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BOSQUE ECOSYSTEM MONITORING PROGRAM (BEMP) SITE MONITORING REPORT FOR 2017

2017 ANNUAL TAMARISK LEAF BEETLE MONITORING TECHNICAL REPORT FOR THE GREATER RIO GRANDE WATERSHED ALLIANCE

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GRGWA BEMP Contract

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Annual Report: Tamarisk Leaf Beetle Monitoring
May-August 2017

Introduction

The presence of exotic invasive saltcedar (*Tamarisk* spp.*)* has proven to be a difficult and pressing ecological issue for land managers and ecologists since the trees' introduction to the Southwest in the 1800s (Gonzalez et al., 2017). There has been increasing concern about water resources and competition between saltcedar and native plant species (e.g., Sher et al., 2002) as well as concern about the contribution of saltcedar to fire risk in the Middle Rio Grande (Glenn and Nagler, 2005). Saltcedar has demonstrated a resistance to soils with high salinity in comparison to other native species (in particular, cottonwood) making it very resilient under current conditions relative to native species (Glenn and Nagler, 2005). Standard removal methods including manual and mechanical extraction and chemical treatments have been applied to saltcedar with minimal success. These management techniques remain an expensive and laborious method of saltcedar removal (Powell, 2005) and still leave native species vulnerable and precious water resources at risk.

In 2001, *Diorhabda* spp., commonly known as the tamarisk leaf beetle (TLB), was introduced into several Southwestern states with extensive saltcedar presence (Dudley and DeLoach, 2004). TLB is an obligate saltcedar consumer and was introduced as an experimental method to manage the saltcedar population in the Southwest. The TLB's ability to defoliate in conjunction with other removal methods was expected to inflict mortality on the saltcedar monocultures within Southwestern riparian ecosystems (Kennard, 2016), or at least sufficiently suppress saltcedar (DeLoach et al., 1996), thereby reducing competition for resources for other native plant species.

The introduction of TLB to the Southwest, like many other intentionally introduced exotic species, has had unintentional consequences. There are now concerns about the impact of TLB on the habitat of the endangered Southwestern willow flycatcher (*Empidonax traillii extimus*) (SWFL). The SWFL have adapted to use saltcedar as a nesting site and the presence of the TLB poses a threat to the species. As TLB defoliate saltcedar, nesting SWFL are exposed to the desert heat and an increased threat of predation, especially in instances where native vegetation is outnumbered by saltcedar (Dudley et al., 2004). Buffer zones around identified nesting sites have been imposed to keep TLB out keep SWFL habitat, but the TLB has made tremendous gains in distribution within the Southwest (Nagler et al., 2014), further threatening the SWFL.

The Bosque Ecosystem Monitoring Program (BEMP) goal is to document and inform managers of the distribution and abundance of TLB throughout the Middle Rio Grande riparian ecosystem. The Tamarisk Coalition started monitoring TLB migration into the Middle Rio Grande beginning in 2012 (Tamarisk Coalition, 2016) and in 2013

BEMP began actively monitoring TLB. BEMP also documented the presence and abundance of competitive defoliators such as the weevil (*Ophryastes spp.*) and the leafhopper (*Opsius stactogalus*), as well as potential predators (e.g., ants and spiders) each summer from 2013 to 2017. The BEMP sites are situated along a 270 mile stretch of the Rio Grande between Santo Domingo (Kewa) Pueblo and Mesilla Valley Bosque State Park in Las Cruces. In 2017, two research sites in Mountainair were added at the request of the Greater Rio Grande Watershed Alliance (GRGWA).

Methods

Field Collections

BEMP protocols are adapted from the Tamarisk Coalition, the University of California Santa Barbara, and the Colorado Department of Agriculture (BEMP Research Protocols). BEMP staff monitored 29 sites in 2017, two of which were not active BEMP sites and lie outside the Middle Rio Grande, Brazil and Sanchez (Fig. 5). Sites were monitored during TLB peak activity, May through August, during the mornings of the week of the third Tuesday in each month, coinciding with BEMP's Monthly Monitoring collections.

At each site, five tamarisk trees were sampled at approximately five meter spacing. Trees were identified with metal tags, labeled saltcedar one through five, and marked with GPS coordinates to ensure consistency between annual collections. In the instance where trees were removed, or could not be located, BEMP staff established a new sampling tree within five meters of the other studied saltcedar trees. Using an insect sweep net, each tree was swiped in an upward motion five times. The time of sampling was recorded for each tree. After swiping, contents of the sweep net were secured and transferred into a gallon zip lock bag labeled with the site name, the tree identifier (for example, saltcedar #3), and date. Samples were taken back to the University of New Mexico's Department of Biology to be frozen and later identified underneath a dissection microscope. While in the field, photographs of each tree were taken from the same vantage point each month. Photographs are available on request, and will be available on the UNM Digital Repository in 2018. Each photograph was labeled by tree identifier, site, and date. Lastly, saltcedar defoliation was recorded using 10% increments to determine the percentage of brown defoliation, yellow defoliation, and refoliation. 2017 was the first year BEMP split the defoliation percentages into brown and yellow. This was done to be consistent with the Tamarisk Coalition, as different defoliators may create different color defoliations. In May, the percentage of dead canopy branches was recorded in order to determine the previous year's impact from the TLB**.**

Lab Protocols

Specimens were frozen for a minimum of two weeks (in order to ensure specimen death rather than dormancy), and emptied onto a tray and inspected under a microscope so plant material could be separated from the specimens. Specimens from all five trees were identified by life cycle: Adult TLB, Early TLB, Late TLB, and TLB egg mass. They were then preserved in vials containing 95% alcohol and labeled by site and month. BEMP also identified and collected other defoliators such as weevils, weevil larva, weevil casings, leafhoppers, as well as their predators', spiders and ants (identified to order). Other insects were identified to order using a New Mexico State University's *One Hundred Common Insects of New Mexico* but were not preserved in alcohol.

