawaii pasture systems. These trials will begin as the TLSB season begins this summer as that will be when we can capture adults to use in the trials.

In February we began establishing nine research units across three cooperating ranches. On each ranch, three units will be completed along an elevational gradient that spans different forage zones and soil types. Each unit contains 32 plots measuring 2 meters x 2 meters in size and arranged in a randomized split-plot design with one half of each research unit excluded from grazing through fencing and the other half exposed to fencing (Figure 3). This arrangement will allow us to test eight varieties of grasses (4 replications per variety per research unit) for TLSB infestation rates, tolerance/resistance, and forage quality and productivity, across different elevations and under grazed and ungrazed conditions (Table 4). As of March 31, three lower elevation units on each ranch had been completed (Figure 4).



Figure 3. Example layout of research unit showing randomized split-plot design of different grass species (color coded) plots exposed to grazing or not (enclosed in fencing depicted in orange). Note, only 16 plots shown.

Table 4. Grass species/varieties, listed by common name, scientific name, our code designation, and a description. These eight forage grasses will be tested for TLSB infestation rates, resistance, forage quality and productivity over the summer 2021 TLSB season in nine different research units spanning different ecological zones on three different cooperating ranches. Establishment of the research units began in February 2021 and continues as of the date of this report.

Grass	Scientific Name	Code	Description	
Sabia	Brachiaria Hybrid v Sabia	BrHyvS	Barenbrug developed hybrid	
Cayana	Brachiaria Hybrid v Cayana	BrHyvC1	Barenbrug developed hybrid	
Bahia T9	Paspalum Notatum v Tifton 9	PanoT9	USDA developed variety of Pensecola Bahia	
Gatton Panic	Panicum maximum v Gatton	Pama		
Kikuyu	Pennisetum clandistinum	Pecl		
Marandu	Braciaria brizantha v Marandu	BrbrM	Base species of Brachiaria for Hybrids with spittlebug resistance	
Mulatto II	Brachiaria Hybrid v Mulatto II	BrHyvM	I CIAT developed Brachiaria hybrid with spittlebug resistance	
Cayman	Brachiaria Hybrid v Cayman	BrHyvC2	2 CIAT developed Brachiaria hybrid with spittlebug resistance	



Figure 4. Completed research unit at PR-1 (left) and research unit at WR-2 (right) being seeded.

Future Plans:

Surveys of established transects on the four ranch properties will continue monthly to monitor TLSB activity, establish biology and ecology of TLSB in Hawaii, collect samples of nymphs and adults for study, and propagation for greenhouse trials on grass selections and pesticides, and inform the development of integrated pest management strategies. Spittlebug activity will be evaluated on each of the nine field research units each month during the peak TLSB season. Forage samples will be collected to evaluate quality and productivity across different ecological zones and elevations.

In addition to the monthly monitoring of the established transects, every two weeks on a select ranch, collection surveys will be conducted to gain insight into the population dynamics of the TLSB across seasons along an elevational gradient. Additional surveys of affected ranchlands within the Kona area will be conducted over the summer on several ranches to quantify the extent and range of damages by TLSB.

We will conduct a series of workshops, in person if the COVID-19 situation allows, or as a webinar series, that will bring together the expertise of several people and the TLSB team to engage and inform Hawaii Livestock Producers on our current knowledge and management protocols for TLSB. These will be held this summer or early fall.

At least two extension publications will be drafted for publication this summer; one will focus on correctly identifying TLSB in the field and the other will provide management protocols for ranchers.

The TLSB Mobil Application will be released in beta form sometime late this summer or early fall. This application will 1) allow users to report, picture, and geolocate TLSB activity; 2) provide for field identification and estimate level of infestation of TLSB; 3) provided a decision support tool for management decisions based on infestation thresholds; and 4) provide general information on the biology and ecology of TLSB (See appendix A).

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Appendix A



Twolined Spittlebug

Hybrid App

UI Design Document Version 0.3 | 01/21/2021

Document History

Date	Author	Version	Changes	Reviewed By	Approved By
11/26/2020	ВА	0.1	Initial Draft.	TW Dept.	-
12/29/2020	ВА	0.2	UI Updates in Reporting Tool (see <u>Figure 8Figure 8</u>) Information Guide (see <u>Figure 13Figure 13</u>) Management Decision Tool (see <u>Figure 11Figure 11</u>).	TW Dept.	-
01/21/2021	ВА	0.3	Home screen (see <u>Figure 3Figure 3</u>) updated Reporting Tool screen (see <u>Figure 8Figure 8</u>) UI update Damage Calculator updated (see <u>Figure 11Figure 11</u>) Information Guide screen (see <u>Figure 13Figure</u> 13) updated Settings screen UI updated Report History (see <u>Figure 15Figure 15</u>), Report Details (see <u>Figure 16Figure 16</u>), Edit Report Details (see Figure 17Figure 17) screens updated.	TW Dept.	-

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Introduction

Document Purpose and Scope

The purpose of this document is to finalize the user interface (UI) design of the **Twolined Spittlebug** Hybrid app. The UI design proposed for the website is illustrated in this document using <u>wireframes</u> and sample data.

Intended Platforms

iOS and Android. Supports Portrait Orientation only.

General Notes

This document is best viewed at 200% zoom level.

All the references to page numbers and figures in the document are <u>clickable</u>.

Project Overview

This document describes the features and working of the **Twolined Spittlebug** Hybrid app. This app allows the user to identify and report the sightings of the Twolined Spittlebug in Hawaii. The Twolined Spittlebug is a pest that has potential to cause great damage to the forage and grass if not identified early and proper measures are not taken. The app has features like, Spittlebug Identification Tool, Information Guide, Report Tool, Management Decision Making Tool, Report History and User Maps.

