Science and Habitat Restoration Work Group Meeting

March 21, 2017

Meeting Materials:

Meeting Agenda

Meeting Minutes

Tamarisk Leaf Beetle Distribution Within the Rio Grande River Watershed and Possible Effects of Riparian Effects of Riparian Nesting Birds [presentation]

Middle Rio Grande Endangered Species Collaborative Program
Habitat Restoration and Science Joint Workgroup Meeting
March 21, 2017
1:00-3:00 PM
at ISC

HRW/ScW Agenda

1. Introductions

2. Approval of Agenda

3. Tamarisk Beetle Presentation- 2016 Monitoring Update: Matt Johnson

4. Approval of February meeting notes

5. Announcements

6. Program Updates

7. Action Item Review

8. Subgroup Report Outs and Follow-up:

(a) Genetics subgroup; ScW/HRW review/approve recommendations to send to CC/EC.

(b) HR Project GIS subgroup; ask for volunteer from each agency to review HR GIS information and help fill in data fields

Action Items:

- ScW/HRW members were asked to contemplate and provide guidance on how to standardize the restoration site names.
- ✓ Ondrea Hummel will find and circulate the ~2003 "Treatment" document and 2013 HRW "treatment definition" documents. – *complete 02/22/17*
- Debbie Lee will discuss the potential for WEST to host the ScW/HRW geo-database/GIS. Contractual and hardware limitations need to be considered.
- Mick Porter will contact the State Forestry in an attempt to incorporate fire location data into the geo-database/GIS.
- Mick Porter will contact Paul Tashjian to find the "naming convention" references.
- Mick Porter will update the geo-database/GIS with the suggested revisions from today's discussion and will distribute the data tables to meeting attendees upon completion.
- Agency volunteers are needed to review their project information for accuracy (treatment, feature, agency site name, inundation targets associated). Please correct the Excel datasheet so revisions can easily be included.
- Alison Hutson will let ScW/HRW members know when the Genetics & Propagation group is scheduled to meet in March.

- Debbie Lee will inform the EC of the concerns regarding how the genetics peer review recommendations will be addressed when many of them have to be included in the Propagation Plan which is not driven by the Program. This will be encouraged as a retreat topic under the Program restructuring discussions.
- Workgroup members are encouraged to propose different approaches (or systems) for naming restoration sites and addressing naming standardization. *(continued from 01/2017)*
- Dana Price will contact Michael Scialdone to determine if the Sandia Restoration citation information (from the Habitat Effectiveness Report) can be made available to the ScW/HRW workgroups. *(revised and continued from 01/17/17)*

Next Meeting: April18, 2017 from 1:00-3:00 PM at ISC

Middle Rio Grande Endangered Species Collaborative Program
Science and Habitat Restoration Joint Meeting
March 21, 2017 – 1:00pm to 3:30pm
ISC

Decisions Items:

- The February 2017 ScW/HRW Joint Meeting notes were approved for finalization with a clarification correction to the Minnow Action Team (MAT) update.

Action Items:

- Matt Johnson will email the ScW/HRW co-chairs with the USGS climate change report website links.
- Matt Johnson offered to provide information on which bird species experienced significant impact ("dropped out") due to tamarisk habitat changes and whether or not they "rebounded" with restoration efforts (for the Virgin River).
- Mick Porter will email a reminder to ScW/HRW members for agency volunteers to review the GIS data tables (populate fields, review for accuracy, etc.). A "focus group" of agency representatives (and/or ScW/HRW members) to review the GIS/geodatabase and discuss restoration site name standardization may be convened.
- Debbie Lee will contact Ann Demint for updates on the DBMS and Program Website needs. Reclamation and the Corps are in the process of determining what options are available.
- Debbie Lee will add the discussion on how all groups will "tie" into the Program to the EC Retreat agenda. The Genetics & Propagation Workgroup will be used as a specific example. (*modified from 02/21/17)*
- Ken Richard will develop examples of his proposed site naming convention and present them to the workgroup at the April meeting.
- ✓ Dana Price will track down the Scopes of Work/RFP documents developed for the previously identified projects. – *completed 03/24/17*
- Mike Marcus will write up a general Scope of Work/project description based on the Tetra Tech report for the Corps that identified potential restoration sites for confirming through groundtruthing.
- ✓ Dana Price will work with Kathy Lang, Alison Hutson, and Wade Wilson to develop the Paired Mating Pilot Study Scope of Work document. –*initiated 03/24/17*
- Mike Marcus will develop a Scope of Work for the Population Monitoring Workgroup projects.
- Mike Marcus to find the written project description for the Restoration Regrowth Comparative Study (looking at historical vegetation development on sites to determine where active restoration might be needed versus a more passive, natural regeneration could be expected) and provide it to the workgroup.
- Draft FY2018 Project Scopes of Work will be circulated to the workgroups by end of this month for feedback before the April 30 deadline.
- ✓ Dana Price will poll workgroup members for the April meeting date (proposed for the week of April 10). – *initiated poll 03/24/17*
- Brian Hobbs will send the Genetics Project contract tasks to workgroup members for a review of what is currently being done and what changes have been included.
- Dana Price will contact Wade Wilson to get clarification on (1) his specific concerns with paired mating and (2) which pieces from the genetics recommendations are being incorporated into the Propagation Plan.
- Mick Porter will coordinate and schedule a presentation on the Corps' 2017 Inundation Monitoring and Activities for the April meeting.

Ongoing Action Items:

- Debbie Lee will discuss the potential for WEST to host the ScW/HRW geo-database/GIS. Contractual and hardware limitations need to be considered. *(continued from 02/21/17)*

- Mick Porter will contact the State Forestry in an attempt to incorporate fire location data into the geo-database/GIS. *(continued from 02/21/17)*
- Mick Porter will contact Paul Tashjian to find the "naming convention" references. *(continued from 02/21/17)*
- Mick Porter will update the geo-database/GIS with the suggested revisions from today's discussion and will distribute the data tables (sites and associated data) to meeting attendees upon completion. *(continued from 02/21/17)*

Recommendations/Requests:

- ScW and HRW members discussed concerns related to database and website consistency. It was suggested this concern be elevated to the CC to address.
- The ScW and HRW workgroups would like to have the Genetics & Propagation workgroup meeting notes be made available for distribution to the Collaborative Program.

Announcements

- A survey protocol training for the New Mexico Yellow-billed Cuckoo is scheduled for June 8, 2017. The field session is from 6:30 am to 10:30 am and the classroom session will held from 10:45 am to 4:30 pm at the Bosque del Apache NWR. Bring binoculars, hiking boots, tight fitting hat, water, pencils, data sheet, bug spray, snacks and sunscreen, and lunch. To register, please email Vicky Ryan at vicky_ryan@fws.gov with attendee name, email address, and phone number.
- A survey protocol training for the New Mexico Southwestern Willow Flycatcher is scheduled for May 16 - 17, 2017. The classroom session will be held on May 16 from 9:00 am to 3:30 pm at the Sevilleta NWR. The field session will be the next day on May 17 from 7:00 am to 12:00 pm at the Bosque del Apache NWR. Bring binoculars, hiking boots, tight fitting hat, water, pencils, data sheet, bug spray, snacks and sunscreen. Be prepared for hot weather. To register, please email Vicky Ryan at vicky_ryan@fws.gov with attendee name, email address, and phone number.

Next Meeting: week of April 10, 2017 from 1:00pm to 3:00pm at ISC

- Tentative April meeting agenda items: (1) Proposed site naming convention examples and discussion (Reach Abbreviation, River Mile, Dominant Treatment Abbreviation) – Ken Richard; (2) Overview of Tetra Tech identified restoration sites in need of groundtruthing – Mike Marcus; (3) Review the FY2018 workgroup projects for submittal to Reclamation; (4) Corps' FY2017 Inundation Monitoring and Activities Presentation – Steven Brown;
- Future Agenda Items: (1) after April, workgroup to develop a catalog and timelines (make the queue) for future projects and work;

Meeting Summary

- Danielle Galloway brought the meeting to order and introductions were made.
- Matt Johnson provided a presentation on the "*Tamarisk Leaf Beetle Distribution Within The Rio Grande River Watershed And Possible Effects On Riparian Nesting Birds*."
    - *Life Cycle*
        - The adult tamarisk beetle gather together on plants (having been attracted by pheromones emitted by adult males), mate, and lay eggs. The eggs hatch into small black larvae that resemble caterpillars.
        - The larvae feed heavily, grow, molt, and pass through the 3 larval stages. Although other species have 5 generations. The larval stage(s) have the largest impact on the vegetation.
        - When they are mature and stop feeding, the larvae descend from the tamarisk foliage; enter the leaf litter beneath the tamarisk plant and pupate within cocoons (made of leaf litter or sand).
        - After about 10 days the pupae molt to adults, leave the cocoons, crawl back up the tamarisk plants and begin feeding.
        - Only after feeding can the females mate and begin to lay eggs. An individual female can live 2 months and lay up to 700 eggs.

- This cycle can occur 3 times (3 generations) per season. When day lengths shorten (to about 14.5 hours of light) the adult beetles cease reproducing and enter "diapause" allowing the adult beetles to pass through the winter when temperatures are low and there is no foliage available.

o *Background*
- Starting back in 1987, research on bio-controls began. Identification of targets and background research occurred in central Asia to document predators of tamarisk.
- *Diorhabda elongata* was selected for research within the USA. Between 1989 and 1994, research continued on potential agent(s) including lab testing.
- Between 1998 and 2000 field cage tests were performed and monitoring was put into place.
- The first open-field releases of the beetle occurred in 2001 in Lovelock, Nevada and Delta, Utah. There were later release sites in 2004.
- The beetles along the Colorado Plateau are of the central Asian ecotype. In 2001 beetles from both Chilik, Kazakhstan and Fukang, China were released into the open within the Western USA. Chinese beetles being released in lovelock, NV as well as multiple other sites in the 11 western States. While the Kazakhstani beetles were only released outside of Delta, UT.
- Between 2007 and 2016 distribution of the beetle occurred quickly.
- The impacts of the beetle in the Rio Grande watershed have been monitored since 2012. The beetle is moving in from the north and south. They are adapting and continue to move through the state.

o *Project Objectives*
- What is the beetle distribution and directionality of their spread along the Rio Grande River in NM?;
- Determine defoliation, re-foliation, and mortality rates along the Rio Grande River in NM;
- Examine beetle species at the genetic level to assess the distribution of the four (4) species populating the regions surrounding the Rio Grande River;
- Map Tamarisk Weevil distribution in the study area and conduct genetic analyses to determine which weevil species (Splendid Tamarisk Weevil?) is present within the Rio Grande River;
- Provide recommendations for approaches that may be used to mitigate the effects of defoliation by the beetle.

o *Methods*
- There are 43 sites along the river that are monitored. A "sweep and net" method is used to collect and document the numbers and stages of the tamarisk leaf hoppers, tamarisk beetles, and tamarisk weevils. Additionally, ants and ladybugs as well as spiders (all predators) are counted.
- There is a number of field staff involved in the annual monitoring of the beetle and, as of 2016, tamarisk weevil. At each point, five sets of five sweeps are conducted. The presence of beetle eggs and weevil egg cases are denoted, as is the percentage of defoliation and/or refoliation. These data are compiled at the end of year into comprehensive maps.
- In 2016, a pheromone (manufactured in California) was used as a monitoring tool to help locate the beetle.

o *2016 Data*
- The northern tamarisk beetle was found between Mountainair Rd. and Bosque del Apache while the southern (subtropical) strain was found between San Marcial and Highway 185/Shalem Crossing.
- The beetle came out of diapause relatively late – in May. But by June, their presence had increased significantly and defoliation occurred rapidly. The seasonal impacts of the beetle really depend on when they come out of diapause.