Results

BEMP has a total of 31 active sites and of those sites, five sites were not sampled for TLB due to their lack of saltcedar. Those five sites are not presented in the results. Two additional sampling sites were added exclusively for the TLB survey but they are not complete BEMP sites. The number of TLB presented here is the sum of three TLB life stages, adult, early larvae, and late larvae, from all five trees (Fig. 1-11). If no data were collected at that site for that year, then there is no TLB total above the site name (Fig. 6-10) or the site is labeled as "not sampled" (Fig. 1-5). If the site was collected and no TLB were found, there is a zero above the site name (Fig. 6-10).

In 2017 there were only three sites with no TLB presence: AOP, Calabacillas, and Bosque Farms (Fig. 5 and Fig. 10). All other sites had a low to high presence of TLB (Fig. 5 and Fig. 10), where a low presence indicates between 1-50 TLB, moderate presence indicates between 51-199 TLB, and high presence indicates 200 or more TLB at a site. In 2017 four sites had a high presence, 13 sites had a moderate presence, and 9 sites had a low presence of TLB. All sites with a high presence of TLB were located south of Albuquerque. Notably, this is the first year since collections began at Mesilla Valley Bosque State Park in Las Cruces that TLB have been recorded at BEMP's southernmost site, there were a total of 321 TLB recorded at Mesilla.

Since the beginning of collection, TLB have been present in the majority of the Albuquerque sites (from Bobcat to the State Land Office) but the total number of TLB has been steadily declining (Fig. 11). Since 2013, there has been a high presence at not less than one of the Albuquerque sites. 2017 is the first year when TLB presence at all of the sites was either moderate or lower, and there are no instances of high TLB presence at any of the Albuquerque sites. To the east of Albuquerque, there was a moderate presence in the Mountainair sites, Brazil and Sanchez (Fig. 5 and Fig. 10).

When BEMP sites are grouped into regions, sites to the north of Albuquerque (north of Bobcat), sites within Albuquerque (between Bobcat and the State Land Office), and sites to the south of Albuquerque (south of the State Land Office), there is a clear geographic shift in TLB abundance. For consistency and accuracy in comparison between years, Fig. 11 only shows the annual sum of sites that have been continuously monitored between 2013 and 2017. If all sites are considered within each region, regardless of continuity of sampling, the general trends remain the same (not shown). There has been a steady shift in TLB distribution, where TLB have migrated southward over the last five years of collection (Fig. 11). At the northern sites there was a steep decline from 2013 to 2015 but a slight increase from 2015 to 2017. At the Albuquerque sites there has been a strong decrease in TLB since 2013. At the southern sites there has been an increase in TLB since 2013, from 33 TLB in 2013 to 559 TLB in 2017. If all sampling sites are considered, not just those that have been continuously monitored since 2013, there were 1169 TLB at the sites south of Albuquerque in 2017.

It is important to note that BEMP has yet to see tree mortality due to defoliation by TLB. The only observations of saltcedar mortality have been at BEMP's Santa Ana site, a site where all shrubs and trees are dying, not just the saltcedar. In this case, there is no direct link between the mortality of the saltcedar to TLB defoliation. Over the course of the collections, severe defoliation has been followed by varying degrees of recovery in every site. At some sites there was 100% defoliation and a large population of TLB (Valencia Forest, Fig. 12), but no mortality—though BEMP cannot determine tree mortality until the following year. There has been branch mortality at 22 of the 27 BEMP sites and severe branch mortality (50% or greater) at five of the 27 BEMP sites.

Discussion

Our data this year showed a dramatic shift in TLB abundance since the first collections in 2013. The migration of the beetles occurred faster and farther than initial projections (Nagler et al., 2014), but now observable patterns are beginning to emerge as a direct result of long-term monitoring efforts. When TLB surveys at BEMP sites first began in 2013, the highest TLB abundance was north of Albuquerque, with a moderate to high abundance in Albuquerque, and low to no numbers recorded south of Albuquerque. Since then, the TLB has continued to disperse to the south where abundance is at its highest number to date. In Albuquerque, we have seen a decline that may mirror the decline of TLB in the sites north of Albuquerque, in which case, we would expect an uptick in TLB abundance in the future. Due to the differences in this ecosystem as compared to the TLB source ecosystems in Eurasia, it is difficult to predict future movement and population numbers and whether or not there will be oscillating population numbers or a levelling out, or some degree of both, as TLB jump to healthier stands of saltcedar within an area, abandoning nearby defoliated trees for a time. For these sites, continued observations will be key to understanding the migration of the TLB and their habitat preferences.

In regards to saltcedar suppression or mortality, there are varying results seen in other areas. In Colorado, managers have had success with both the presence of the beetle and anthropogenic intervention, and have found that the beetle is a worthy and effective component of management practices in riparian ecosystems (Kennard et al., 2016). In other states, 25-40% mortality was reached after three to four consecutive years of defoliation (Puckett and van Riper, 2014). To date, there has been no recorded saltcedar mortality at BEMP sites that can be attributed directly to TLB defoliation. Even at sites with large TLB populations and high defoliation levels, there has yet to be a site that has not recovered. Of the five sites with severe branch mortality, there are only 9 trees within the 25 sampled trees that have 50% or more branch mortality.