Workflow

The following is the proposed workflow of the app.



Figure 1

Twolined Spittlebug | Hybrid App | UI Design Document | v0.3

1. Splash



Twolined Spittlebug | Hybrid App | UI Design Document | v0.3

Figure 2Figure 2 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Blue
	Text Image	The logo of the app is displayed here.	
TWOLINED			
SPITTLEBUG			

2. Home





Figure 3Figure 3 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Twolined Spittlebug	Text	The name of the app is displayed on the Home screen.	
Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac.	Text	A description of the app is displayed here.	
Identify Twolined Spittlebug Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo.	Image Text Button	Tap to access Identify Twolined Spittlebug screen (see <u>Figure 4Figure 4</u>). The user will be able to positively identify the Twolined Spittlebug with the help of the Spittlebug Wizard. The wizard will guide the user through a series of steps to identify the Twolined Spittlebug.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Report Twolined Spittlebug Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo.	Image Text Button	 Tap to access the Report Twolined Spittlebug screen (see Figure 8Figure 8). The user can use this tool to report confirmed sightings of the Twolined Spittlebug to the Twolined Spittlebug (TLSB) Research Team. User can enter the following details in the Reporting Tool, Life Stage of the Twolined Spittlebug (Nymph or Adult) Images Description Location coordinates of the Twolined Spittlebug sighting Location details Date and time Total size of the affected land in acres (Optional) Select the percentage of area affected (4 Categories: 0-25%, 26-50%, 51-75%, 76-100%) (Optional) Number of Nymphs found per m² based on different Instar Age Classes (Optional) Calculated damage level caused by the Twolined Spittlebug (Optional) 	Formatted: Font color: Custom Color(RGB(0,0,204))

	Image Text	Tap to access the Management Decision Tool (see Figure 9Figure 9). The Management	Formatted: Font color: Custom Color(RGB(0,0,204))
Management Decision Tool	Button	Decision Tool can be used by ranchers and farm owners to understand the extent of damages	
etiam, nunc amet dolor ac odio		infestation and reduce the damage to grass and crops.	
mauris justo.		The Management Decision Tool has a set of pre-defined steps that ranchers and farm owners	
		can follow to control the spread of the Twolined Spittlebug.	
	Image Text	Tap to access the Information Guide screen (see <u>Figure 13</u> Figure 13). The Information Guide	Formatted: Font color: Custom Color(RGB(0,0,204))
Information Guide	Button	neips the user to understand more about the types of Spittlebugs found in Hawaii.	
Lorem ipsum dolor sit amet,		Commonalities between all three species:	
ac odio mauris justo.		1. Sucking insects	
		2. Three life stages: Egg, Nymph, Adult	
		3. Five Nymphal developmental stages	
		4. Introduced exotic species to Hawaii	
		5. Xylem feeding	
		6. Spittlemass production for protection	
		7. Adult Spittlebugs will hop and fly	
		The Information Guide will have the following details for the Twolined Spittlebug (<i>Prosapia bicincta</i>), Meadow Spittlebug (<i>Philaenus spumarius</i>) and Clastoptera spp:	
		- Description of the different Spittlebug species	
		- Life Stages of the selected Spittlebug species	
		- Details of the Spittlebug	
		- Spittlemass formation	
		- Habitat	
		- Biology	
		Ecology	

1		1		
	-	Tab Bar	User can tap this button to navigate to the Settings screens (see Figure 14Figure 14).	 Formatted: Font: Bold, Font color: Custom
	1			Color(RGB(0,0,204))
				<u></u>

3. Home > Identify Twolined Spittlebug

 Identification Tool Help us with some quick question to identify Twolined Spittlebug 	Shown on tapping the Shown on the Home screen (see Figure 3Figure 3).	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi.	The user will be able to positively identify the Twolined Spittlebug using the help of the Spittlebug Wizard. The wizard will guide the user through a series of steps to identify the Twolined Spittlebug. Tap the Start Wizard button to start the Spittlebug Wizard (see Figure 5Figure 5). For details on the UI Elements, see the next page.	Formatted: Font color: Custom Color(RGB(0,0,204))
Figure 4		
Twolined Spittlebug Hybrid App UI Design Document	v0.3 Zco Confidential 12	

Figure 4 Figure 4 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
\leftarrow	Button	Tap the Back button to go the previous screen (see Figure 3Figure 3).	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Help us with some quick question to identify Twolined Spittlebug Lorem ipsum dolor sit amet, saplen etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi.	Text	Description about the working of the Spittlebug Wizard.	
	Button	Tap to start the Spittlebug Wizard (see <u>Figure 5Figure 5).</u>	Formatted: Font color: Custom Color(RGB(0,0,204))
Start Wizard			

**	Step 1 of the Spittlebug Wizard is shown when the user taps the Start Wizard button in Figure 4Figure 4.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Spittlebug Wizard 🗙	Every step of the wizard will have selectable options that will help the user to positively identify the Twolined	
1 of 7	Spittlebug If the user is unsure about the answer to the question asked, he/she can tan the CHECK button	
	to navigate to the Information Guide (see Figure 13Figure 13). User can refer to the guide for information on	Formatted: Font color: Custom Color(RGB(0.0.204
is your specifien		
Not sure? Check the Information Guide CHECK	how to correctly answer the question in the wizard. When on the Information Guide screen, tap the	
	button to return to the Spittlebug Wizard.	
An Adult?		
A Nymph?	The answer selected by the user will be indicated by the radio button.	
O A Spittlemass?	NEXT	
	wizard (see Figure 6Figure 6	Formatted: Font color: Custom Color(PGB(0.0.204)
	Tap the button to close the wizard anytime.	
	For details on the UI Elements, see the next page.	
NEXT		
Figure 5		

