

**Project Title:** Biological control of BMSB using *Trissolcus japonicus*

**Report Type:** Final Project Report

**Primary PI:** Christopher Adams  
**Organization:** OSU  
**Telephone:** 248-850-0648  
**Email:** chris.adams@oregonstate.edu  
**Address:** 3005 experiment station drive  
**City/State/Zip:** Hood River, OR 97031

**Co-PI 2:** Nik Wiman  
**Organization:** OSU  
**Telephone:** 541-250-6762  
**Email:** nik.wiman@oregonstate.edu  
**Address:** 15210 NE Miley Rd  
**City/State/Zip:** Aurora, OR 97002

**Cooperators:**

**Project Duration:** 3 Year

**Total Project Request for Year 1 Funding:** \$ 30,550

**Total Project Request for Year 2 Funding:** \$ 31,347

**Total Project Request for Year 3 Funding:** \$ 32,167

**Other related/associated funding sources:** Awarded (\$30,324)

**Funding Duration:** 2022 - 2023

**Amount:** \$30,324

**Agency Name:** CGFG

**Notes:**

**WTFRC Collaborative Costs:**

<b>Item</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>
Salaries 1	\$7,975.00	\$8,215.00	\$8,461.00
Benefits	\$5,575.00	\$5,742.00	\$5,914.00
Wages			
Benefits			
RCA Room Rental			
Shipping			
Supplies 2	\$2,000.00	\$2,000.00	\$2,000.00
Travel 3	\$1,000.00	\$1,000.00	\$1,000.00
Plot Fees			
Miscellaneous			
<b>Total</b>	<b>\$16,550.00</b>	<b>\$16,957.00</b>	<b>\$17,375.00</b>

**Footnotes:**

<sup>1</sup>Faculty Research Assistant at 0.15 FTE, with 3% increase in years 2 and 3; OPE 70%

<sup>2</sup>Research consumables

<sup>3</sup>Travel to field plots

**Budget 1**

**Primary PI:** Christopher Adams

**Organization Name:** OSU

**Contract Administrator:** Charlene Wilkinson

**Telephone:** 541-737-3228

**Contract administrator email address:** Charlene.wilkinson@oregonstate.edu

**Station Manager/Supervisor:** Brian Pierson

**Station manager/supervisor email address:** brian.pierson@oregonstate.edu

Item	2021	2022	2023
Salaries 1	\$9,100.00	\$9,373.00	\$9,654.00
Benefits	\$3,900.00	\$4,017.00	\$4,138.00
Wages			
Benefits			
RCA Room Rental			
Shipping			
Supplies	\$1,000.00	\$1,000.00	\$1,000.00
Travel 2			
Plot Fees			
Miscellaneous			
Total	\$14,000.00	\$14,390.00	\$14,792.00

**Footnotes:**

<sup>1</sup>PhD student in Wiman lab at 0.15 FTE with 3% increase in years 2 and 3; OPE 30%

<sup>3</sup>Travel to field plots

**Budget 2**

**Co PI 2:** Nik Wiman

**Organization Name:** OSU

**Contract Administrator:** Charlene Wilkinson

**Telephone:** 541-737-3228

**Contract administrator email address:** Charlene.wilkinson@oregonstate.edu

**Station Manager/Supervisor:**

**Station manager/supervisor email address:**

## Recap of Original Objectives

This project addresses management of the invasive brown marmorated stink bug (BMSB) using a biological control agent, *Trissolcus japonicus* (Tj), a small egg-parasitoid wasp of BMSB. This project aims to raise and then release large numbers of this wasp, in and around managed pear orchards in Hood River, and then measure establishment and impact in subsequent years.