- Monitoring continued into September. Since eggs were found in September, the impact of the beetle could have extended into October or even November. The 2016 beetle "season" may have started "late" but it also extended later in the year.
    - A general trend is that the beetle is rapidly adapting to conditions – exiting diapause earlier and earlier each year and possibly extending later into the year as well.
- Please note that the northern and southern beetles are migrating towards each other. As of the 2016 monitoring, most of the "gaps" had disappeared and the beetle could be found throughout the Rio Grande system.

o *2016 Tamarisk Defoliation*

- It is difficult to track the defoliation because there are multiple cycles of defoliation and then refoliation per season.
- The average tamarisk defoliation rate at all sites from July to September increased on average each month by 26.8 ± 6.2% per month.
- The average percent of tamarisk canopies defoliated by tamarisk leaf beetles at all sites monitored by EcoPlateau Research between Los Lunas – La Mesa, NM averaged 37.9 ± 8.2% from July to August, however, declined to 8.9 ± 5.0% from August to September.

o *Tracking Tamarisk Defoliation, Refoliation and Mortality by Tamarisk Leaf Beetle*

- Trees are defoliated and then refoliate by utilizing stored carbohydrates. Remarkably, the trees continue to persist through multiple cycles of impact. Eventually, they may be depleted of the carbohydrates which can lead to branch die-back or even mortality.
- Tamarisk leaf beetles have the most impact on tamarisk in regions where they have defoliated trees multiple times. The resulting impacts include: decrease in canopy cover, plant density, and flowering of plants that have experienced multiple defoliations.

o *2015-2016 Mortality*

- Tamarisk mortality was evaluated by recording the percent of the canopy tree that were observed as dead branches versus living green foliated branches. While this is not a gauge of true mortality, it is a way to gauge the impact of tamarisk leaf beetle herbivory on the health and overall condition of tamarisk in relation to canopy cover, and above root living biomass.
- The mean percentage of tamarisk canopies that were comprised of dead branches (measure of mortality) in 2016 (18.7%) was significantly greater at sites previously defoliated in September 2015.
- The percentage of dead branches in tamarisk across all sampling sites where defoliation was observed was 11% greater 2016 than in areas defoliated previously in 2015.
- Please note that mortality is highly variable in a site as well as between sites. The causes of mortality have been attributed to variable soil salinity and potentially genetic differences in growth rates (susceptibility of individual trees with faster growing trees being more susceptible to beetle induced mortality).

o *Possible Effect Of Defoliation On Birds*

- Defoliation of tamarisk trees affects not just birds but small mammals and reptiles as well.
- Defoliated sites have higher temperatures (as indicated from work on the Virgin River). But the microclimate effects are still under examination.
- Other affects include:
    - Increased visibility – risk of depredation and brood parasitism;
    - Timing of defoliation occurs during the nest building and breeding season;
    - Unfavorable microclimates
        - Temperatures at unshaded nests may reach highs (41°C = 106°F) sufficient to kill embryos
        - Adults expend energy to moderate temp at nest (shading) → attract attention to the nest.

        - Birds tend to eat the weevil most frequently (preferred). It may be related to the chemical compounds in the beetle that make is less appealing.
            - It is noted that the larval stages and leafhopper are more soft-bodied making the remains hard to identify in feces.

    - *Habitat Restoration and Enhancement*
        - There appears to be a decline in bird species richness after the beetle becomes established in a system (based on work from the Virgin River system).
        - Tamarisk shrubs continue to be most valuable when mixed with native vegetation. In areas that have undergone restoration, the flycatcher will move into the willows but are continuing to use the tamarisk as well.
        - Restoration considerations:
            - Protect the current breeding sites.
            - Restoration/enhancement of former breeding sites.
            - Larger-scale restoration in vicinity of current breeding sites.
            - Time-scale; beetles are affecting breeding sites now, and restoration likely to take several years.
            - In other flycatcher breeding areas, restoration/enhancement should start several years in advance of anticipated beetle arrival.

- The February 2017 ScW/HRW Joint Meeting notes were approved for finalization with a clarification correction to the MAT updates.
- A brief Program Update was shared:
    - The EC retreat is scheduled April 26 and 27 at the Sagebrush Inn in Taos. The agenda is not yet available.
    - The Minnow Action Team (MAT) will meet on April 12. The WEST statisticians are working to provide feedback on ISC's 2016 monitoring work and inform ISC's 2017 spring monitoring efforts.
    - WEST interviewed a Program Manger candidate yesterday. The candidate will next meet with the EC representatives next week.
- Attendees reviewed the February Action Items.
- Attendees discussed the FY2018 project proposals due to Reclamation no later than April 30. At a minimum, the proposals should include a project title, short description, and funding need estimate. The workgroups had previously identified the following projects: RGSM Life History, Genetics, and Program Economics. Other suggested projects included: one or two projects from the Genetics Peer Review Recommendations (studies, research, or analyses of existing data); one or two projects as identified by the Population Monitoring workgroup; groundtruthing of potential restoration sites (from the Tetra Tech report for the Corps); and revisit the Long-term Plan for identified projects, as needed.
- After cautioned by some attendees, there was general agreement that the Genetics Subgroup's Recommendations document(s) could be more refined before being elevated to the CC and EC. Concerns included: (1) addressing the red-line edits; (2) including more of the adaptive management piece/link; (3) making sure the document(s) are clearly "linked" back to the original Peer Review Recommendations.

Full Meeting Notes

Introductions and Agenda Review: Danielle Galloway brought the meeting to order and introductions were made. The agenda was approved with the addition of a MAT update to occur in the Program Update.

Presentation: Tamarisk Beetle 2016 Monitoring

- Mr. Matt Johnson, with EcoPlateau Research, was introduced. He presented "*Tamarisk Leaf Beetle Distribution Within The Rio Grande River Watershed And Possible Effects On Riparian Nesting Birds*."

- *Life Cycle*
  - The adult tamarisk beetle gather together on plants (having been attracted by pheromones emitted by adult males), mate, and lay eggs. The eggs hatch into small black larvae that resemble caterpillars.
  - The larvae feed heavily, grow, molt, and pass through the 3 larval stages. (Thus having a total of 4 stages: 3 larval and 1 adult.) The larval stages have the largest impact on the vegetation.
  - When they are mature and stop feeding, the larvae descend from the tamarisk foliage, enter the leaf litter beneath the tamarisk plant, and pupate within cocoons (made of leaf litter or sand).
  - After about 10 days the pupae molt to adults, leave the cocoons, crawl back up the tamarisk plants and begin feeding.
  - Only after feeding can the females mate and begin to lay eggs. An individual female can live 2 months and lay up to 700 eggs.
  - This cycle can occur 3 times (3 generations) per season. When day lengths shorten (to about 14.5 hours of light) the adult beetles cease reproducing and enter "diapause" allowing the adult beetles to pass through the winter when temperatures are low and there is no foliage available.
- *Background*
  - Starting back in 1987, research on bio-controls began. Identification of targets and background research occurred in central Asia to document predators of tamarisk.
  - *Diorhabda elongata* was selected for research within the USA. Between 1989 and 1994, research continued on potential agent(s) including lab testing.
  - Between 1998 and 2000 field cage tests were performed and monitoring was put into place.
  - The first open-field releases of the beetle occurred in 2001 in Lovelock, Nevada and Delta, Utah. There were later release sites in 2004.
  - In 2007, the beetle was released in Colorado. Between 2007 and 2016, the beetle migrated quickly; more quickly than expected.
  - The beetle has been tracked for 3 years since 2013 for the purpose of understanding the impacts to the habitat and bird species. In the Rio Grande watershed, the beetle is moving in from the north and south and they are in the process of converging. They are adapting and continue to move through the state.
    - However, the northern beetle appears to have reached its "physiological" limit and is expected to migrate into Arizona next.
- *Project Objectives*
  - What is the beetle distribution and directionality of their spread along the Rio Grande River?;
  - Determine defoliation, refoliation, and mortality rates along the Rio Grande River;
  - Examine beetle species at the genetic level to assess the distribution of the four (4) species of populating the regions surrounding the Rio Grande River;
  - Map Tamarisk Weevil distribution in the study area and conduct genetic analyses to determine which weevil species (Splendid Tamarisk Weevil?) is present within the Rio Grande River;
  - Provide recommendations for approaches that may be used to mitigate the effects of defoliation by the beetle.
- *Methods*
  - There are 43 sites along the river that are monitored. The Bosque Ecosystem Monitoring Program (BEMP) assists with the sampling and tracking.
  - A "sweep and net" method is used to collect and document the numbers and stages of the tamarisk leaf hoppers, tamarisk beetles, and tamarisk weevils. Additionally, ants and ladybugs as well as spiders (all predators) are counted.

- There is a number of field staff involved in the annual monitoring of the beetle and, as of this year, tamarisk weevil. At each point, five sets of five sweeps are conducted. The presence of beetle eggs and weevil egg cases are denoted, as is the percentage of defoliation and/or re-foliation. These data are compiled at the end of year into comprehensive maps.
- In 2016, a pheromone (manufactured in California) was used as a monitoring tool to help locate the beetle.

o *Tamarisk-Obligate Insects In The Southwest*

- *Leaf Hopper*
  - The tamarisk leaf hopper was first described in 1907. It is a "phloem" or sap feeder that consumes the "juices" of the plant causing leaves and stems to yellow.
  - The leaf hopper has established itself throughout the system.
- *Tamarisk Leaf Beetle*
  - The tamarisk beetle was introduced as a biocontrol in the western United States in 2001. It is a foliage feeder – consuming the actual leaves of the plant.
  - There has been a lot of variability observed through the years, but it appears the beetle is adapting to the region and slowly coming out of diapause earlier every year and extending its presence into the fall.
- *Splendid Tamarisk Weevil*
  - Details on the introduction of the weevil are unknown. The first published occurrence is referenced in Nevada in 2011. However, there are earlier accounts of the weevil in Arizona.
  - The weevil eats the tamarisk shoot tips.
  - Little is known about the weevil such as its natural history, generations, etc. They are just getting established in the Rio Grande but seem to be concentrated in the south end in 2013 with concentrations slightly increasing in 2014.

o *How does tamarisk habitat quality change?*

- The beetle can have "seasonal" impacts caused by defoliating the tamarisk trees. Eventually, the tamarisk plants will die with enough defoliation and refoliation cycles. In terms of defoliation from the beetle, most occurs between June and August each year.
- There is much variation and it really seems to depend on when the beetle comes out of diapause.
- The combination of effects from all three insects is unknown.

o *2016 Data*

- The northern tamarisk beetle was found between Mountainair Rd. and Bosque del Apache while the southern (subtropical) strain was found between San Marcial and Highway 185/Shalem Crossing.
- The beetle came out of diapause relatively late – in May. But by June, their presence had increased significantly and defoliation occurred rapidly. The seasonal impacts of the beetle really depend on when they come out of diapause.
- Monitoring continued into September. Since eggs were found in September, the impact of the beetle could have extended into October or even November. The 2016 beetle "season" may have started "late" but it also extended later in the year.
  - A general trend is that the beetle is rapidly adapting to conditions – exiting diapause earlier and earlier each year and possibly extending later into the year as well.
- Please note that the northern and southern beetles are migrating towards each other. As of the 2016 monitoring, most of the "gaps" had disappeared and the beetle could be found throughout the Rio Grande system.
- In response to a question on the use of elevation maps, it was responded that latitudes are important when tracking when the beetle goes in and comes out of diapause. The northern

beetle appears to have reached its northern latitude "limit" (around the Bosque del Apache) and is expected to move laterally into Arizona. Original research indicated it would not surpass the 38th Parallel and that it would take 20 years to do so; instead, the beetle distributed within 2 to 3 years.