Twolined Spittlebug | Hybrid App | UI Design Document | v0.3

Figure 5Figure 5 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Spittlebug Wizard	Text	Title text of the screen.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
×	Button	Tap this button to close the Spittlebug Wizard.	
1 of 7	Text	Indicates the current step in the Spittlebug Wizard.	
ls your specimen	Text	Question asked in the current step of the Spittlebug Wizard.	_
Not sure? Check the Information Guide	Text Button	Informs the user that he/she can tap the CHECK button to navigate to the Information Guide (see Figure 13 Figure 13) for more details.	Formatted: Font color: Custom Color(RGB(0,0,204))
An Adult?	Radio Button Text	Answer options to the question asked in the current step of the Spittlebug Wizard. User can select his/her answer.	
O A Nymph?			
O A Spittlemass?			
NEXT	Button	Tap this after selecting the answer to navigate to the next step in the Spittlebug Wizard.	



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Figure <u>6Figure 6</u> - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
A Twolined Spittlebug	Radio Button Text Image	The answer selected by the user is shown by the selected radio button. Some answers will also have images and a description to make the identification process easy and accurate.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
O A Meadow Spittlebug	Radio Button Text Image	An unselected answer is denoted by an empty radio button.	



<u>Figure 7</u> Figure 7 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Great.!!! You have found a Twolined Spittlebug	Text	Informs the user that he/she has spotted the Twolined Spittlebug.	
	Image	Image of the Twolined Spittlebug is shown to help the user compare it with the Spittlebug that he/she spotted. User can perform one last check before reporting the sighting to the TLSB Research Team.	
Report Now	Button	Tap the button and the Report the Twolined Spittlebug screen (see <u>Figure 8Figure 8</u>) will be shown. User can enter the details and report the sighting to the TLSB Research Team.	Formatted: Font color: Custom Color(RGB(0,0,204))

4. Home > Report Twolined Spittlebug

* 🕿 🔳 **Report Twolined Spittlebug** Report Twolined Spittlebug Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor Follow these steps to Report a Twolined ac odio mauris justo. Shown on tapping the option on the Home screen (see Figure 3Figure Spittlebug (Nymph/Adult) ₴). 1.Select the Twolined Spittlebug Life Stage Nymph Adult The user can use this tool to report the sighting of the Twolined Spittlebug to the Twolined Spittlebug (TLSB) Research Team. Not sure about Twolined Spittlebug? Check out the Identification Tool now User can enter the following details in the Reporting Tool, Check Now Select the Twolined Spittlebug Life Stage (Nymph or Adult) 2.Take a picture or Upload from your phone Image Description (e.g. Location (pasture, forest, lawn, garden), Spotted on (grass, shrub, tree, other plant), and Species of plant type) +Location coordinates of the Twolined Spittlebug sighting 3.Enter details about the Twolined Spittlebug Location details found (e.g. Location (pasture, forest, lawn, Date and time garden), Spotted on (grass, shrub, tree, other plant), and Species of plant type) Enter total estimated area of affected land in acres (Optional) Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent Select the percentage of area affected (4 Categories: 0-25%, 26-50%, 51-75%, 76-100%) (Optional) at id quisque ac. Arcu es massa vestibulum malesuada. integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer Number of Nymphs found per Square Meter based on different Instar Age Classes (Optional) vivamus elit. Calculated damage level caused by the Twolined Spittlebug (Optional) 4.Get your current location Only the Twolined Spittlebug should be reported to the TLSB Research Team. The TLSB Research Team will use the location coordinates and other details shared by the user to create a Master Map to track the Figure 8 sightings and spread pattern of the Twolined Spittlebug in Hawaii. This master map will not be displayed in

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	the app.



Every sighting that is reported by the user is stored in the mobile device's local storage (iPhone and Android). User will be able to see this data when he/she opens the Report History screen (see <u>Figure 15Figure 15</u>) from the Home screen.

User can edit the details of the reported sightings from the Report Details screen (see Figure 16Figure 16). However, he/she will not be able send the edited details to the TLSB Research Team.



When user taps button, all the details will be sent to Firebase Cloud Firestore of the TLSB Research Team. Images will be uploaded to TLSB Firebase Storage and url of the image will be sent along with other details.

For details on the UI Elements, see the next page.

[Zco: TLSB has mentioned in the "Spittlebug_Hybrid_UI Design_Document_v0.1 MT Comments" document to add "or adults collected with sweep net" to "Number of Nymphs found per m2" to the optional section of the Reporting Tool. Please check the image below for reference.

Location details

Date and time

Number of Nymphs found per m² or adults collected with sweep net

But the damage calculator in the Management Decision Tool mentions only about the Twolined Spittlebug Nymphs. "Adult Twolined Spittlebugs" are not mentioned in the Instar Table or Age Class Distribution Table. So would it be accurate to include the phrase "or adults collected with sweep net" in the optional section of Reporting Tool? Could you please validate this scenario?]

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Commented [MT1]: There are a couple of things at work here: 1) the need to provide users with some estimate of the potential for damage with some accuracy; and 2) the option for users to monitor the change in TLSB population at a given location over time (monitoring). Calculating TLSB damage accurately is best done with counting the nymphs because they do not move around, and we can easily determine their density. Adult TLSB move around too much and counting their numbers using sweep net capture will not yield population density. However, we do feel that adult sweep net counts taken over time can provide a relative indication of the trend in the population (increasing, decreasing, staying the same). This would be a useful way to track TLSB nymph-to-adult transition, and to determine the effect of any management actions taken.