### 1. Raise and release Tj for release in key locations. (every year)

A colony of *T. japonicus* was established in 2021, and new wasps were reared from BMSB eggs collected from the MCAREC lab colony. Releases of the wasps occurred weekly from August 12<sup>th</sup>- October 7<sup>th</sup> at 12 sites in 2021, June 1<sup>st</sup>- October 3<sup>rd</sup>, 2022 at 12 sites, and June 9<sup>th</sup>- September 20<sup>th</sup>, 2023 at 12 sites

### 2. Measure establishment using sentinel egg masses and yellow sticky traps (years 2 & 3)

Sentinel egg masses were placed at the 2021 release sites and left for 24 hours on 6-Jul and 20-July, 2022. Three yellow sticky cards were placed at each site and left for two weeks on 6-July, 20-Jul, and 1-Aug. In 2023 two yellow sticky cards were placed at each site and left for two weeks on 25-July, 17-Aug, and 1-Sep.

### 3. Describe the habitats where wasp establishment is most successful (years 2 & 3)

The sites that appear to have successful establishment from the 2021 releases were bordered by mixed oak and conifer forest. This habitat provides the brown marmorated stink bug additional host plant resources, as well as refugia for both the stink bug and Tj from pesticide sprays applied in the pear orchards.

### 4. Measure the effectiveness of Tj biocontrol for preventing fruit damage (years 2 & 3)

BMSB populations will be measured with lure baited (congregation pheromone) traps to measure BMSB populations in year zero (before releases of wasps) and then during each subsequent year, to measure change in populations. Growers hosting release sites will be asked to share cull reports from the packing houses.

## Significant findings / outcomes

- **Other:** As part of these efforts, we have been sending out weekly reports of BMSB captured across the network of traps. This report allows stakeholders to see BMSB numbers across the entire growing region and see populations numbers are changing through time.
- **Objective 1:** A total of 72,234 Tj wasps were released during this project. A total of 8,434 Tj were reared at the MCAREC insectary and released at 15 pear orchards (14 pear and 1 peach) located throughout Hood River County in 2021. A total of 44,200 Tj were reared at the MCAREC insectary, and released at 12 orchards (11 pear and 1 peach) located throughout Hood River County in 2022. A total of 16,500 Tj were reared at the MCAREC insectary, and released at 12 pear orchards (11 pear in Hood River Co. and 1 apricot in Wasco Co.) in 2023.
- **Objective 1:** We collaborated with the Oregon Department of Agriculture and helped them release 1,400 Tj from their colony at our release sites in Hood River in 2021, and an additional 1,700 Tj in 2022.
- **Objective 2:** Tj were recovered on yellow sticky traps at 4 out of 14 of the 2021 release sites in 2022. In 2023 Tj were collected from 11 out of 12 release sites. The number of Tj found on yellow sticky cards ranged from 2-55 specimens at these 11 sites. Recovery of wasps at 28% (2022) and 92% (2023) of release sites is extremely encouraging.
- **Objective 3:** The 2021 sites where Tj was successfully recaptured were surrounded by mixed oak and conifer forest bordering the pear orchard.
- **Objective 4:** There was no correlation between wasp release site and reduced BMSB capture. Measurable impact may take several years.

## Methods

### 1. Raise and release Tj for release in key locations.

We currently have a dozen cages of stink bugs housing about 30 insects each that regularly produce several hundred eggs per week (Figure 5). Stink bugs require daily fresh food and water, colony maintenance, and egg collection, totaling several hours per day 7 days per week. Stink bug eggs are collected daily, and newly emerged wasps are placed in small cup containers with fresh stink bug eggs (Figure 5). Releases occurred every week from August through October at 15 sites in 2021, June- October at 12 sites in 2022, and June- September at 12 sites in 2023 (Figure 1). Weekly release numbers varied in 2021, depending on the number of wasps available each week. In 2022, 200-300 wasps were released at each site each week. In 2023, 50-200 wasps were released at each site each week. To maintain colony health, wild caught Tj wasps and wasps from other regional rearing programs will occasionally be added to our colony to prevent genetic drift within the colony.