Through the annual TLB survey, we hope to further understand the TLB and its impact on the Rio Grande bosque. By using BEMP's other datasets collected at these same sites we can begin to provide a wide scope into the impacts that TLB have on native and non-native vegetation coverage, litterfall changes, and the overall health of the bosque. We hope that with the addition of access to our data from the UNM Digital Repository (expected in 2018), BEMP will remain an active informant to land managers about the presence and impacts of the TLB. BEMP's raw data and photographs are available upon request, and in early 2018 they will be available on the UNM Digital Repository.

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Figures

Figures 1-5. Maps of the total TLB captured at BEMP sites from 2013 to 2017. The colors indicate the number of TLB captured at each site. The annual total TLB is the sum of three life stages, adult, late larvae, and early larvae, from all five trees, during all four months of collection. Green indicates that there were zero TLB, yellow indicates that there were 1-50 TLB, orange indicates that there were 51-200 TLB, and red indicates that there were 200 or more TLB found at a site. Sites that were not sampled are indicated in white.

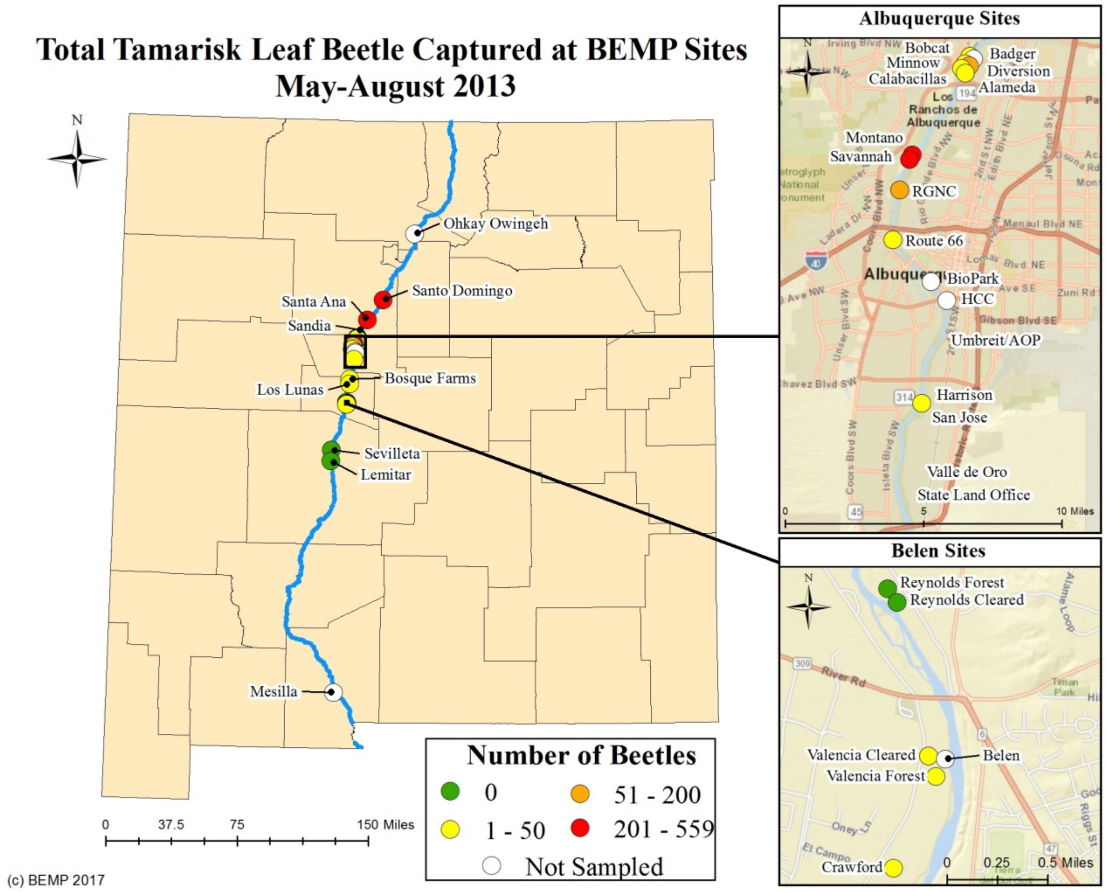

Figure 1. Total TLB captured at BEMP sites from 2013.