I don't know how this would play out in the design of the TLSB tool app, but it would be best to separate the calculation of damage that is strictly based on nymphs/m2 and the adult sweep net counts which are useful for monitoring as explained above.

Alternatively, we could try to derive a damage scale based on adult sweep net counts to be used to supplement the damage scale by nymph density. I will have a discussion with my colleagues about this.

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Figure <u>8</u> Figure 8 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Report Twolined Spittlebug	Text	Title text of the screen is displayed here.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Follow these steps to Report a Twolined Spittlebug (Nymph/Adult)	Text	Description of the screen is shown here.	
1.Select the Twolined Spittlebug Life Stage Nymph Adult	Text Button	User can select the life stage of the Twolined Spittlebug spotted, according to its Life stage: Nymph or Adult.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Not sure about Twolined Spittlebug? Check out the Identification Tool now Check Now	Text Button	If the user is not sure about the species of Spittlebug found, tap the Check Now button to navigate to the Identify the Twolined Spittlebug screen (see Figure 4Figure 4).	
2.Take a picture or Upload from your phone	Text Button	Tap the button to take a picture or upload an image of the sighted Twolined Spittlebug from the mobile device's gallery.	

Figure <u>8</u> Figure 8 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
3.Enter details about the Twolined Spittlebug found (e.g. Location (pasture, forest, lawn, garden), Spotted on (grass, shrub, tree, other plant), and Species of plant type)	Text Textbox	User can enter the details of the Twolined Spittlebug spotted. Details like spotted location (e.g. pasture, forest, lawn, garden etc.), spotted on (e.g. grass, shrub, tree, other types of plant etc.) and species of affected plant type helps the TLSB Research Team to evaluate the species of the Twolined Spittlebug found.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit.			
4.Get your current location	Text Image Button	User can tan the Get Current Location button to get the current location using	
Antipolitika An		the Location Services (mobile device GPS) feature of his/her mobile phone. Tap the button and the mobile device will request for permission to find the current location. If permission is given, the current location of the user will be acquired and the location coordinates displayed as, Your coordinates are 19.896767, -155.582779 The location will also be marked using a	
Get Current Location			
Your coordinates are 19.896767, -155.582779			

Figure <u>8</u> - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
5.Enter Location Details Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit.	Text Text box	User can enter the details of the Twolined Spittlebug's location. The TLSB Research Team can use these coordinates to mark the sighting on a master map.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
6.Select Date and Time	Text Text field Button	User can tap the button to select the date and time of spotting the Twolined Spittlebug.	
Use the Damage Calculator in Management Decision Tool to enter the following details Note: The following Information is Optional Check Damage Calculator	Text Button	The remaining information that needs to be entered in the Reporting Tool is optional. The user can skip entering these details if he/she chooses to. User can also report the sighting of a Twolined Spittlebug without entering these details. If the user wants to enter this information, he/she can use the Damage Calculator in the Step 3 of the Management Decision Tool (see Figure 11Figure 11). If the user is not sure about the damage level calculated earlier or he/she hasn't already calculated the damage level caused by the Twolined Spittlebug, he/she can tap the Check Damage Calculator button to view the Damage	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
		Calculator.	
Figure <u>8</u> Figure 8 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
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7.Enter total estimated area of affected land in acres Enter the total affected land in Acres 8.Select percentage of area affected 0-25% 26-50% 51-75% 76-100% 9.Enter number of Nymphs found/m² Age Class 1: Enter Value Age Class 2: Enter Value Age Class 3: Enter Value 10.Enter calculated Damage Level Enter Damage Level	Text Text field Button	 The user can do the following details in this section, Enter the total estimated area of the affected area in acres. Select the percentage of affected area in his/her land. User can select from 4 Categories (0-25%, 26-50%, 51-75%, 76-100%). Enter the number of Twolined Spittlebug Nymphs found per Square Meter. If there are Twolined Spittlebug Nymphs in different Age Classes, the user has to enter their count separately in the dedicated text field. The user has to enter the number of Twolined Spittlebug Nymphs found, in at least 1 Age Class. Enter the calculated damage levels calculated using the Damage Calculator in the Management Decision Tool (see <u>Figure 11Figure 11</u>). 	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))

Name	Scenario	Сору
Blank fields/Invalid data	If the required fields are left blank or invalid data is entered.	Enter details about Spittlebug found.
		Enter location details.
		Select Date and Time.
No Image	If the user has not captured or selected an image.	Take a picture or Upload from your phone.
No Location	If the user has not acquired his/her current location.	Get your current location.

Error States in Report Twolined Spittlebug screen

5. Home > Management Decision Tool

 Management Decision Tool This tool will help you to understand the extent of damages caused by Twolined Spittlebugs and effective solutions to manage them 	Shown on tapping the Shown on	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Step 1 : Survey Protocols	The Management Decision Tool can be used by ranchers and farm owners to understand the extent of	
Follow the Survey Protocols to find the Twolined Spittlebug Nymph density in the affected area Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus ellt eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus ellt eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget. Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget.	damages caused by the infestation of the Twolined Spittlebug and the effective solutions to manage the spread of infestation and reduce the damage to grass and crops. The Management Decision Tool has a set of pre-defined steps that ranchers and farm owners can follow to control the spread of the Twolined Spittlebug. Step 1 is to follow the Survey Protocols to find the density of the Twolined Spittlebug Nymphs in the affected area. After Step 1 is finished, the user can tap the Management Decision Tool (see Figure 10Figure 10). For details on the UI Elements, see the next page.	Formatted: Font color: Custom Color(RGB(0,0,204))
NEXT Figure 9		