### 2. Measure establishment using sentinel egg masses and yellow sticky traps (years 2 & 3)

We began to measure Tj establishment in 2022 using yellow sticky cards and sentinel egg masses at each of this year's release sites. Cards and sentinel eggs were placed at sites where Tj was previously released and checked after 24 hours (eggs) or 2 weeks (traps) to see if any wasps were recovered. Sentinel eggs were brought back to the lab and held in cages until wasps emerged. Parasitism by Tj in subsequent years will be considered evidence of establishment. Yellow sticky cards were examined under microscope for presence of Tj wasps (Figure 6). Capture of adults in subsequent years will be considered evidence of establishment.

Expected outcome: Early results from research done by Dr. Wiman's PhD student show recapture (establishment) at 25% of the sites wasps where she released in 2018 and 2019 (13 sites in Hood River County). Considering the minute size of these wasps, the size of the landscape they are occupying, and the small number of traps used (3 sticky cards per site), the 25% recapture rate is very encouraging. We expect similar recapture rates from our releases.

### 3. Describe the habitats where wasp establishment is most successful (years 2 & 3).

Orchard border habitat will be recorded capturing species richness (diversity), size of habitat, and distance from managed orchard. Establishment data will be analyzed against habitat parameters to determine if successful establishment is strongly correlated with surrounding habitats.

The sites that appear to have successful establishment from the 2021 releases were bordered by mixed oak and conifer forest. This habitat provides the brown marmorated stink bug with additional host plant resources, as well as refugia for both the stink bug and Tj from pesticide sprays applied in the pear orchards.

Expected outcome: Results of this research could lead to planting recommendations to increase the probability of wasp establishment in future efforts.

#### 4. Measure the effectiveness of Tj biocontrol for preventing fruit damage (years 2 & 3)

Year zero stink bug populations were measured using pyramid traps containing the Trécé BMSB dual pheromone lure to measure the abundance of BMSB within each orchard. Pheromone baited traps will be maintained at each release site and traps checked weekly. Abundance of stink bugs will be used as one measure of effectiveness of biocontrol. Packing house cull report will be gathered from each grower to see how fruit damage changes from year to year.

Expected outcome: We expect to increase the population and expand the range of the egg parasitoid (Tj) throughout the Hood River pear growing region. While it may take several years to measure the impact, we expect that BMSB fruit damage will decrease near these 36 sites and that this established population will continue to spread to other orchards.

### Results and Discussion

We successfully established and maintained a colony of BMSB large enough to produce a steady supply of eggs. These BMSB eggs were used to establish and maintain a colony of Tj wasps, and to date we have released **72,234 wasps at 39 locations** across the Hood River growing region from this colony. In collaboration with Oregon Department of Agriculture's state-wide Tj distribution program an additional 3,100 Tj were released in Hood River Co. This collaboration added 1,400 wasps in 2021 and 1,700 wasps in 2022. In addition, we are assisting Dr. Nik Wiman's PhD student with her Tj wasp release in the Hood River area. Her project added another 1,200 wasps to the total released. The combination of these three efforts resulted in a total of 73,434 Tj released in the Mid-Columbia region between the years of 2017-2023.

In 2022 we began trapping efforts to look for establishment of the wasp in these locations. Sentinel egg masses were placed at the 2021 release sites and left for 24 hours on 6-July and 20-July, 2022. None of the recovered egg masses were parasitized, and so we discontinued the use of egg masses. Three yellow sticky cards were placed at each site and left for two weeks on 6-July, 20-July, and 1-Aug resulting in catch of Tj at 4 sites. A total of 100 wasps were collected at these four sites (n= 1, 3, 25, and 71). Another 41 wasps were captured that appear to be another *Trissolcus* species from 7 other sites. These established Tj wasps will continue to increase their populations in and around these orchards over time.

In 2021 the population of BMSB was extremely low (Figure 3) statewide, likely due to the warm winter, dry spring, and summer heat dome. These low catch numbers slowed the initial establishment of the stink bug colony and delayed the timing of our first wasp releases. Low wild numbers of BMSB will also make it more difficult for released wasps to find stink bug eggs to parasitize. In 2022, with the established BMSB colony we were able to ramp up production and start the 2022 releases earlier and were able to release more wasps each week.