- *2016 Tamarisk Defoliation*
  - It is difficult to track the defoliation because there are multiple cycles of defoliation and then refoliation per season.
  - The average tamarisk defoliation rate at all sites from July to September increased on average each month by 26.8 ± 6.2% per month.
  - The average percent of tamarisk canopies defoliated by tamarisk leaf beetles at all sites monitored by EcoPlateau Research between Los Lunas – La Mesa, NM averaged 37.9 ± 8.2% from July to August, however, declined to 8.9 ± 5.0% from August to September.
- *Tracking Tamarisk Defoliation, Refoliation and Mortality by Tamarisk Leaf Beetle*
  - Trees are defoliated and then refoliate by utilizing stored carbohydrates. Remarkably, the trees continue to persist through multiple cycles of impact. Eventually, they may be depleted of the carbohydrates which can lead to branch die-back or even mortality.
  - Tamarisk leaf beetles have the most impact on tamarisk in regions where they have defoliated trees multiple times. The resulting impacts include: decrease in canopy cover, plant density, flowering that have experienced multiple defoliations.
- *2015-2016 Mortality*
  - Tamarisk mortality was evaluated by recording the percent of the canopy tree that were observed as dead branches versus living green foliated branches. While this is not a gauge of true mortality, it is a way to gauge the impact of tamarisk leaf beetle herbivory on the health and overall condition of tamarisk in relation to canopy cover, and above root living biomass.
  - The mean percentage of tamarisk canopies that were comprised of dead branches (measure of mortality) in 2016 (18.7%) was significantly greater at sites previously defoliated in September 2015.
  - The percentage of dead branches in tamarisk across all sampling sites where defoliation was observed was 11% greater 2016 than in areas defoliated previously in 2015.
  - Please note that mortality is highly variable in a site as well as between sites. The causes of mortality have been attributed to variable soil salinity and potentially genetic differences in growth rates (susceptibility of individual trees with faster growing trees being more susceptible to beetle induced mortality).
- *Tamarisk Leafhoppers and Tamarisk Weevils Affects on Tamarisk Habitat*
  - Weevils feed on tamarisk foliage (leaf tips) and may attain high enough densities to cause visible damage to trees. The adults can be found on tamarisk plants both earlier and later in the season than beetle adults. However, not much is really known on their impact on the tamarisk and the interaction with the beetle.
  - The leafhopper feeds on phloem nutrients in the plant tissue and its presence can be indicated by the discoloration of plant leaves and stems.
    - Stem growth was reduced on caged tamarisk plants when fed upon by large numbers of leafhoppers.
- *Genetic Sampling and Hybridization*
  - To determine beetle species and hybridization, 5 samples were collected from each of 15 sites between Los Lunas and La Mesa. Individual beetles and weevils were collected and preserved.
  - DNA was collected from adult specimens and sequenced to identify species designation.
  - Next year, genetic sampling will be done for the Albuquerque area as well.

- The subtropical beetle species displayed 8% to 10% hybridization characters of Mediterranean beetle at sites surrounding Elephant Butte Reservoir. These two species of beetles have been shown to readily hybridize.
    - The theory is that the subtropical species will overtake the northern beetle or they will experience some form of hybridization.
    - What does this hybridization mean? Could they migrate quicker? Have more generations per season? Could the latitude limits change and result in increased distribution?

- *Possible Effect Of Defoliation On Birds*
    - Defoliation of tamarisk trees affects not just birds but small mammals and reptiles as well. Birds can fly and have opportunity to seek other habitat compared to the mammals and reptiles.
    - Affects include:
        - Increased visibility – risk of predation and brood parasitism;
        - Timing of defoliation occurs during the nest building and breeding season;
        - Unfavorable microclimates
            - Temperatures at unshaded nests may reach highs (41°C = 106°F) sufficient to kill embryos
            - Adults expend energy to moderate temp at nest (shading) → attract attention to the nest.

- *Research Questions*
    - What are patterns of avian richness and abundance at sites that vary in amount of tamarisk and amount of defoliation by the beetle?
    - How does diet of breeding birds differ within and among areas with different abundances of beetle and other tamarisk associated insects?
        - Are the birds eating the beetle? Leaf hopper? Weevil?
        - Adapted protocol from the Tamarisk Coalition that included insect sweeps, point counts, and fecal investigations were used to determine the amount of these insects the birds were eating. (Targeted bird species included Lucy's warbler, Abert's towhee, yellow warbler, and Bewick's wren.)
        - *Findings:*
            - Birds tend to eat the weevil most frequently (preferred). It may be related to the chemical compounds in the beetle that makes it less appealing.
            - It is noted that the larval stages and leafhopper are more soft-bodied making the remains hard to identify in feces.

- *Species Richness*
    - Research has included looking into the impacts of these insects on all bird species.
    - Fortunately, there was one year of data prior to the arrival of the beetle.
    - *Findings:*
        - In general, there was a high species richness that appears to declines after the beetle gets established in the system.
        - Comparatively, the flycatcher has actually done better than the yellow warbler which took a productivity "hit" and parasitism increased.

- *Virgin River Temperature Changes*
    - Defoliated sites have higher temperatures (as indicated from work on the Virgin River). But the microclimate effects are still under examination.

- *Habitat Restoration and Enhancement*
    - Restoration and enhancement will be important to protecting current breeding sites and improving former breeding sites for birds.
    - There appears to be a decline in bird species richness after the beetle becomes established in a system (based on work from the Virgin River system).

- Tamarisk shrubs continue to be most valuable when mixed with native vegetation. In areas that have undergone restoration, the flycatcher will move into the willows but are continuing to use the tamarisk as well.
- Restoration considerations:
  - Protect the current breeding sites.
  - Restoration/enhancement of former breeding sites.
  - Larger-scale restoration in vicinity of current breeding sites.
  - Time-scale; beetles are affecting breeding sites now, and restoration likely to take several years.
- In other flycatcher breeding areas, restoration/enhancement should start several years in advance of anticipated beetle arrival.

o *Conclusions*

- Research studies need to continue for the long-term to really determine the impacts of the insects on the habitat.
- A mix of tamarisk and willow plants provides the best combination for nest success.
- The monitoring of the beetle and other tamarisk insects will continue next year – tracking of distribution/movement, sampling for genetics and hybridization, changes in seasons/cycle, impacts and mortality of the tamarisk, etc.

o *Questions*

- In response to a question on the "conceptual model" diagram for the flycatcher, it was shared that these models were developed for each species for a USGS climate change project. The diagram highlights the complexity of all the different factors.
- In response to a question on the "typical" lag time between defoliation and refoliation, it was shared that it all depends on the site – from weeks to several months. Much is still unknown.
  - Defoliation rates vary by site and can change annually depending on when the beetle comes out of diapause. There has to be green vegetation for them to feed on or they die off quickly.
  - The original intent was a biocontrol agent, but nothing is replacing the tamarisk plants that do die. There is no sufficient regrowth except by weeds. Some areas would be very difficult to accomplish restoration work as they would require irrigation. The tamarisk plants do provide habitat, shade, and erosion control.
- In response to a question regarding the assessment of avian diversity and abundance, it was shared that there has definitely been a decrease in the avian diversity and abundance over time (as exampled in the Virgin River). However, a longer time series is needed to determine avian trends on the Rio Grande.
- It was commented that temperatures are warming and water available is declining (climate change). And the beetle is adapting and potentially hybridizing – which could result in longer seasons and more generations. What plant species are recommended for consideration in restoration activities given that willows take time to establish and mature?
  - It was responded that Tom Whitham from Northern Arizona University is working on identifying which plants (trees, in particular) are adapting to climate changes and which ones are likely to be successful in the future.
- In response to a question if there is evidence that the beetle can "switch" plants, it was shared that the beetle strictly feeds on the tamarisk and no "shift" has been observed. There is nothing like (similar to) the tamarisk plant in the system.

Approval of February 2017 Meeting Notes

- The February 2017 ScW/HRW Joint Meeting notes were approved for finalization with a clarification correction to the Minnow Action Team (MAT) update.
  - On page 8, under *Habitat Restoration Monitoring – Current Efforts*, the first bullet will be clarified to: "After the Minnow Action Team (MAT) meeting on February 10, 2017, some staff met to begin

discussing 2017 monitoring…A Sampling and Analysis Plan is being developed by SWCA for review by Reclamation/WEST to verify inclusion of 2015 RA and 2016 BO ITS."

Announcements

- A survey protocol training for the New Mexico Yellow-billed Cuckoo is scheduled for June 8, 2017. The field session is from 6:30 am to 10:30 am and the classroom session will held from 10:45 am to 4:30 pm at the Bosque del Apache NWR. Bring binoculars, hiking boots, tight fitting hat, water, pencils, data sheet, bug spray, snacks and sunscreen, and lunch. To register, please email Vicky Ryan at vicky_ryan@fws.gov with attendee name, email address, and phone number.
- A survey protocol training for the New Mexico Southwestern Willow Flycatcher is scheduled for May 16 - 17, 2017. The classroom session will be held on May 16 from 9:00 am to 3:30 pm at the Sevilleta NWR. The field session will be the next day on May 17 from 7:00 am to 12:00 pm at the Bosque del Apache NWR. Bring binoculars, hiking boots, tight fitting hat, water, pencils, data sheet, bug spray, snacks and sunscreen. Be prepared for hot weather. To register, please email Vicky Ryan at vicky_ryan@fws.gov with attendee name, email address, and phone number.

Program Updates

- The statisticians from WEST participated in the ad hoc 2017 Spring Efforts Planning meeting. They continue to work with Rich Valdez (SWCA) to provide feedback on ISC's 2017 Monitoring and Sampling plans and 2016 results.
- The Minnow Action Team (MAT) is scheduled to meet on April 12, 2017.
- The Executive Committee (EC) has scheduled a retreat for April 26 and 27 at the Sagebrush Inn in Taos. The agenda is still being formulated. The draft agenda is expected to be available for distribution later this week.
- WEST interviewed a Program Manager candidate yesterday. The candidate will hopefully meet with the EC representatives next week. WEST will continue identifying other potential candidates, and is focusing on individuals with environmental conflict resolution experience.