<u>Figure 9</u> - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Management Decision Tool	Text	Title text of the screen is displayed here.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
This tool will help you to understand the extent of damages caused by Twolined Spittlebugs and effective solutions to manage them	Text	Description of the screen is shown here.	
Step 1 : Survey Protocols Follow the Survey Protocols to find the Twolined Spittlebug Nymph density in the affected area	Text	Step 1 of Management Decision Tool is displayed here. User can follow the Survey Protocols to find the density of the Twolined Spittlebug Nymphs in the affected area.	
Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget. Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris etis, mi mattis pariatur aliquam pharetra eget.	Text	A detailed description of the Survey Protocols is displayed here. [TLSB Team : (sample ring size (.25 m2); number of rings to sample, description of locating and counting nymphs, measuring and sizing nymphs (age class distribution); using tool to 1) determine how many rings to collect (sample size calculations); 2) record number of nymphs by age class (age class distribution); estimate potential damage and by age class.] [Zco : This will be implemented after collecting further details from TLSB Team.]	
NEXT	Button	After Step 1 is finished, the user can tap the button to view Step 2 of the Management Decision Tool (see Figure 10Figure 10).	Formatted: Font color: Custom Color(RGB(0,0,204))

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Management Decision Tool	Shown on tapping the button in Step 1 of the Management Decision Tool (see Figure	
Step 2 : Find Nymph Density	9Figure 9). Step 2 is to find the density of the Twolined Spittlebug Nymphs in the affected area using data from the Instar	
Find the different growth stages of Twolined Spittlebug Nymph	Stages Table and Age Class Distribution Table.	
Twolined Spittlebug Nymph Instar Stages Table	After Step 2 is finished, the user can tap the NEXT button to view Step 3 of the Management Decision Tool (see <u>Figure 11Figure 11</u>).	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Find TLSB Age Class distribution and expected days to adult by comparing Nymph Density	For details on the UI Elements, see the next page.	
Twolined Spittlebug Nymph Age Class Distribution Table		
Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac.		
NEXT		
Figure 10		

Figure <u>10</u> Figure 10 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Find the different growth stages of Twolined Spittlebug Nymph	Text Button	Find the different Life Stages of the Twolined Spittlebug Nymph using the Instar Stages Table. [TLSB Team: "This has been completed and I will send you the table in as a separate attachment."]	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Twolined Spittlebug Nymph Instar Stages Table		[TLSB Team: Somewhere between step one and step 2 we need a tool to estimate the number of).25 m2 rings to collect. This is a sample size calculation; one of my colleagues has been working on this and we will be able to provide a formula that can be used to generate the number based on the absolute nymph counts in one or two rings. Once they have counted and age classed the nymphs (i.e. 5 in age class one, 4 in age class 2; and 1 in age class 3) I think these should be entered into the tool to calculate to give us an age class distribution, they can determine the expected days to adult/ and potential future damage level (1-3).]	
		[Zco: This will be implemented after collecting further details from TLSB Team.]	
Find TLSB Age Class distribution and expected days to adult by comparing Nymph	Text Button	Find the Twolined Spittlebug Age Class distribution and expected days to maturity by comparing the density of the nymph spotted per Square Meter.	
Density Twolined Spittlebug Nymph Age Class Distribution Table		[TLSB Team: This should appear for the user based on the age class density distribution data recorded by the user: i.e. they should record the total number of age class 1, 2, and 3 observed across all rings the tool would then calculate, based on the density distribution of the age classes the expected days to adults and potential future damage level (1-3); and also provide an estimate, by expected days to adult, of the number adults per acre for each age class. You will need some data to work with for this and I will get that to you. I will also draft something up to explain better what I want here. This would probably go in	
		the next screen "Damage Calculator".] [Zco: This will be implemented after collecting further details from TLSB Team.]	
NEXT	Button	After Step 2 is finished, the user can tap the button to view Step 3 of the Management Decision Tool (see Figure 11Figure 11).	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))

Image: Constraint of the series of the se	Shown on tapping the	Formatted: Font color: Custom Color(RGB(0,0,204))
Figure 11	For details on the UI Elements, see the next page.	

Figure 11Figure 11 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Step 3 : Damage Calculator Calculate the damage levels caused by Twolined Spittlebugs	Text Text Text	Title and explanation of the screen are displayed here.	
Enter total size of affected land in Acres Enter Value Select percentage of area affected 0-25% 26-50% 51-75% 76-100% Enter total number of Nymphs found/m ² Age Class 1: Enter Value Age Class 2: Enter Value Age Class 3: Enter Value Calculate	field	 based on a variety of factors like, Total size of affected land in Acres Percentage of area affected (4 Categories: 0-25%, 26-50%, 51-75%, 76-100%) Number of Nymphs found per Square Meter based on different Instar Age Classes. Note that, the user has to enter the number of Twolined Spittlebug Nymphs found, in at least 1 Age Class. Expected days to maturity Enter/select the above factors and tap the	

<u>Figure 11</u> Figure 11 - UI Element	Туре	Functionality / Requirements	 Formatted: Font color: Custom Color(RGB(0,0,204))
View	Button	User can tap the button to view the Recommended Damage Management Action suggested by the Damage Calculator (see <u>Figure 12</u> Figure 12).	Formatted: Font color: Custom Color(RGB(0,0,204))

Error States in Management Decision Tool screen

Name	Scenario	Сору	
Blank fields/Invalid data	If the required fields are left blank or invalid data is entered.	d. Enter total size of affected land in acres.	
		Enter number of Nymphs found/m ² in minimum 1 Age Class.	