The 2022 season had much higher BMSB abundance everywhere. This makes it difficult to measure the impact from our released wasps. However, high wild BMSB populations should increase the success rate of released wasps and may benefit the Tj program in the long term.

In 2023 the egg production of the BMSB colony was lower than the previous year but still very productive. We had hoped that our 2023 release numbers would exceed 2022's numbers, and even hired a high school aged student to spend more time with the colony. Unfortunately, for reasons that are not clear, our colony (and wasp production) was less in the 3<sup>rd</sup> year than in the previous year, but still respectable.

It is worth noting that the number of wasps we were able to produce in this small project far exceeded the total number of wasps produced by the Oregon Department of Agriculture program over the same period.

It may take years to detect measurable impact on BMSB numbers. However, getting wasps established throughout the fruit growing region now, *before* BMSB numbers grow to levels seen on the East coast, will improve our chance of slowing the BMSB populations. In addition, biocontrol techniques are more effective at reducing populations of BMSB off site where pesticides cannot be applied and where BMSB are building their numbers.

The cost of this biocontrol works out to be less than \$1.00 per wasp to rear and release this insect across the valley. It appears that it was successful in establishing itself in and around pear orchards in Hood River. This initial investment in biocontrol should pay dividends in the future in the form of free biological control of the invasive BMSB as the wasps reproduce and spread.