Action items

- ScW/HRW members were asked to contemplate and provide guidance on how to standardize the restoration site names. *– ongoing;*
    - Reminders will be sent. It was suggested this task could be addressed through a focus group, if needed.
- ✓ Ondrea Hummel will attempt to find (and if successful will circulate) the ~2003 "Treatment" document and 2013 HRW "treatment definition" documents. *– completed ;*
- Debbie Lee will discuss the potential for WEST to host the ScW/HRW geo-database/GIS. Contractual and hardware limitations need to be considered. *– ongoing; on hold;*
    - It is unknown if this is a task that WEST can take over.
    - Regarding the Program's Database Management System (DBMS), it was clarified that the Corps has extended the time of the existing contract in order to facilitate continued hosting. The Program has to determine what the next steps are.
        - It was pointed out that federal regulations mean this project (or anything similar) has to be re-competed at least every five (5) years. The contract has been extended multiple times and now requires a full RFP to rebid the work. Or find another way to host/house it.
        - It was suggested the workgroup consider elevating a statement of concern regarding how changes in database management every several years is not good for the Program. This is especially pertinent given the turnover in agency personnel and continuity of knowledge.
            - At a minimum, the Program needs a public calendar with notifications to meet the Open Meetings Act requirements.
        - It was suggested this concern be elevated to the CC for continued discussion.
- Mick Porter will contact the State Forestry in an attempt to incorporate fire location data into the geo-database/GIS. *– ongoing;*
- Mick Porter will contact Paul Tashjian to find the "naming convention" references. *– ongoing;*

- Mick Porter will update the geo-database/GIS with the suggested revisions from today's discussion and will distribute the data tables (sites and associated data) to meeting attendees upon completion. *– ongoing;*
- Agency volunteers are needed to review their project information for accuracy (treatment, feature, agency site name, inundation targets associated). Please correct the Excel datasheet so revisions can easily be included. *– ongoing;*
- ✓ Alison Hutson will let ScW/HRW members know when the Genetics & Propagation group is scheduled to meet in March. *– completed ;*
- Debbie Lee will inform the EC of the concerns regarding how the genetics peer review recommendations will be addressed when many of them have to be included in the Propagation Plan which is not driven by the Program. This will be encouraged as a retreat topic under the Program restructuring discussions. *– ongoing ; modify*
    - Debbie Lee will add the discussion on how all groups will "tie" into the Program to the EC Retreat agenda. The Genetics & Propagation Workgroup will be used as a specific example.
- Workgroup members are encouraged to propose different approaches (or systems) for naming restoration sites and addressing naming standardization. *(continued from 01/2017) – ongoing; discussion below:*
    - In response to this action, attendees discussed suggestions during the meeting. Suggestions included:
        - *Coordinates* – while coordinates don't change, it was pointed out that they aren't intuitive enough to be useful for database users. The coordinates are included in the database fields, so the information is available.
            - Attendees discussed how to best incorporate the use of polygons and where coordinates would be taken. One concern is how to address changes in features over time.
                - Some attendees cautioned against attempting to store all that information in polygon form on the main layer. There could be separate layers, if the need is determined.
                - There would eventually be multiple "treatment" polygons as part of the same site. Some attendees questioned whether the coordinates would refer to the centroid for each of the treatments or one centroid for the site?
                - One of the GIS developers cautioned that there should be no centroid coordinates but that the polygon itself is the identifier. If needed, there should be two separate databases: (1) one for individual features pulled out as smaller polygons that make up a site and then (2) another for larger site boundaries polygon. The larger "site boundaries" with boarders is of particular importance for restoration accounting ability.
        - *3-Part Site Abbreviations/Shorthand* – sites could be referenced with Reach Abbreviation (AL, IS, SA) followed by River Mile and finally a "dominate" treatment abbreviation. This nomenclature standard would provide users an immediate understanding of the site without having to look up additional information. The specific details on the site will be included in the data fields, including the other treatments.
            - For example: IS159SW for Isleta RM 159 Swale.
- Dana Price will contact Michael Scialdone to determine if the Sandia Restoration citation information (from the Habitat Effectiveness Report) can be made available to the ScW/HRW workgroups. *(revised and continued from 01/17/17) – ongoing;*
    - This action was completed as written, but no response has been received.
    - A lot of the information in included in Sandia's Restoration Monitoring Plan and the contents were discussed generally in the document on Effectiveness Habitat Monitoring (completed for the Corps).

FY2018 RFPs

- The ScW and HRW groups were asked to begin working on FY2018 projects and budgets which are due to Reclamation before the end of April. At a minimum, the proposals should include a project title, short

description, and funding need estimate. These proposals have to be entered into the Reclamation acquisition plan spreadsheet by April 30.

- Some attendees questioned if potential projects were limited to those submitted by the workgroups or if agency partners or others (ex. landowners) could also submit a request for funding.
    - Federal agencies can submit a request for funding; but often these projects are advertised to potential bidders through FedBizOps.
    - In the past, a lot of the restoration work has been funded through the grant process.
- *Previously Identified Workgroup Projects*
    - Silvery Minnow Life History, Genetics, and Program Economics were all projects that the workgroup had identified and worked on previously.
- *New/Additional Projects for Consideration*
    - *Genetic Peer Review Suggestions:* the Genetics Peer Review Panel and the genetics subgroup had identified priorities, potential projects, and next steps.
        - One or two of these projects could be selected. The genetics subgroup identified several projects that involved reanalyzing existing data. There are also pilot genetic studies that should be considered sooner instead of later.
    - *Population Monitoring Subgroup Suggestions:*
        - The Population Monitoring Subgroup is scheduled to meet later this week. They might have one or two projects to recommend.
    - *Habitat Restoration:*
        - Given the restoration suggestions in the beetle presentation, larger-scale restoration in the vicinity of current flycatcher breeding sites is needed *now* since maturity of vegetation is likely to take several years.
        - A Tetra Tech report completed for the Corps looked at the salt cedar impacts to habitat and identified sites most likely to be impacted. Field validations are the next step.
        - There is a lot of variety in how a restoration site experiences regrowth. There have been past discussions on the possibility of doing a comparative study looking at historical data and historical vegetation development on sites to determine where active restoration might be needed versus where a more passive, natural regeneration could be expected.
    - *Long-Term Plan (LTP):*
        - The Program's LTP contained a lot of previously identified activities and projects. This document could be reviewed for needed project recommendations.
- Draft project scopes will be developed by April 7 and circulated through the joint workgroup for feedback by the end of this month.
- After April, the workgroup could begin to develop a "catalog" with timelines (i.e., make a project queue) for future projects and work.
    - Attendees briefly discussed the uncertainty regarding how restoration projects in the 2016 Biological Opinion (BO) will proceed versus other Program projects.
    - Attendees discussed an approach to providing funding for creating habitat in conjunction with work that is already being done. In other words, there is a logical step to "piggy backing" onto work that is already underway.
    - The roles of the BO partners (specifically the Corps) and other Program partners need to be talked about. What projects are already "underway" and what projects need to occur?
    - It was cautioned that the email communications avoid potential conflict of interest by not including contractors who might wish to submit an RFP bid. Potential contractors should also be excused from meeting discussions if budget or project details are to be covered.

Subgroup Report Outs

- *Genetics & Propagation Joint Group*:
    - In response to the Genetics Subgroup's recommendation to present the work (genetic priorities, projects, etc.) to the CC/EC for discussions and decisions, it was cautioned that documents/spreadsheets are not yet ready for elevating to the CC.

- The concerns included: (1) addressing the red-line edits; (2) including more of the adaptive management piece/link; (3) making sure the document(s) are clearly "linked" back to the original Peer Review Recommendations.
- Given the approaching FY2018 project deadlines for Reclamation, the documents could provide guidance on potential projects and the development of the project description.

- It was suggested the subgroup (and any interested individuals) meet to refine the document(s) and possibly better define/describe the identified projects and priorities.
  - The Genetics Monitoring Contract was recently awarded. A Reclamation contracting representative for the Genetics Contract should be included in the subgroup meeting(s) to address any contracting changes compared to previous years (such as the collection of samples from broodstock).
  - It will also be important to know what SNARRC (Southwestern Native Aquatic Resources & Recovery Center; formerly Dexter) is currently doing and what changes have been made in order to make sure there isn't a "duplication" on things already being addressed.
- Many of the projects identified by the subgroup are closely "intertwined" with the Genetics & Propagation group. How this group "fits in" with the Program going forward remains unknown at this time. The roles and "relationship" with the Genetics & Propagation group has yet to be defined by the EC.
  - The Genetics & Propagation Plan is being updated right now. This is an important "connection" piece that will drive the genetics work for the facilities.
    - It will be important to know which pieces from the genetics recommendations are being incorporated/included in the revised plan.
    - It was shared that the Genetics Peer Review is considered the "best available science" so it has to be addressed in (or utilized in the development of) the plan.
    - The expected process is that the Revised Propagation Plan will be available in draft form for a full year and there will be period for comments before it will be finalized next year.
    - The ScW and HRW workgroups would like to have the Genetics & Propagation workgroup meeting notes be made available for distributed to the Collaborative Program.
  - Some attendees discussed the perception that the Service representative (on the genetics subgroup) did not support the suggestions on paired mating for the minnow.
- Ideally, some of the FY2018 funding will be used for addressing of the Genetics Peer Review Panel recommendations.
  - The Pilot Study is a first step toward implementing paired mating. Attendees were reminded that any work on paired mating trials would have a whole "cohort" delay in the information (on costs, feasibility, etc.).
- In a follow up from the RFI action item assigned last meeting, it was shared that Reclamation's contracting office suggested that the project lends itself better to a grant process. Usually universities do genetics work and a grant process is a more appropriate way to reach the right people for future genetics work. As a grant, the "targeted experts" can be in the room as the project gets developed and can result in a better product.

- In a brief hydrology update, it was shared that several reservoirs are still in flood operations. Thomas Archdeacon began egg monitoring last week and SWCA will begin this week. ASIR is not set up to begin monitoring until mid-April.
  - It is better to begin too early (i.e. have "negative data" beforehand) compared to missing the beginning of the spawn as happened last year.
  - The Program will need to discuss future monitoring work and when monitoring should be initiated.