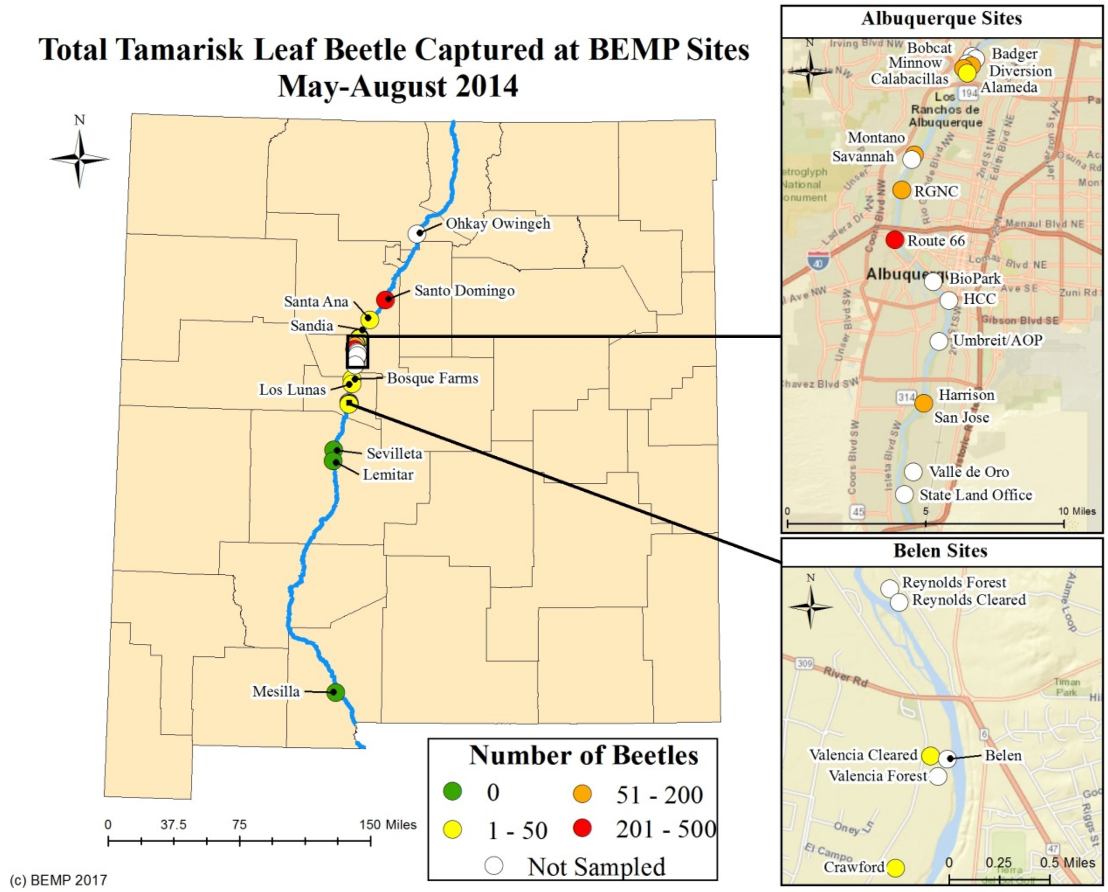

Figure 2. Total TLB captured at BEMP sites from 2014.

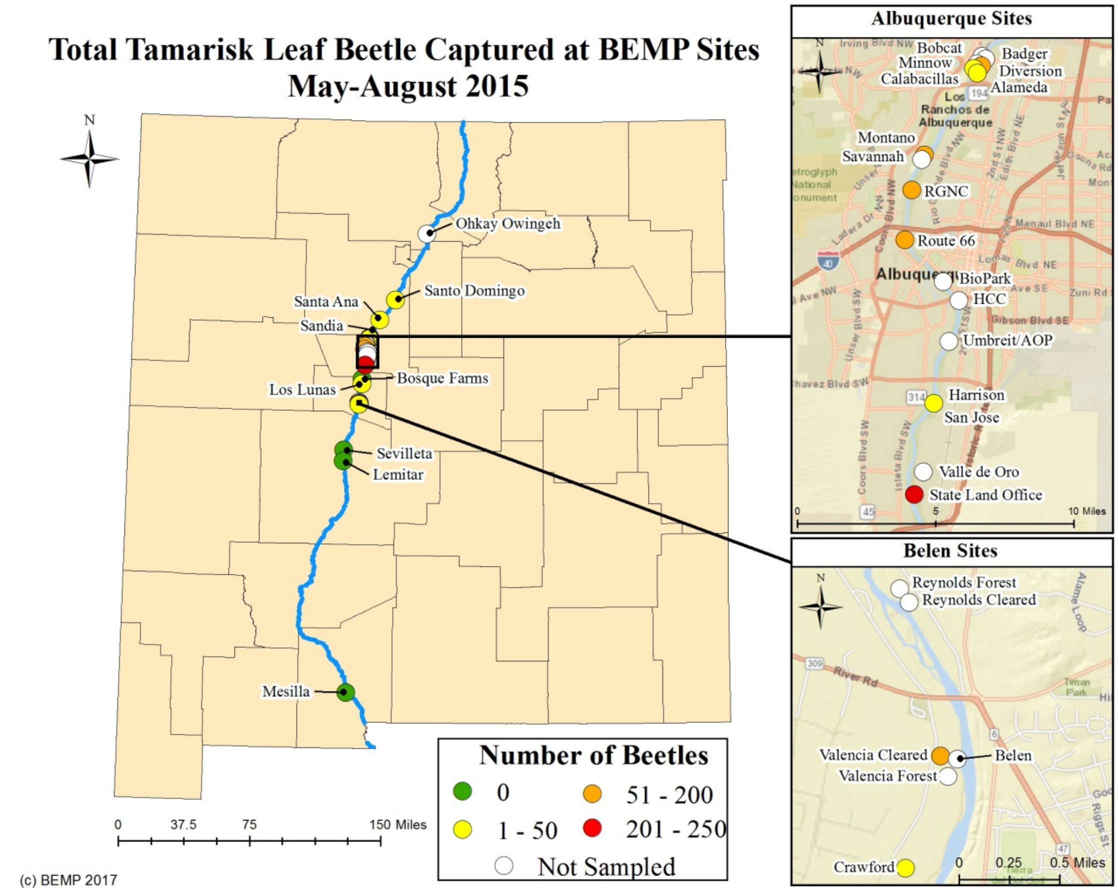

Figure 3. Total TLB captured at BEMP sites from 2015.