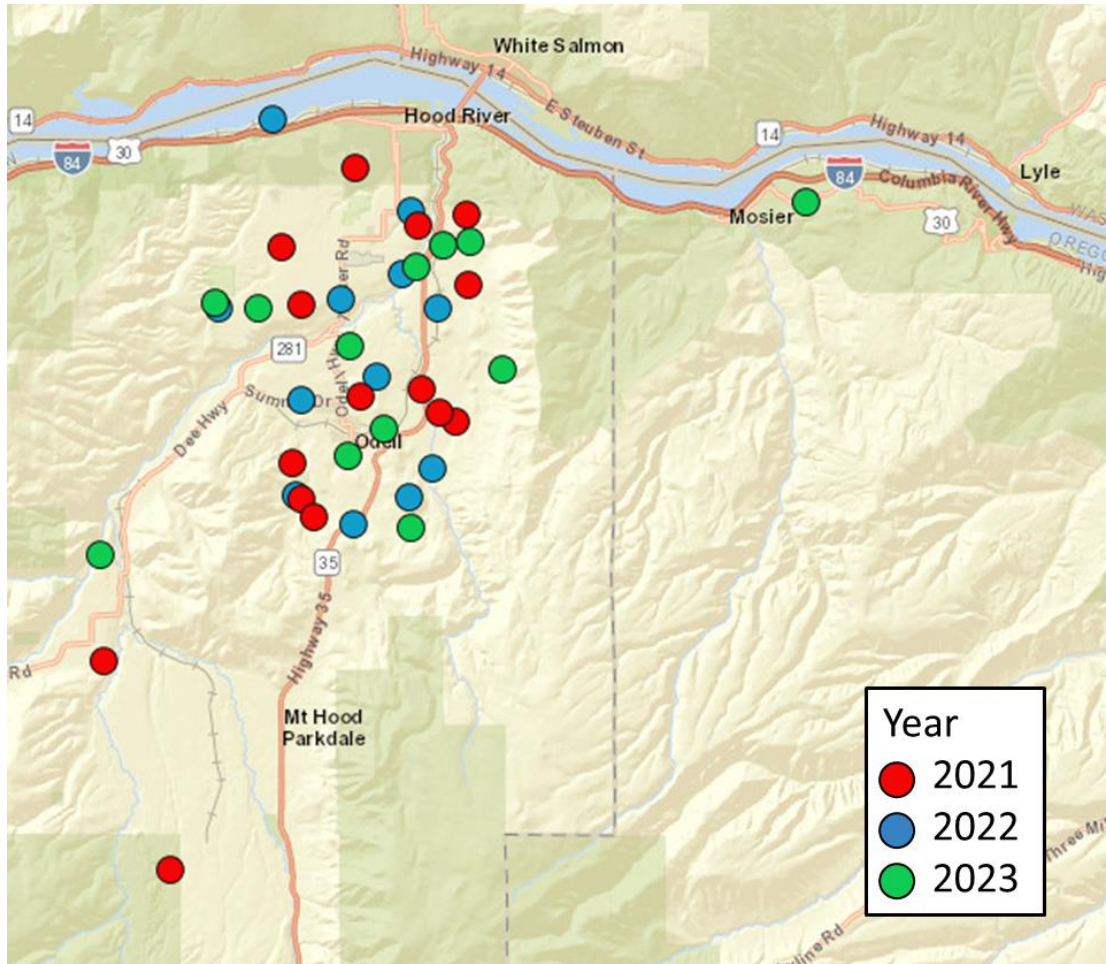


Figure 1: 2021-2023 *Trissolcus japonicus* release sites.