Next Meeting: week of April 10, 2017 from 1:00pm to 3:00pm at ISC

- Tentative April meeting agenda items: (1) Proposed site naming convention examples and discussion (Reach Abbreviation, River Mile, Dominant Treatment Abbreviation) – Ken Richard; (2) Overview of Tetra Tech identified restoration sites in need of groundtruthing – Mike Marcus; (3) Review the FY2018

workgroup projects for submittal to Reclamation; (4) Corps' FY2017 Inundation Monitoring and Activities Presentation – Steven Brown;

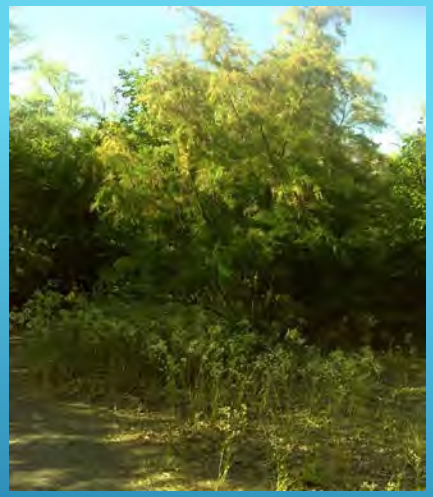
- Future Agenda Items: (1) after April, workgroup to develop a catalog and timelines (make the queue) for future projects and work;

Science and Habitat Restoration Joint Meeting
March 21, 2017 Meeting Attendees

	NAME	AFFILIATION	PHONE NUMBER	EMAIL ADDRESS	Primary, Alternate, Other
1	Dana Price	Corps	505-342-3378	dana.m.price@usace.army.mil	P – ScW Co-Chair
2	Rick Billings	ABCWUA	505-259-0535	rbillings@abcwua.org	P – HRW Co-Chair
3	Danielle Galloway	Corps	505-342-3661	danielle.a.galloway@usace.army.mil	P – HRW Co-Chair
4	Michael Porter	Corps	505-342-3264	michael.d.porter@usace.arm.mil	A - ScW
5	Malia Volke	NMDGF	505-476-8160	malia.volke@state.nm.us	P - ScW
6	Mike Marcus	For APA	505-379-6891	mdmenv@gmail.com	P - ScW
7	Joel Lusk	FWS	505-761-4209	joel_lusk@fws.gov	P - ScW
8	Grace Haggerty	ISC	505-383-4042	grace.haggerty@state.nm.us	P - HRW
9	Susan Bittick	Corps	505-342-3397	susan.m.bittick@usace.army.mil	O
10	Lynette Giesen	Corps	505-342-3187	lynette.m.giesen@usace.army.mil	O
11	George MacDonell	Corps	505-342-3281	george.h.macdonell@usace.army.mil	O
12	Brian Hobbs	Reclamation	505-462-3564	bhobbs@usbr.gov	O
13	Kenneth Richard	Reclamation	505-462-3553	karichard@usbr.gov	O
14	Gina Dello Russo	SOBTF	575-517-5306	gdellorusso@wildblue.net	O
15	Ondrea Hummel	Tetra Tech	505-881-3188 xt 124	ondrea.hummel@tetratech.com	O
16	Jean-Luc Cartron	DBS&A	977-7716	jcartron@dbstephens.com	O
17	Matt Johnson	EcoPlateau Research	928-853-0488	mjjohnson29@gmail.com	O
18	Debbie Lee	WEST	505-492-2239	dlee@west-inc.com	O
19	Marta Wood	Alliant Env.	505-259-6098	mwood@alliantenv.com	O – note taker

Tamarisk Leaf Beetle Distribution within the Rio Grande River Watershed and Possible Effects Riparian Nesting Birds

Matthew Johnson and Levi Jamison
EcoPlateau Research,
Flagstaff AZ 86005



TAMARISK LEAF BEETLE LIFE CYCLE

Courtesy of Dr. Dan Bean, Palisade Insectary

TAMARISK LEAF BEETLE LIFE CYCLE

- The adults gather together on tamarisk plants; attracted by pheromones released by the males and by the smell of tamarisk foliage.
- They mate, lay eggs and move on to the next plant, often in large numbers. The eggs hatch into small black larvae that resemble caterpillars.
- These feed heavily, grow, molt and pass through three larval stages.
- When they are mature and stop feeding, the larvae descend from the tamarisk foliage, enter the leaf litter beneath the tamarisk plant and pupate within cocoons made of leaf litter or sand.
- After about 10 days the pupae molt to adults, leave the cocoons, crawl up the tamarisk plants and begin feeding.
- Only after feeding can the females mate and begin to lay eggs. An individual female can live about 2 months and she can lay up to 700 eggs.
- When day lengths shorten reach about 14.5 hours of light the adult beetles cease reproducing and enter “diapause” allowing the adult beetles to pass through the winter when temperatures are low and there is no foliage available.

TAMARISK (*DIORHABDA* SPP.) LEAF BEETLE

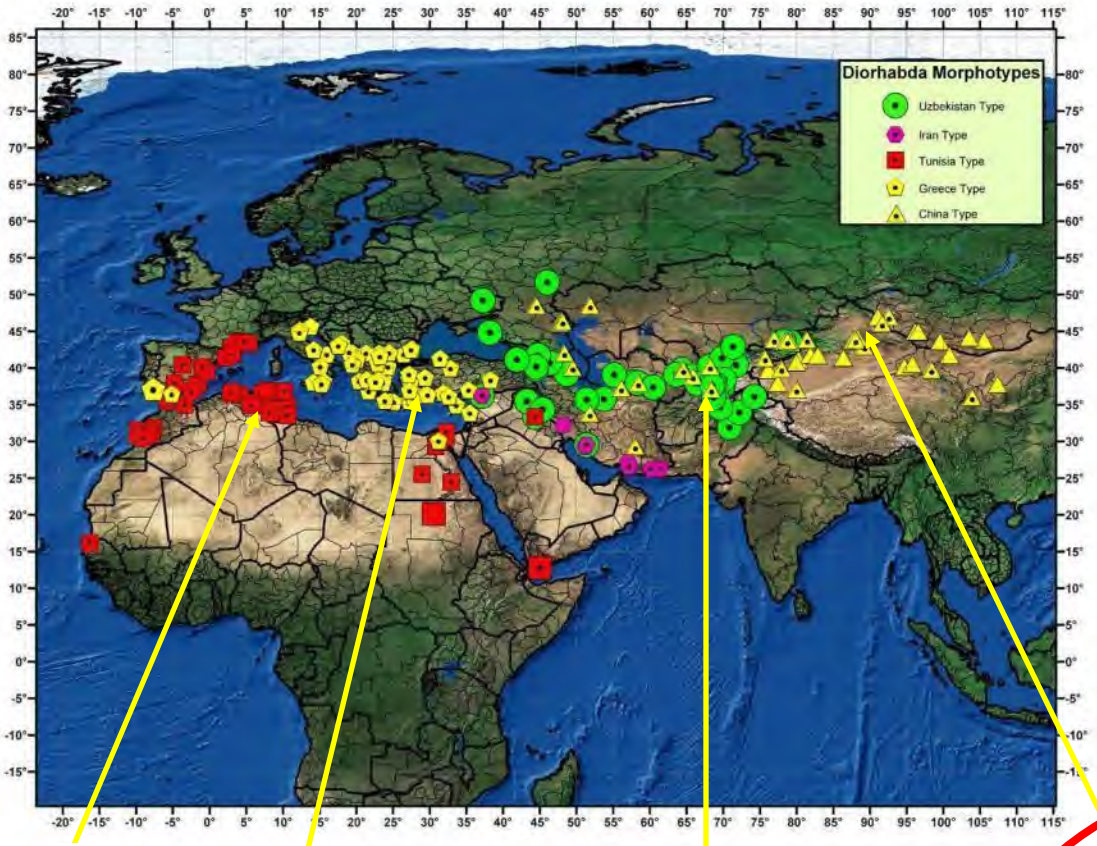
Photo courtesy of Ed Kosmicki

Photo Sonoran Joint Venture

Released in North America in May 2001

East Salt Creek - Mesa County, CO

Before & After



Tunisia

Crete

Uzbekistan

Chilik, Fukang, Turpan

TAMARISK BIOCONTROL TIMELINE

Identification of target/background research

1987

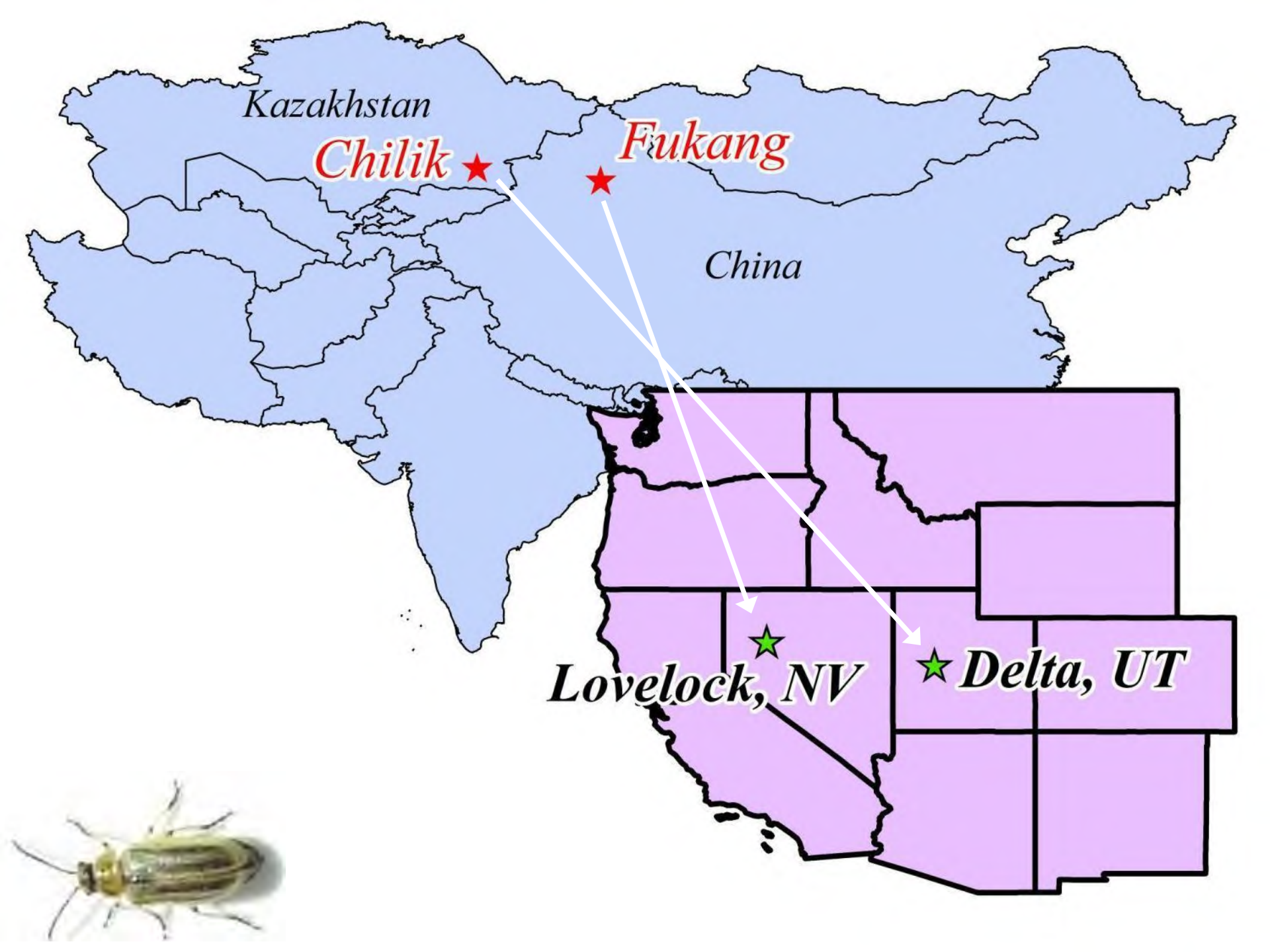
Overseas exploration and research to find agent or agents (*D. elongata and Trabutina mannipara* are promising)