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 Management Decision Tool Damage Level 2 	Shown on tapping the <u>View</u> button in Step 3 of the Management Decision Tool (see <u>Figure 11</u>). <u>11</u> Figure 11). There are 4 levels of Management Actions. Recommended Damage Management Action is decided on the	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Management Action	basis of the damage level determined by the Damage Calculator based on a variety of factors. Scrolling down	
 Intensive grazing Objective: Reduce suitability of pasture conditions for nymph and adult habitat. Grazing should reduce forage biomass by more than 65% within one week and be folowed by at least 40 days, but no more than 50 days of rest. Estimated cost \$10 per acre Strategic pesticide application (one or the other, but not both) Contact pesticide (for example, Carbary) Objective: Control adults Estimated Cost \$40 per acre per application) Systemic Pesticide Imbda-cyhalothirin/Chlorantraniliprole) Objective: Control nymphs and adults Must have Restricted Use Pesticide Permit Estimated Cost \$45 per acre per application Objective: Control nymphs and adults Must have Restricted Use Pesticide Permit Stimated Cost \$45 per acre per application Objective: Control nymphs and adults Must have Restricted Use Pesticide Permit Stimated Cost \$45 per acre per application Objective: Control nymphs and adults Must have Restricted Use Pesticide Permit Stimated Cost \$45 per acre per application Objective: Determine effectiveness of post grazing and animal withdrawal periods considered. Monitoring of TLSB nymph and adult activity Stictive: Determine effectiveness of patients of patients. 	the screen will display a DONE button. 3. Monitoring of TLSB nymph and adult activity a. Objective: Determine effectiveness of intensive grazing and strategic pesticide applications b. Repeat grazing bouts as needed every 40-50 days as precipitation/forage production allows until detection of nymph/adult activity is zero. c. Repeat pesticide applications according to label instructions DONE Tap the DONE button to go back to Step 3 of the Management Decision Tool (see <u>Figure</u> 11Figure 11) and reset the Damage Calculator. For details on the UI Elements, see the next page.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))

Figure <u>12</u> Figure 12 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Damage Level 2 Management Action 1. Intensive grazing a. Objective: Reduce suitability of pasture conditions for nymph and adult habitat. b. Grazing should reduce forage biomass by more than 65% within one week and be followed by at least 40 days, but no more than 50 days of rest. c. Estimated cost \$10 per acre 2. Strategic pesticide application (one or the other, but not both) a. Contact pesticide (for example, Carbaryl) i. Objective: Control adults ii. Estimated Cost \$40 per acre per application) b. Systemic Pesticide (lambda-cyhalothirin/Chlorantraniliprole) i. Objective: Control nymphs and adults ii. Estimated Cost \$45 per acre per application c. Pesticide applications must be applied post grazing and animal withdrawal periods considered. 3. Monitoring of TLSB nymph and adult activity a. Objective: Determine effectiveness of	Text	The details of the recommended damage management action based on damage level are displayed here. Ranchers and farm owners can use this information to plan and implement the required damage management action.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
DONE	Button	Tap the button to go back to Step 3 of the Management Decision Tool (see <u>Figure 11Figure 11</u>) and reset the Damage Calculator.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))

6. Home > Information Guide



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Figure 13 Figure 13 - UI Element	Туре	Functionality / Requirements
Information Guide	Text	Title text of the screen is displayed here.
 This guide will help you to understand more about the 3 Species of Spittlebug found in Hawaii Commonalities between all three species: Sucking insects Three life stages: Egg, Nymph, Adult Five Nymphal developmental stages Introduced exotic species to Hawaii Xylem feeding Spittlemass production for protection Adult Spittlebugs will hop and fly 	Text Button	Commonalities between all 3 species of Spittlebug found in Hawaii are displayed here. Commonalities are, 1. Sucking insects 2. Three life stages: Egg, Nymph, Adult 3. Five Nymphal developmental stages 4. Introduced exotic species to Hawaii 5. Xylem feeding 6. Spittlemass production for protection 7. Adult Spittlebugs will hop and fly
TwolinedMeadowClastopteraSpittlebugSpittlebugspp	Text Button	User can select a button to learn about the different species of Spittlebugs found in Hawaii.
Twolined Spittlebug Description	Text	Detailed description of the selected species of Spittlebug is displayed here. User can view the additional images by tapping the and buttons. User can tap an image to view it in full screen mode.

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Location Description	Text Image Button	The reason for selecting location to create spittlemass by the selected species of Spittlebug is explained here. User can view the additional images by tapping the and buttons. Tap an image to view it in full screen mode.
Habitat Habitat Ha	Text Image Button	Images and detailed descriptions of the Habitat of the selected species of Spittlebug are displayed here. User can expand this section by tapping the button. Tap the button again to collapse it. User can view the additional images by tapping the and buttons. User can tap an image to view it in full screen mode.
Biology	Text Image Button	Images and detailed descriptions of the Biology of the selected species of Spittlebug are displayed here. User can expand this section by tapping the button. Tap the button again to collapse it. User can view the additional images by tapping the and buttons. User can tap an image to view it in full screen mode.

Egg Dispersal Description		Text Image Button	Images and detailed descriptions of the egg dispersal of the selected species of Spittlebug are displayed here.
	>		User can view the additional images by tapping the and buttons. Tap an image to view it in full screen mode.
Feeding Habits		Text Image Button	Images and detailed descriptions of the feeding habits of the selected species of Spittlebug are displayed here.
	>		User can view the additional images by tapping the and buttons. Tap an image to view it in full screen mode.
Life Span		Text Image Button	Images and detailed descriptions of the life span of the selected species of Spittlebug are displayed here.
	>		User can view the additional images by tapping the and buttons. Tap an image to view it in full screen mode.