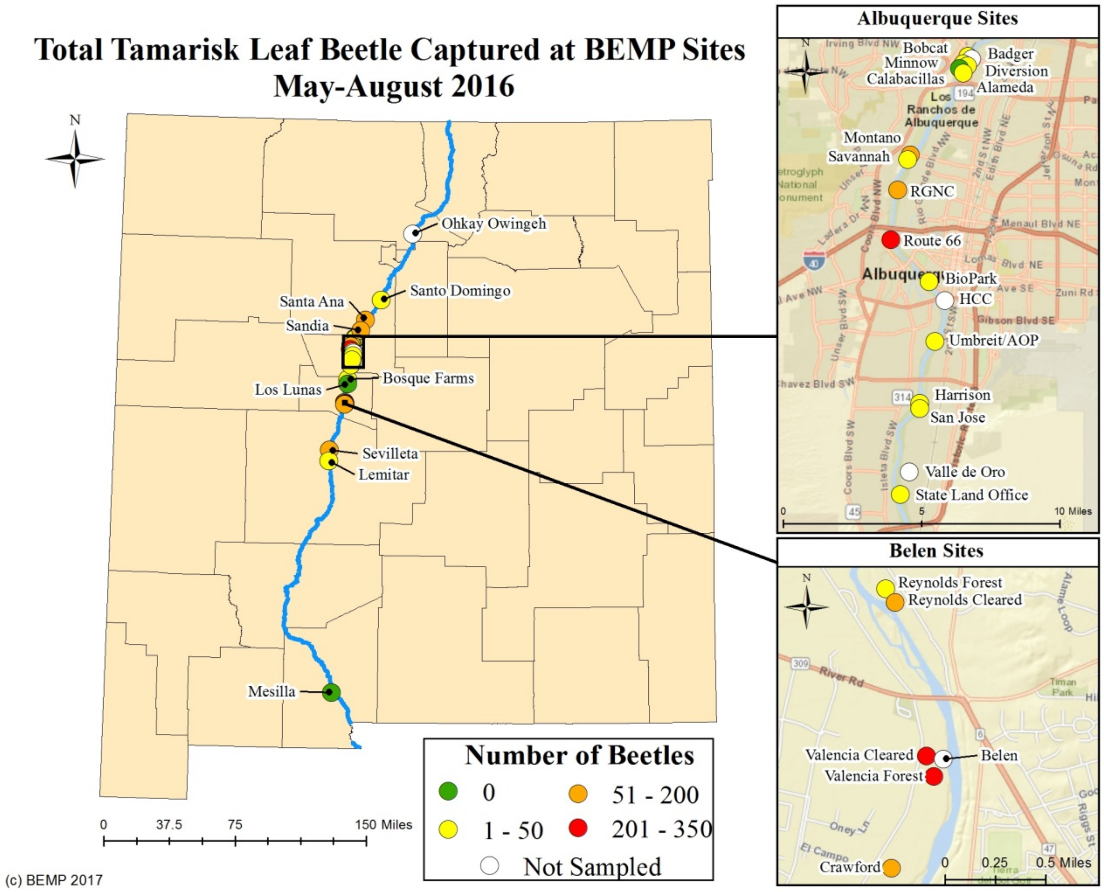

Figure 4. Total TLB captured at BEMP sites from 2016.

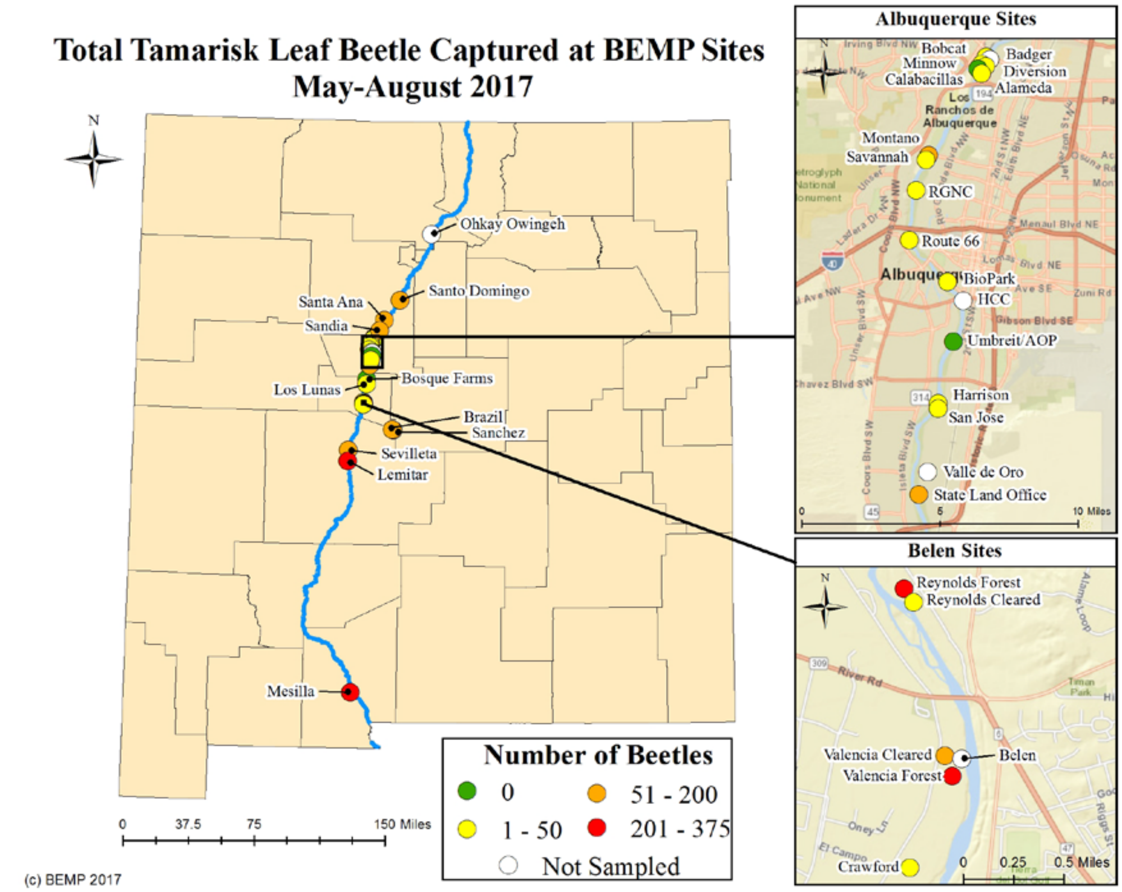

Figure 5. Total TLB captured at BEMP sites from 2017.