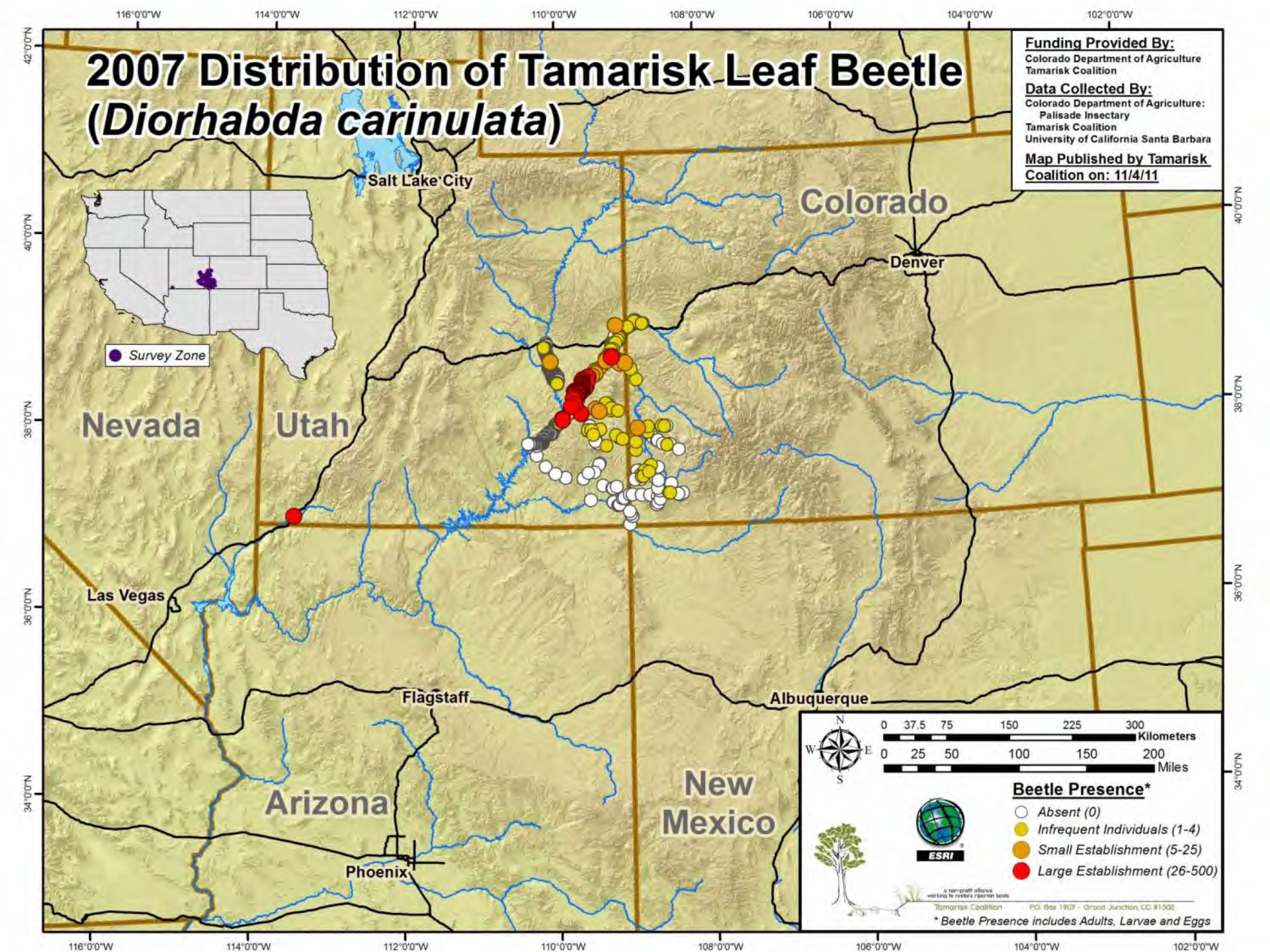
1989-1994

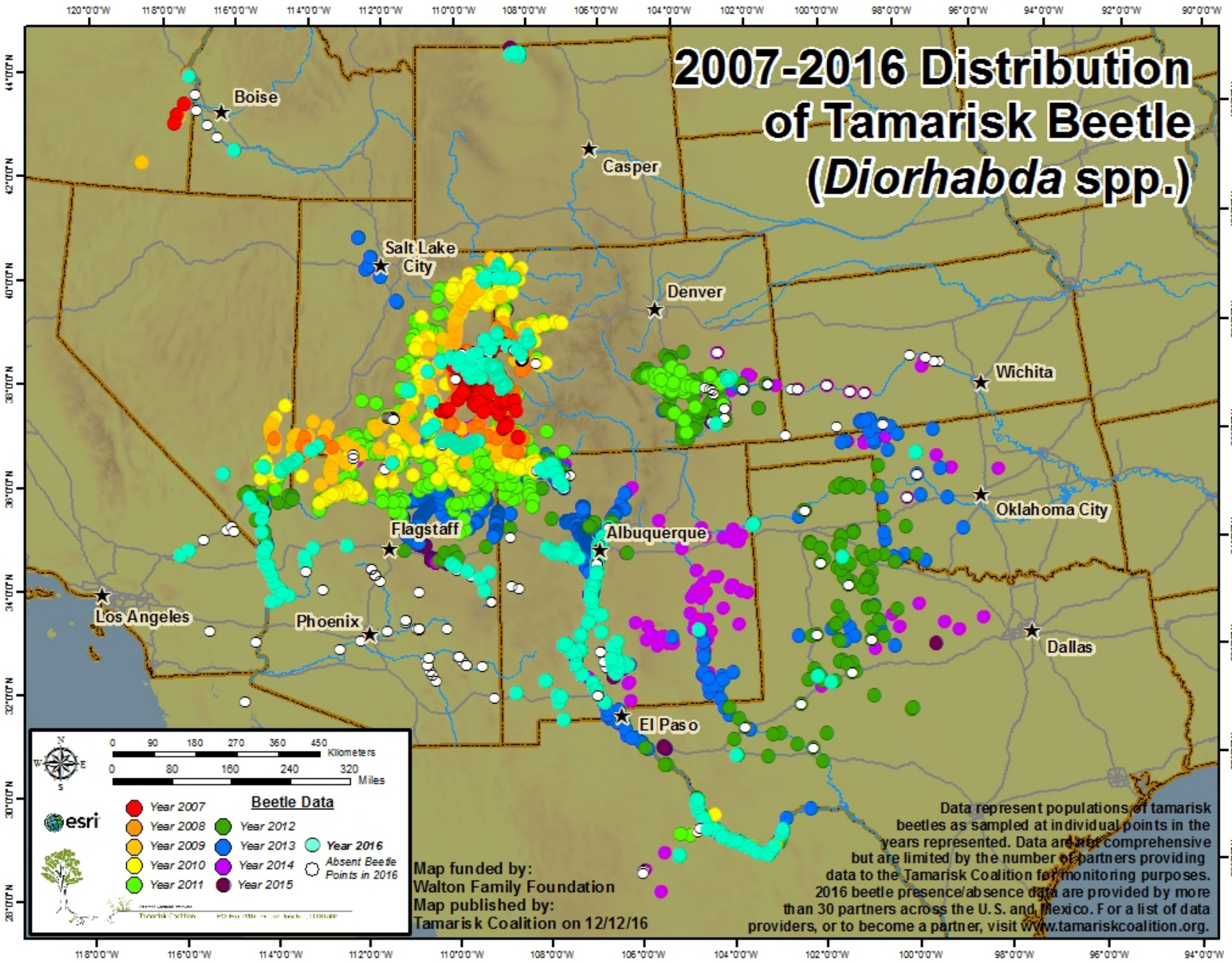
TAG approval for both species, 1994

1998-2000 field cage tests and monitoring plan put into place

2001, limited open releases

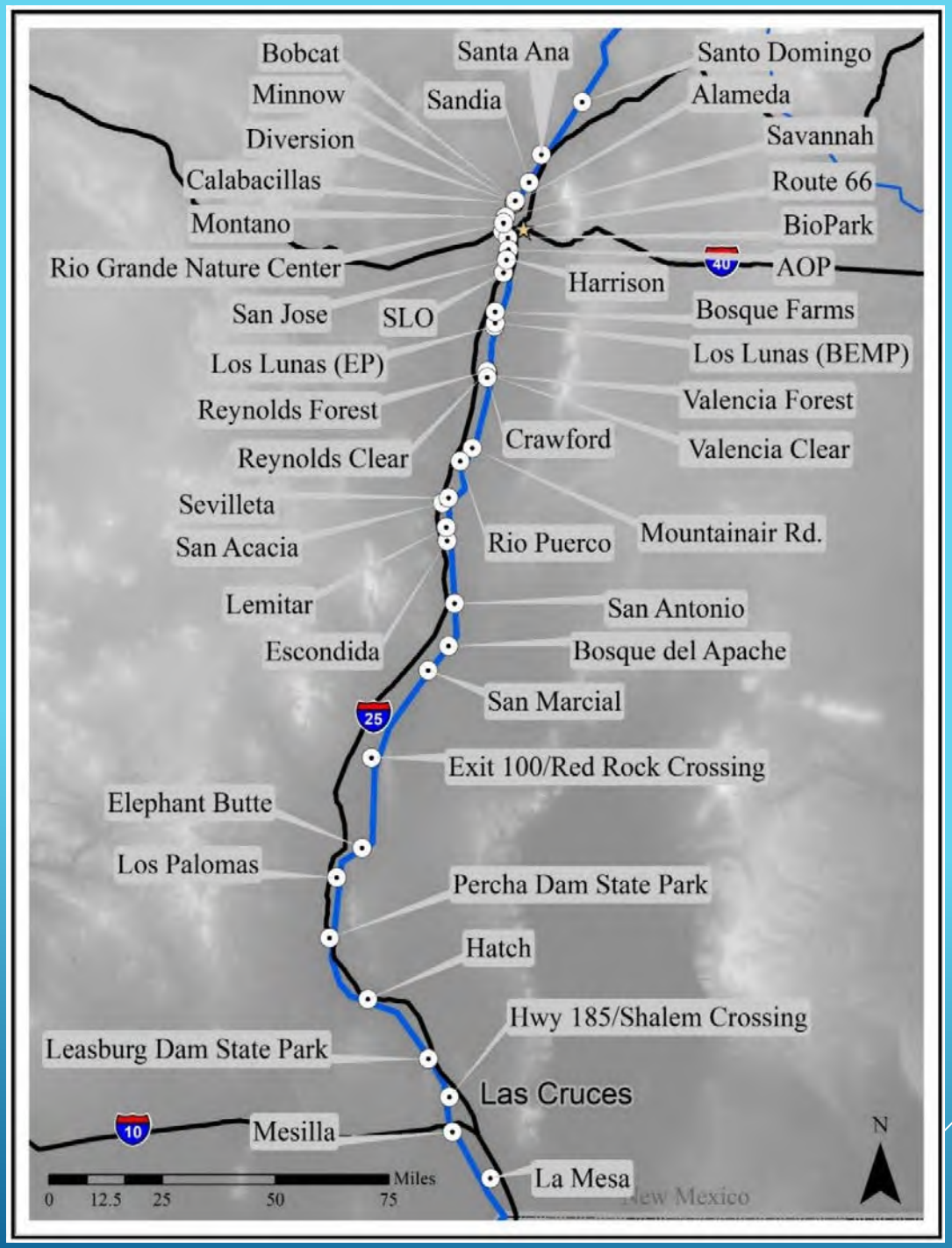

Kazakhstan
Chilik
Fukang
China
Lovelock, NV
Delta, UT


2007 Distribution of Tamarisk Leaf Beetle
(Diorhabda carinulata)
Funding Provided By:
Colorado Department of Agriculture
Tamarisk Coalition
Data Collected By:
Colorado Department of Agriculture:
Palisade Insectary
Tamarisk Coalition
University of California Santa Barbara
Map Published by Tamarisk Coalition on: 11/4/11
Survey Zone
Salt Lake City
Colorado
Denver
Nevada
Utah
Las Vegas
Flagstaff
Albuquerque
Arizona
New Mexico
Phoenix
0 37.5 75 150 225 300 Kilometers
0 25 50 100 150 200 Miles
Beetle Presence*
Absent (0)
Infrequent Individuals (1-4)
Small Establishment (5-25)
Large Establishment (26-500)
ESRI
Tamarisk Coalition
PO Box 1907 · Grand Junction, CO 81502
* Beetle Presence includes Adults, Larvae and Eggs


2007-2016 Distribution of Tamarisk Beetle (Diorhabda spp.)
Boise
Casper
Salt Lake City
Denver
Wichita
Oklahoma City
Flagstaff
Albuquerque
Los Angeles
Phoenix
Dallas
El Paso
Beetle Data
Year 2007
Year 2008
Year 2009
Year 2010
Year 2011
Year 2012
Year 2013
Year 2014
Year 2015
Year 2016
Absent Beetle Points in 2016
Kilometers
Miles
Map funded by:
Walton Family Foundation
Map published by:
Tamarisk Coalition on 12/12/16
Data represent populations of tamarisk beetles as sampled at individual points in the years represented. Data are not comprehensive but are limited by the number of partners providing data to the Tamarisk Coalition for monitoring purposes. 2016 beetle presence/absence data are provided by more than 30 partners across the U.S. and Mexico. For a list of data providers, or to become a partner, visit www.tamariskcoalition.org.

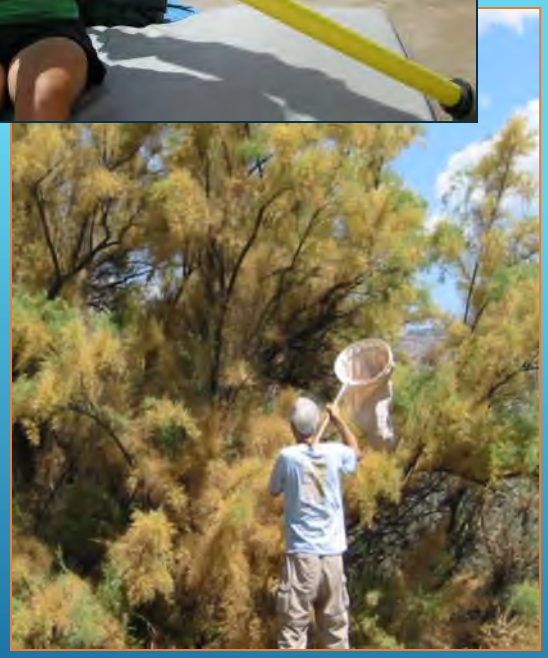
Project Objectives

- ***What is the beetle distribution and directionality of their spread along the Rio Grande River, New Mexico?***