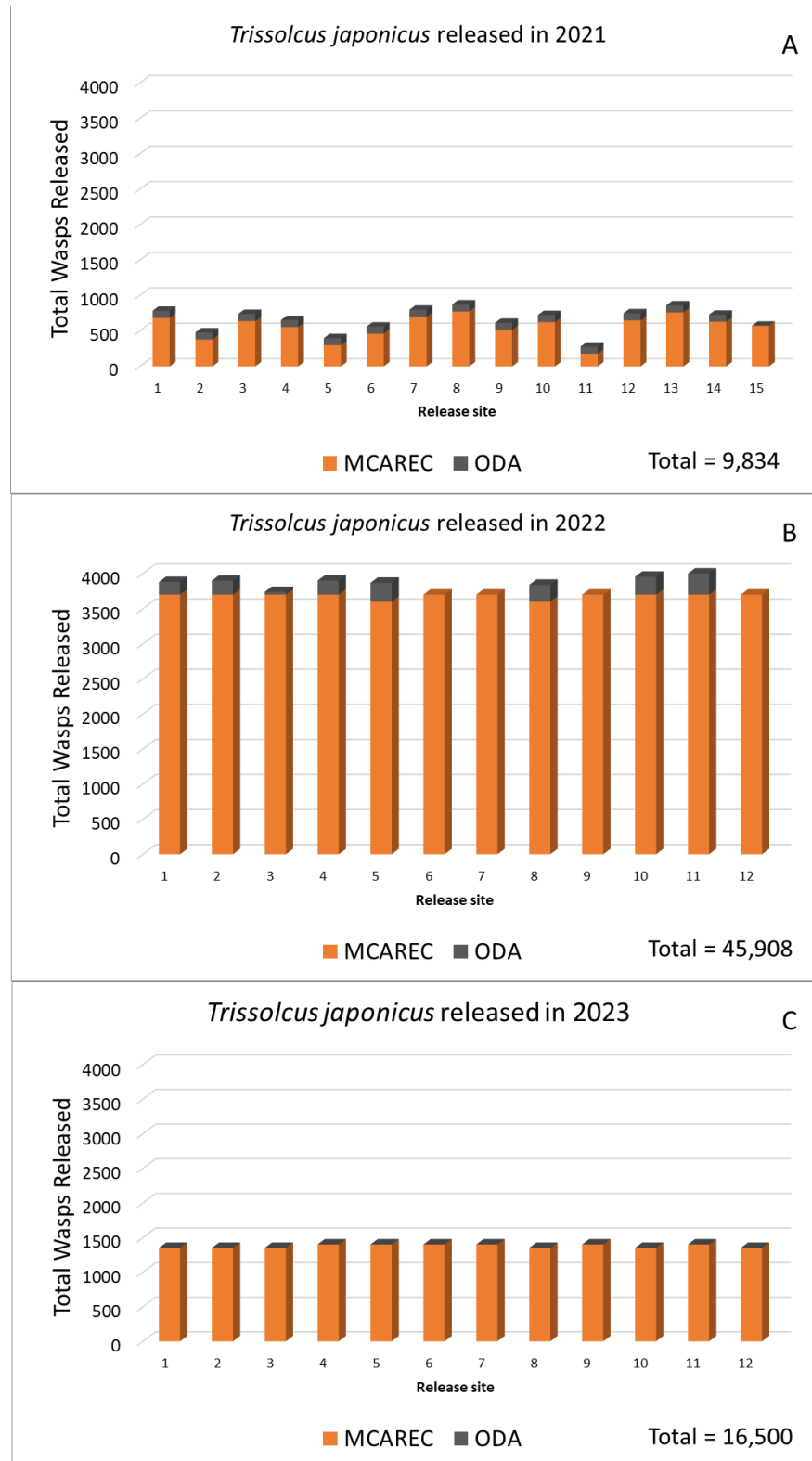


Figure 2. Number of *T. japonicus* released at each site reared by MCAREC and ODA in 2021 (A), 2022 (B), and 2023 (C). 2022 was an exceptionally good year and I had high hopes that we would continue at that rate into year three. Rearing insects can be challenging, it is not clear why we struggled in 2023.

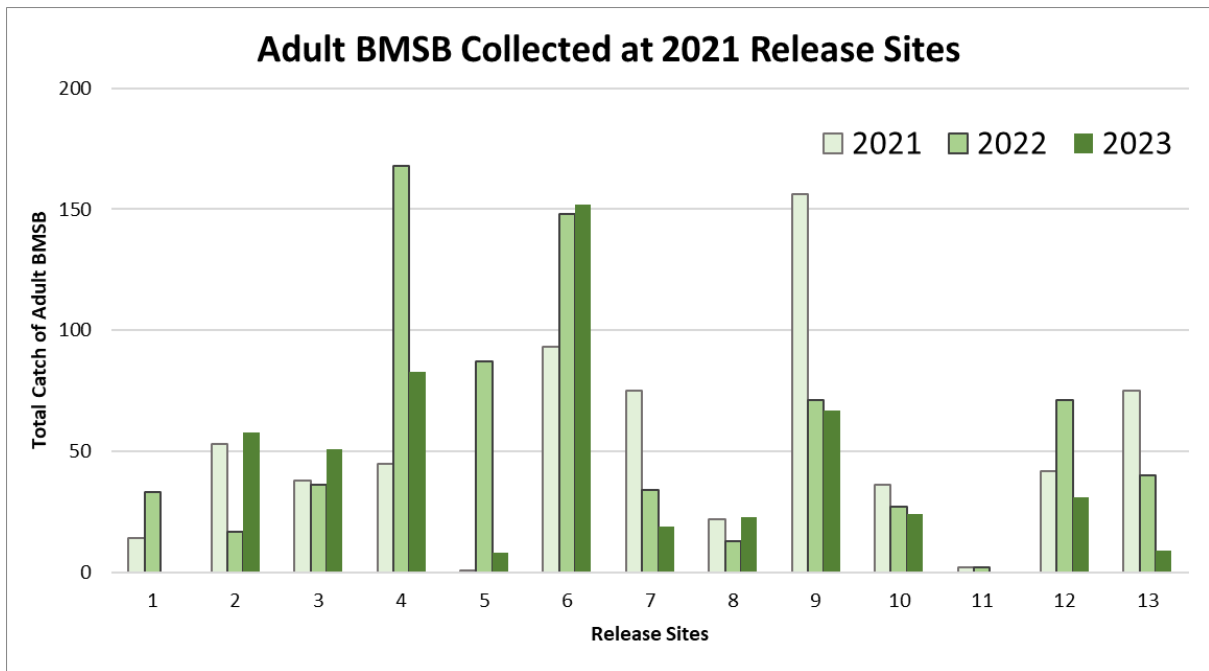


Figure 3. Total of BMSB adults collected in 2021-2021 at 2021 Tj release sites.