Figures 6-10. Plots of the total TLB captured at BEMP sites from 2013 to 2017. The sites are organized left to right, north to south along the Rio Grande, with the exception of the last two sites; Brazil and Sanchez are not along the Rio Grande and are located to the east in Mountainair. The annual total TLB is the sum of three life stages, adult, late larvae, and early larvae, from all five trees, during each month of collection. Each bar represents the total number of TLB captured at a site with the annual total displayed at the top of the bar. If no data were collected at that site for that year, there is no information above the site name. If the site was surveyed and there were no TLB found, there is a zero above the site name. Note that the y-axis scale is not consistent across years.

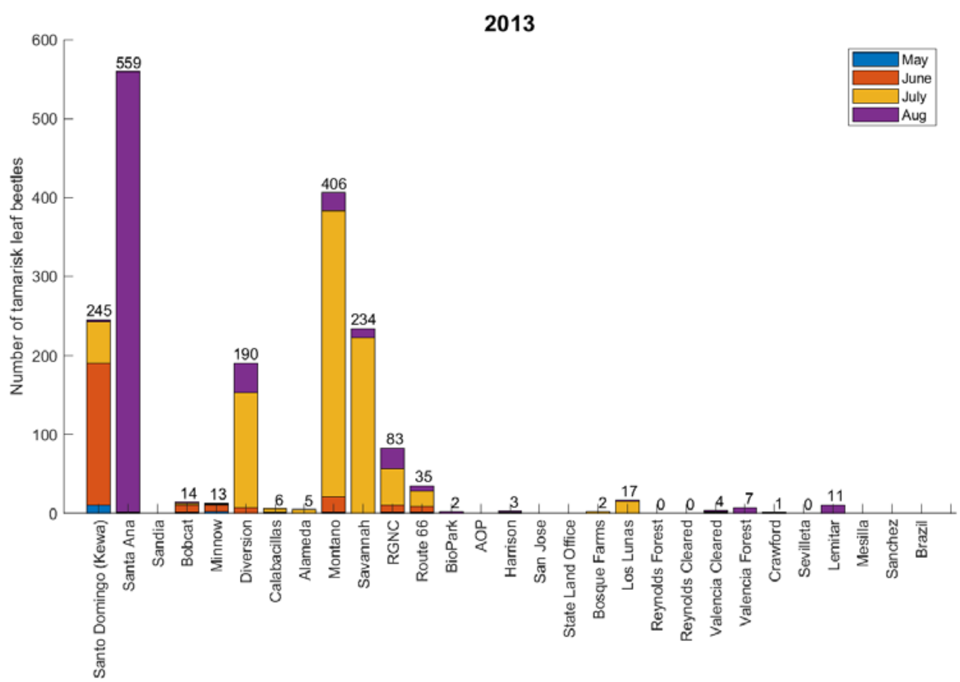

Figure 6. Total TLB captured at BEMP sites from 2013.

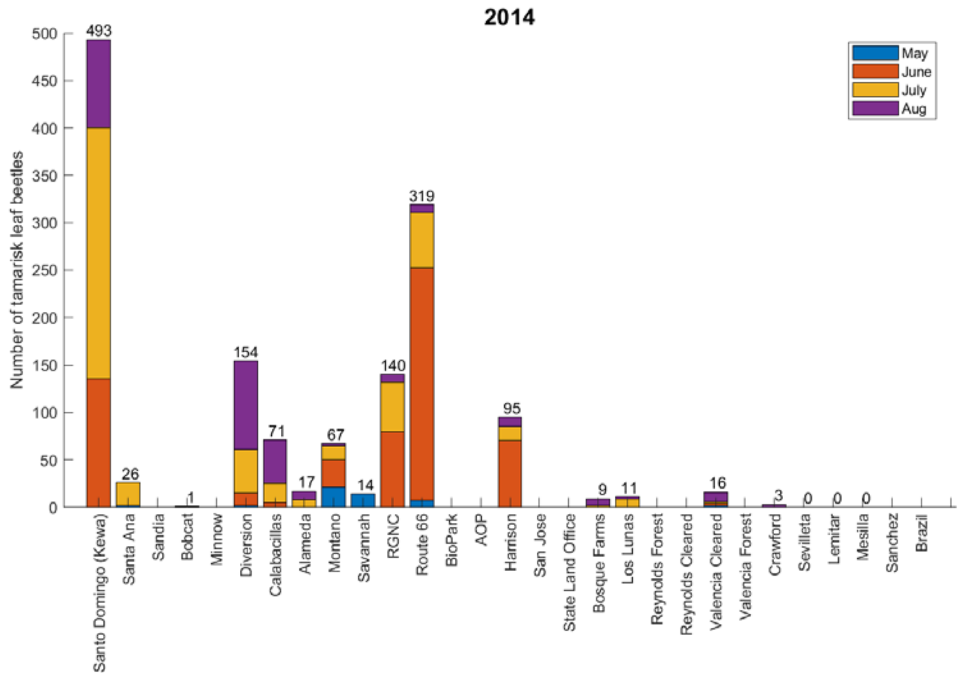

Figure 7. Total TLB captured at BEMP sites from 2014.