- ***Determine defoliation, refoliation and mortality rates along the Rio Grande River, New Mexico.***
- ***Examine TLB species at the genetic level to assess the distribution of 4 species of Diorhabda populating the regions surrounding the Rio Grande River, NM Watershed.***
- ***Map Tamarisk Weevil (Coniatus spp.) distribution in the study area and conduct genetic analyses to determine which weevil species (Splendid Tamarisk Weevil (Coniatus splendidulus)?) is present within the Rio Grande River, NM Watershed.***
- ***Provide recommendations for approaches that may be used to mitigate the effects of defoliation by the beetle.***


Bobcat
Minnow
Diversion
Calabacillas
Montano
Rio Grande Nature Center
San Jose
Los Lunas (EP)
Reynolds Forest
Reynolds Clear
Sevilleta
San Acacia
Lemitar
Escondida
Santa Ana
Sandia
SLO
Crawford
Rio Puerco
San Antonio
Bosque del Apache
San Marcial
25
Exit 100/Red Rock Crossing
Elephant Butte
Los Palomas
Percha Dam State Park
Hatch
Hwy 185/Shalem Crossing
Leasburg Dam State Park
Las Cruces
10
Mesilla
La Mesa
Miles
0
12.5
25
50
75
Santo Domingo
Alameda
Savannah
Route 66
BioPark
40
AOP
Harrison
Bosque Farms
Los Lunas (BEMP)
Valencia Forest
Valencia Clear
Mountainair Rd.
N
New Mexico

HOW ARE BEETLES TRACKED?

Date	GPS Point ID	UTM Coordinates	River mi/km		Sweep 1	Sweep 2	Sweep 3	Sweep 4	Sweep 5	Eggs	Coniatus Spp	Defoliation	Re-foliation	Photo	Comments
		Lat:		Adults										ID:	
				Early Larvae						☐	☐		☐		
		Long:		Late Larvae										Direction	



THREE LIFE-STAGES OF THE TAMARISK LEAF BEETLE (*DIORHABDA CARINULATA*)

A. **FIRST INSTAR LARVA.**
B. **THIRD INSTAR LARVAE.**
C. **ADULT BEETLE**

Tamarisk Leafhopper (*Opsius stactogalus*)

Splendid Tamarisk Weevils (*Coniatus splendidulus*)

Tamarisk-obligate insects in the Southwest

Tamarisk leafhopper

Homoptera. First described in Texas, 1907 (Harding 1930). Phloem feeder.

Tamarisk leaf beetle

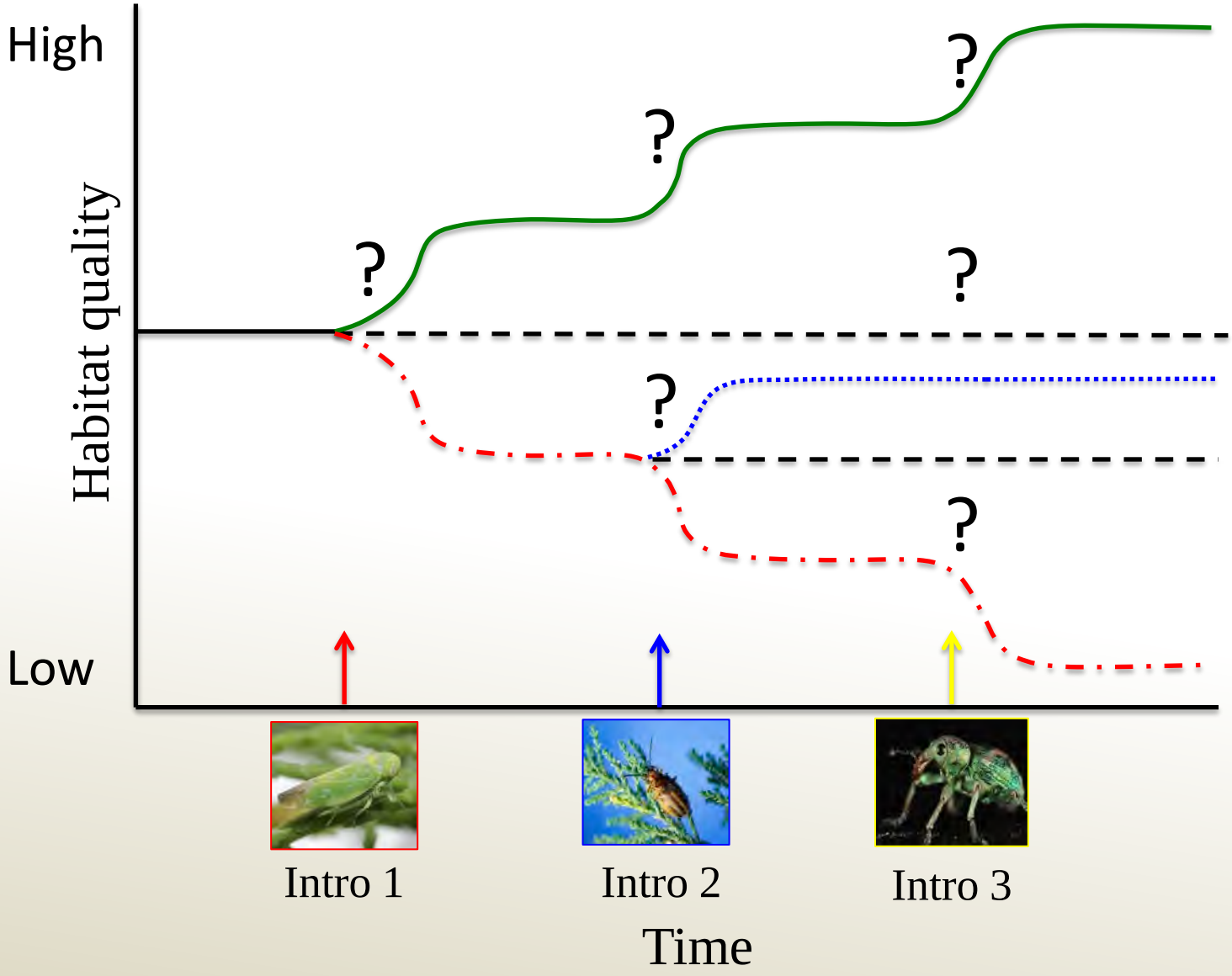
Coleoptera. Introduced as biocontrol in Western US, 2001 (Bean et al. 2012). Foliage feeder.