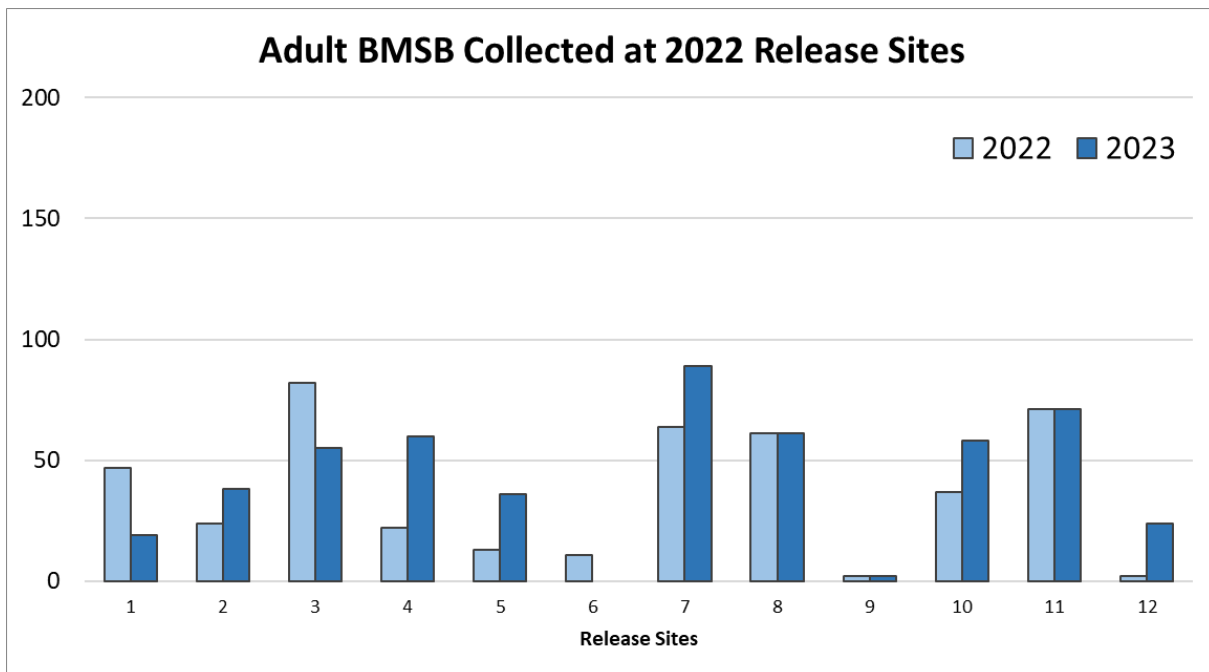


Figure 4. Total of BMSB adults collected in 2022-2023 at 2022 Tj release sites.