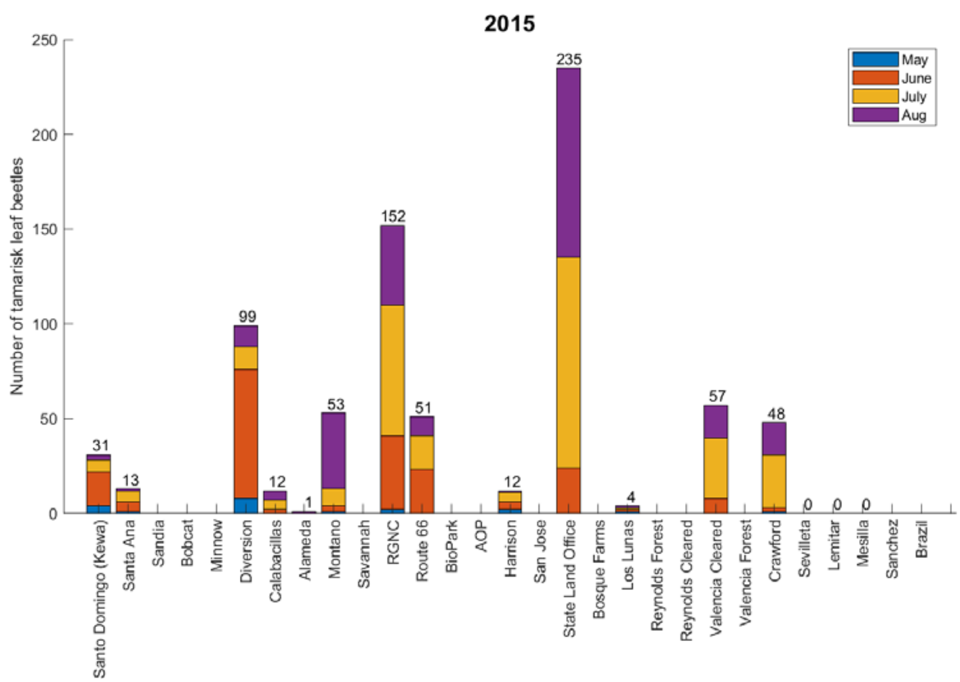

Figure 8. Total TLB captured at BEMP sites from 2015.

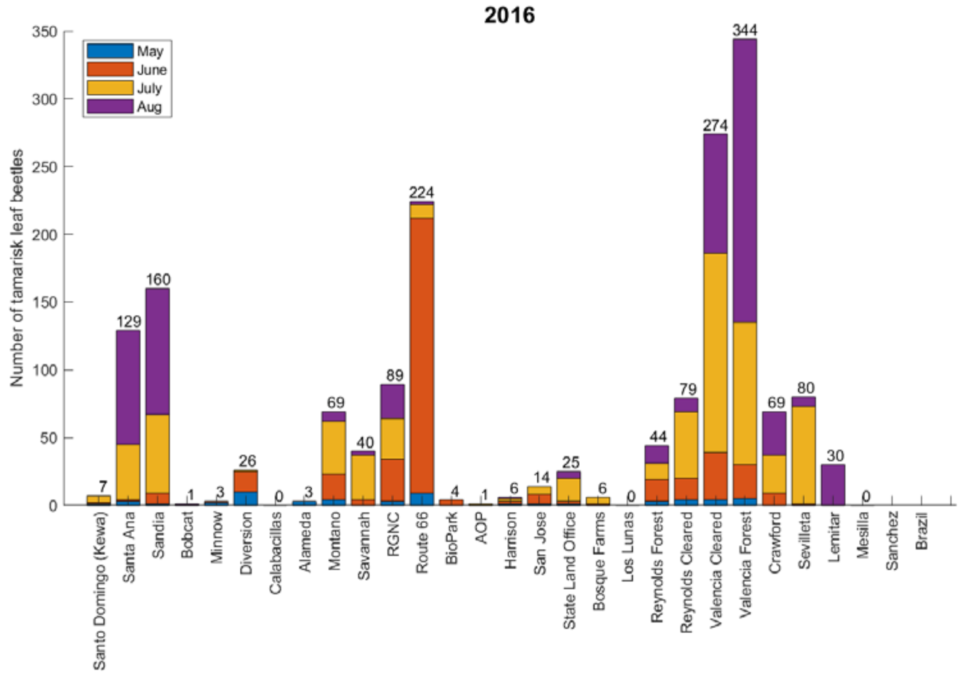

Figure 9. Total TLB captured at BEMP sites from 2016.

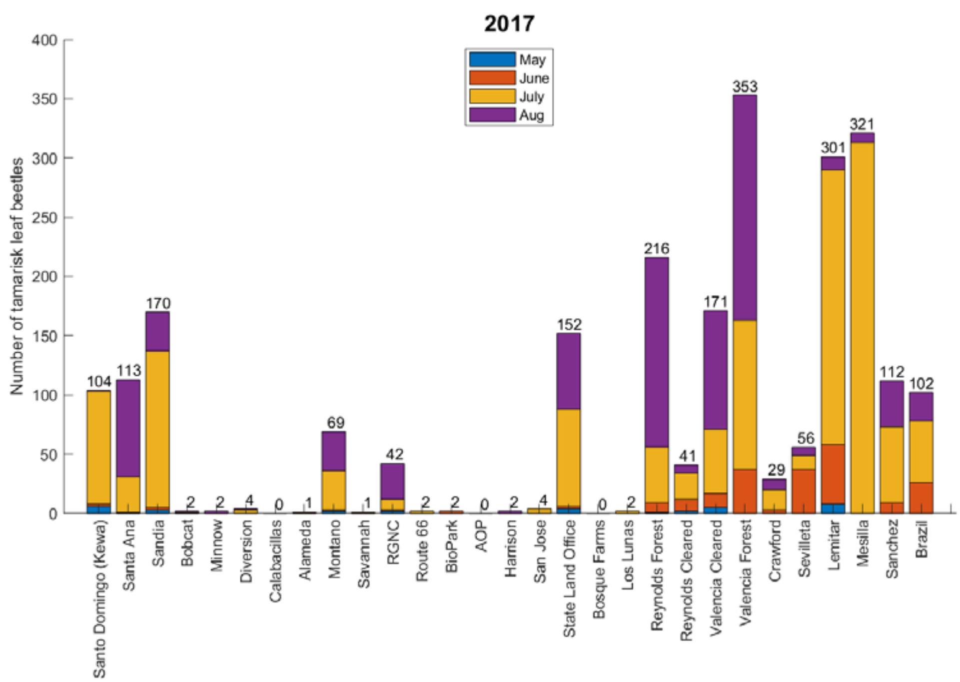

Figure 10. Total TLB captured at BEMP sites from 2017.