Ecology	Text Image Button	Images and detailed description of the Ecology of the selected species of Spittlebug is displayed here. User can expand this section by tapping the button. Tap the button again to collapse it. User can view the additional images by tapping the and buttons. Tap an image to view it in full screen mode.
Nymphs Adults Description	Text Image Button	Images and detailed description of the feeding locations of the selected species of Spittlebug are displayed here. User can view the additional images by tapping the and buttons. Tap an image to view it in full screen mode.
Plant Damage Description	Text Image Button	Images and detailed description of the damages to plants cause by the selected species of Spittlebug are displayed here. User can view the additional images by tapping the and buttons. Tap an image to view it in full screen mode.

Natural Enemies Description	Text Image Button	Images and detailed description of the natural enemies of the selected species of Spittlebug are displayed here. User can view the additional images by tapping the and buttons. Tap an image to view it in full screen mode.
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7. Settings



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Figure 14Figure 14 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Twolined Spittlebug	Image Text	Logo and name of the app is displayed here.	
 Home Report History Terms of Use Privacy Policy About Us Contact Us 	Button	 User can navigate to the following screens by tapping these options, Home (see <u>Figure 3Figure 3</u>) Report History (see <u>Figure 15Figure 15</u>) Terms of Use (see <u>Figure 18Figure 19</u>) Privacy Policy (see <u>Figure 19Figure 19</u>) About Us (see <u>Figure 20Figure 20</u>) Contact Us (see <u>Figure 21Figure 21</u>) 	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204)) Formatted: Font color: Custom Color(RGB(0,0,204)) Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204)) Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Version 1.0	Text	The current version of the app is displayed here.	

8. Settings > Report History



Figure 15Figure 15 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Report History	Text	Title text of the screen is displayed here.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
Twolined Spittlebug Nymph 10/25/2020, 03:00 PM	Image Text	All the Twolined Spittlebug sightings reported by the user will be displayed on the Report History screen in a List view. Tap any report to view the corresponding Report Details screen (see <u>Figure 16Figure 16</u>). The image uploaded by the user, date, time and location coordinates of the sighting will be displayed for every entry in the List view.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
:	Button	Tap the i button to view the dropdown menu option to export the Report History Data in CSV format. Tap the Delete option to enable deleting of report history data. User can select previously reported sightings and delete them.	

9. Settings> Report History > Report Details



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	Remaining report details are shown when user scrolls down.
Date & Time:	For details on the UI Elements, see the next page.
October 25, 2020 3:00 PM	
Spotted Location Details:	
Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit. Total estimated area of affected land in acres: 120 Acres	
Percentage of area affected	
0-25% 26-50% 51-75% 76-100%	
Number of Nymphs found/m ² :	
Age Class 1: 5 Nymphs/m ²	
Age Class 2: 12 Nymph/m ²	
Age Class 3: 7 Nymph/m ²	
Calculated Damage Level:	
Damage Level 2	

Figure 16Figure 16 - UI Element	Туре	Functionality / Requirements		Formatted: Font color: Custom Color(RGB(0,0,204))
Report Details	Text	Title text of the screen is displayed here.		
Edit	Button	Tap this button to edit the report details (see Figure 17Figure 17).		Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
	Map view Text	Location coordinates of the reported sightings are displayed on the map as pins. User can tap a pin to view the details of that particular sighting.		
Twolined Spittlebug Life Stage: Nymph	Image Button	Life Stage of the reported Twolined Spittlebug will be displayed here.		
Uploaded Images:	Text	Images uploaded by the user to report the sighting of the Twolined Spittlebug are displayed here. User can view the additional images by tapping the and buttons. User can tap an image to view it in full screen mode.		

Figure 16Figure 16 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Twolined Spittlebug Sighting Details: Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit.	Text	Details entered by the user about the sighted Twolined Spittlebug are displayed here.	
Spotted Location Details: Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit.	Text	Location details entered by the user are displayed here.	
Total estimated area of affected land in acres:120 AcresPercentage of area affected0-25%26-50%51-75%76-100%Number of Nymphs found/m²:Age Class 1: 5 Nymphs/m²Age Class 2: 12 Nymph/m²Age Class 3: 7 Nymph/m²Calculated Damage Level:Damage Level 2	Text	 Optional details entered by the user regarding Twolined Spittlebug infestation and the damage level caused will be displayed here as follows. Total estimated area of the affected land in acres Percentage of affected area The number of Twolined Spittlebug Nymphs found per Square Meter based on different Instar Age Classes Calculated damage level Damage levels are calculated using the Damage Calculator in the Management Decision Tool (see Figure 11Figure 11). 	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))



Get Current Location Your coordinates are 19.896767, -155.582779 5.Enter Location Details Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesenta at id quisque ac. Arcu es massa vestibulum malesenta integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit.	User should enter the damage level calculated by Damage Calculator in Management Decision Tool (see Figure 11Figure 11 Tap the UPDATE button after editing the details to save the changes. Tap the LanceL button to cancel editing the details.	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
6.Select Date and Time Date and Time T.Enter total estimated area of affected land in acres Enter the total affected land in Acres 8.Select percentage of area affected 0-25% 26-50% 51-75% 76-100%	For details on the UI Elements, see the next page.	
9.Enter number of Nymphs found/m² Age Class 1: Enter Value Age Class 2: Enter Value Age Class 3: Enter Value 10.Enter calculated Damage Level Enter Damage Level UPDATE CANCEL		