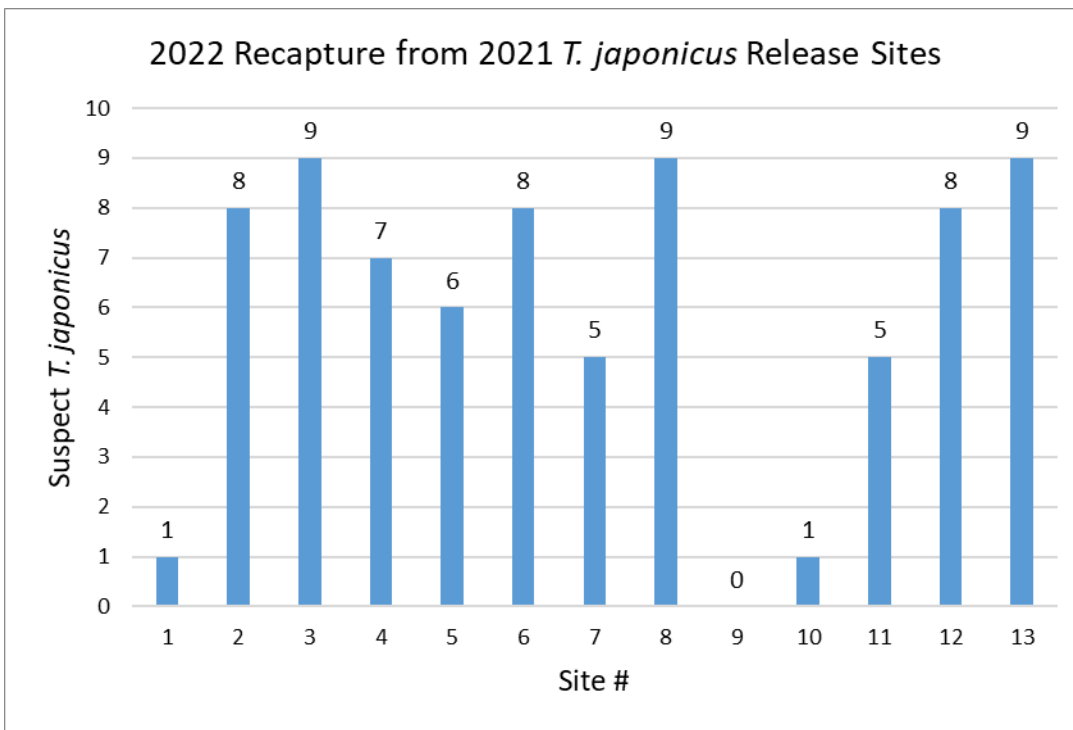


Figure 5. Total number of suspect Tj captured on sticky cards in 2022 at the 2021 release sites, used to measure successful establishment.

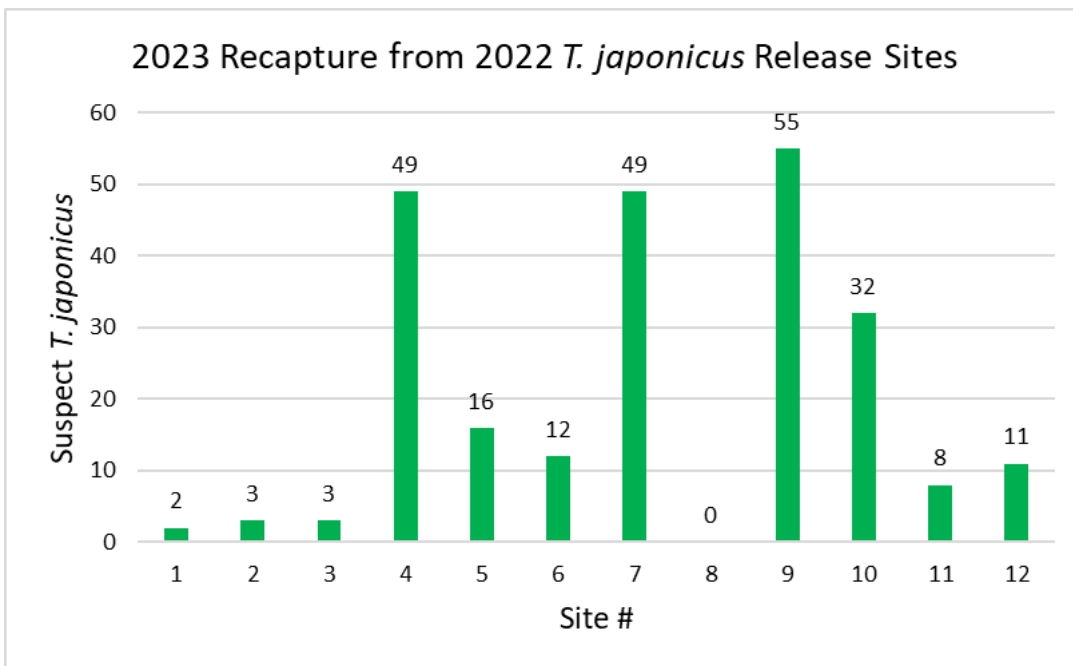


Figure 6. Total number of suspect Tj captured on sticky cards in 2023 at the 2022 release sites, used to measure successful establishment.



Figure 5. BMSB colony cages, *Trissolcus japonicus* colony, and Release of wasps in field.



Figure 6. Sticky card placed at a 2021 release site to measure catch (considered establishment) of *Trissolcus japonicus*. Red lines indicate a suspected *Trissolcus japonicus*.