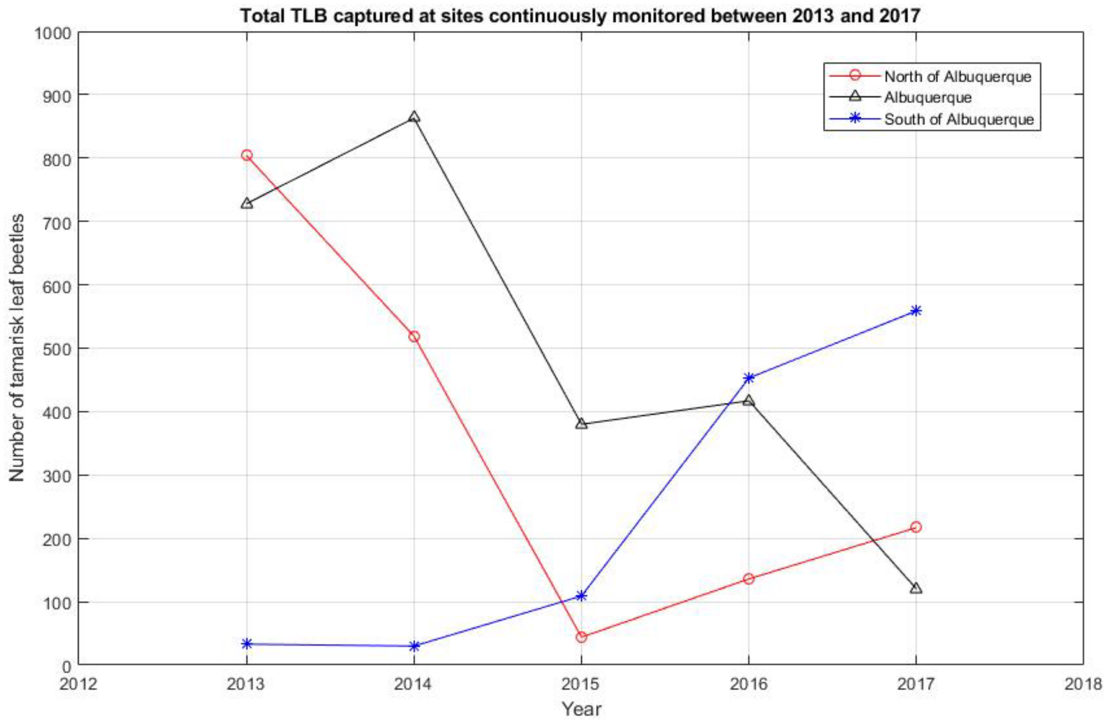

Figure 11. Total TLB captured at BEMP sites continuously monitored between 2013 and 2017. The sites are separated into three geographic regions: sites to the north of Albuquerque (north of Bobcat), sites within Albuquerque (between Bobcat and the State Land Office), and sites to the south of Albuquerque (south of the State Land Office). Sites that were not collected for all five years were not included.

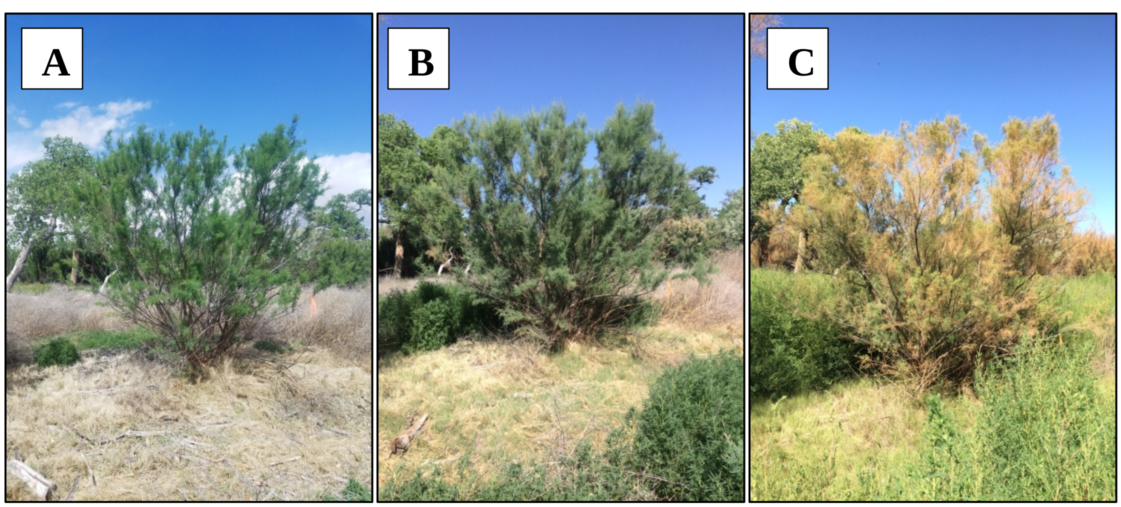

Figure 12. Saltcedar #5 at the BEMP Valencia Clear site during (A) May, (B) June, and (C) August of 2017.