Figure 16 - UI Element	Туре	Functionality / Requirements
1.Select the Twolined Spittlebug Life Stage Nymph Adult	Text Button	User can change the life stage of the Twolined Spittlebug found. The Twolined Spittlebug has two life stages: Nymph and Adult (There are actually three life stages: Egg, Nymph, and Adult. However, TLSB Team is only concerned about Nymph and Adults stages for the sake of reporting).
2.Take a picture or Upload from your phone	Text Button	Tap the button to take a picture or upload a new image from the mobile device's gallery.
3.Enter details about the Spittlebug found Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna præsent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit.	Text Text box	User can edit the details of the Twolined Spittlebug found. (E.g. Twolined Spittlebug Nymph found on Kikuyu grass root).
4.Get your current location Get Current Location Your coordinates are 19.896767, -155.582779	Text Map view Button	Get Current Location button to get the current location using the Location Services (mobile device GPS) feature of his/her mobile phone. Tap the button and the mobile device will request for permission to find current location. If permission is given, the current location of the user will be acquired and the location coordinates displayed as Your coordinates are 19.896767, -155.582779 The location will also be marked using a

5.Enter Location Details Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna præsent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquem wisi. Nulla wisi laoreet suspendisse integer vivamus elit.	Text Textbox	User can edit the details of the Twolined Spittlebug's location. (E.g. Twolined Spittlebug Nymph found in Kikuyu grass pasture or 200 Acres with approximately 60% damage).	
6.Select Date and Time	Text Text field Icon	User can tap the tion to change the date and time of spotting the Twolined Spittlebug.	
7.Enter total estimated area of affected land in acres Enter the total affected land in Acres 8.Select percentage of area affected 0-25% 26-50% 51-75% 76-100% 9.Enter number of Nymphs found/m² Age Class 1: Enter Value Age Class 2: Enter Value Age Class 3: Enter Value 10.Enter calculated Damage Level Enter Damage Level	Text Text field	 User can update the, Total estimated area of the affected land in acres Percentage of area affected Number of the Twolined Spittlebug Nymphs found per Square Meter based on different Instar Age Classes Calculated Damage Level The Damage Level can be calculated using the Damage Calculator in the Management Decision Tool (see Figure 11Figure 11). 	Formatted: Font: Bold, Font color: Custom Color(RGB(0,0,204))
UPDATE CANCEL	Button	Tap the UPDATE button to save the changes. Tap the CANCEL button to discard the changes.	

Error States in Report Details screen

Name	Scenario	Сору		
Blank fields/Invalid data	If the required fields are left blank or invalid data is entered.	Enter details about Spittlebug found.		
		Enter location details.		
		Select Date and Time.		

10. Settings > Terms of Use



Figure 185igure 18 - III Flement	Type	Functionality / Requirements	1	Formatted: Font color: Custom Color(RGB(0.0.204))
Terms of Use	Text	Title text of the screen is displayed here.		
Twolined Spittlebug Terms of Use Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget. Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. * Luctus arcu, urna praesent at id quisque ac. * Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. * Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget. Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. * Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget suspendisse integer vivamus elit eu mauris eus, cum eros quis aliquam wisi.	Text	The Twolined Spittlebug app's terms of use are loaded from an HTML page in a web view.		Commented [MT2]: I am checking with the University of Hawaii Office of Research and Innovation on specific policies and terminology that may need to be included here. I will follow up when I receive information.
Twolined Spittlebug© 2021	Text	Copyright information regarding the Twolined Spittlebug app is displayed here.		Commented [MT3]: This should be copyrighted to the University of Hawaii
11. Settings > Privacy Policy



Figure 19Figure 19 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Privacy Policy	Text	Title text of the screen is displayed here.	
Twolined Spittlebug Privacy Policy Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget. Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget. Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget.	Text	The Twolined Spittlebug app's privacy policy is loaded from an HTML page in a web view.	Commented [MT4]: I am checking with the University of Hawaii Office of Research and Innovation regarding specific privacy policy terminology for this section. I will follow up when I receive information.

12. Settings > About Us



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<u>Figure 20Figure 20</u> - UI Element	Туре	Functionality / Requirements	
About Us	Text	Title text of the screen is displayed here.	
Twolined Spittlebug Version 1.0	Text	Name and version of the app is displayed here.	
Lorem ipsum dolor sit amet, sapien etiam, nunc amet dolor ac odio mauris justo. Luctus arcu, urna praesent at id quisque ac. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris eus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget. Arcu es massa vestibulum malesuada, integer vivamus elit eu mauris cus, cum eros quis aliquam wisi. Nulla wisi laoreet suspendisse integer vivamus elit eu mauris hendrerit facilisi, mi mattis pariatur aliquam pharetra eget.	Text	Information about the Twolined Spittlebug app is displayed here. <u>I will craft specific language for this section, we will want to include a statement recognizing</u> <u>the Hawaii Dept. of Agriculture who has funded the development of the application. Along</u> <u>with identifying the University of Hawaii-Manoa, College of Tropical Agriculture and Human</u> <u>Resources, and other funding sources.</u>	

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13. Settings > Contact Us



<u>Figure 21</u> Figure 21 - UI Element	Туре	Functionality / Requirements	Formatted: Font color: Custom Color(RGB(0,0,204))
Contact Us	Text	Title text of the screen is displayed here.	
If you need our help or have any questions about the app, please do not hesitate to contact us	Text	A description of the Contact Us screen is shown here.	
& +1 (222) 333-4444	Text	User can tap the phone number to place a call to the Twolined Spittlebug team. The call will be placed through the Carrier network of the user's.	Commented [MT5]: What is typical here? Should this be my office number? 1-808-887-6183
Support@twolinedspittlebug.com	lcon Text	User can tap the email address to send an email to the Twolined Spittlebug team. The default email composer will be displayed with support@twolinedspittlebug.com in the Recipient field.	Commented [MT6]: So, we don't have a specific support section. Mostly this would likely be me. Can this be set up so that this address goes to mine, or do you recommend we set up something specific?

Emails

Email	Description
-	-

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Notifications

Notification	Туре	Description
-	-	-

Queries

NONE