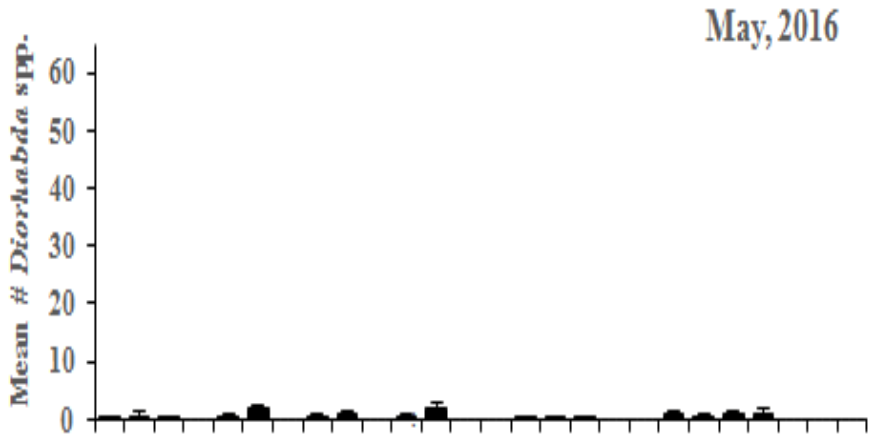
Splendid tamarisk weevil

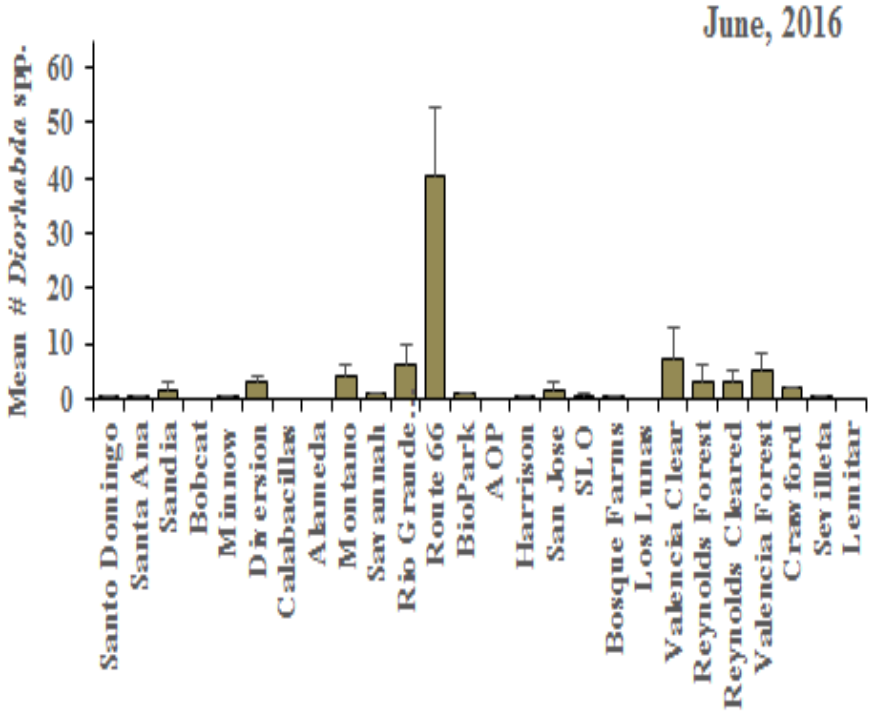
Coleoptera. Unknown introduction. First published occurrence in NV, 2011 (Eckberg and Foster 2011). Earlier accounts in AZ. Eats shoot tips.

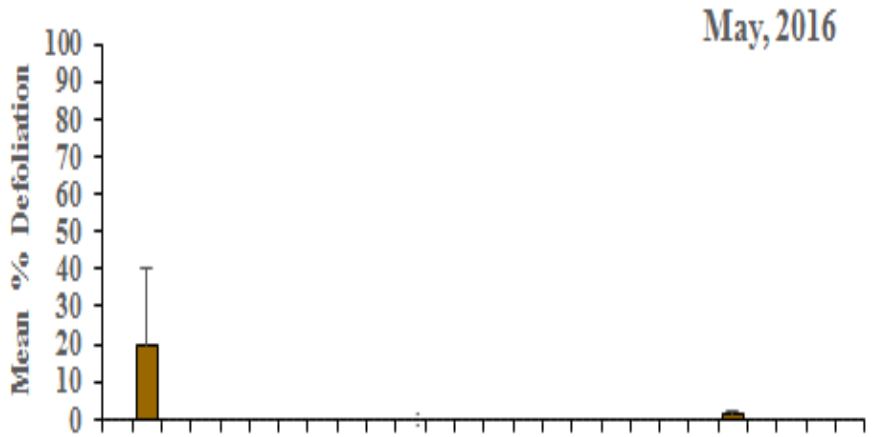
All similar in size.

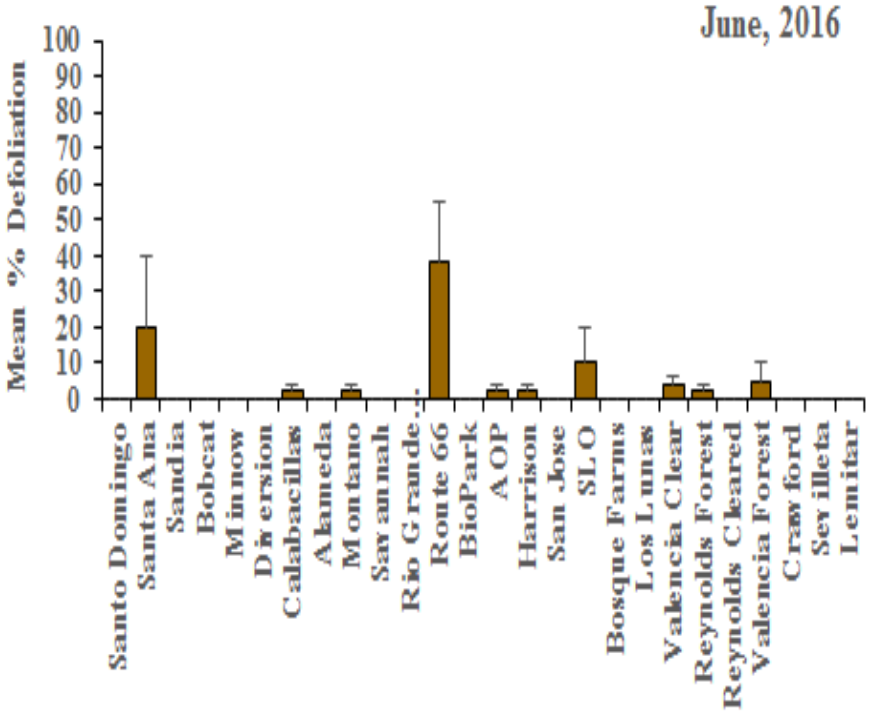
How does tamarisk habitat quality change?

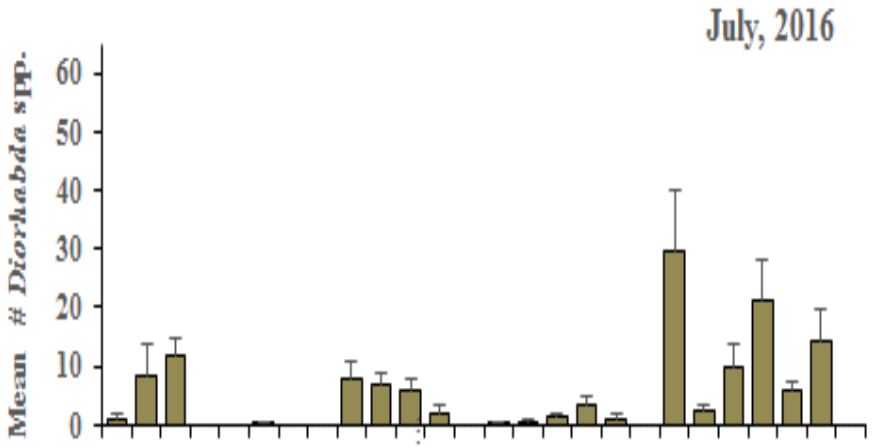


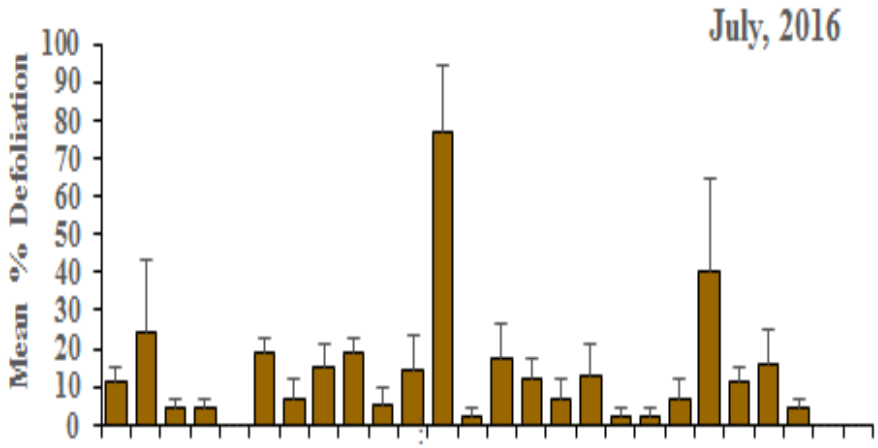

May, 2016
Mean # Diorhabda spp.
0
10
20
30
40
50
60

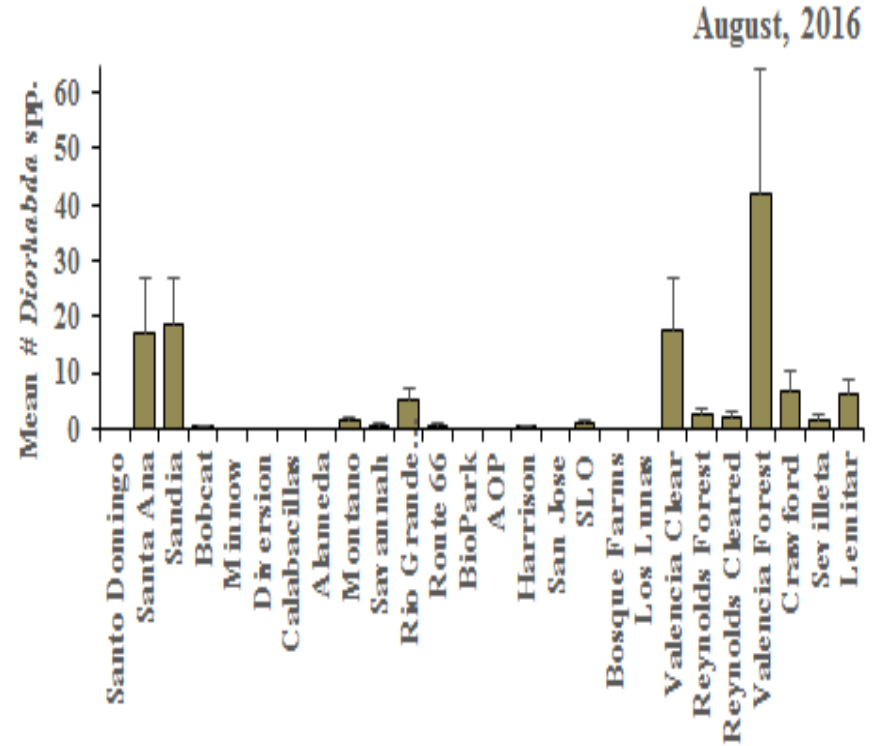

June, 2016
Mean # Diorhabda spp.
0
10
20
30
40
50
60
Santo Domingo
Santa Ana
Sandia
Bobcat
Minnow
Diversion
Calabacillas
Alameda
Montano
Savannah
Rio Grande...
Route 66
BioPark
AOP
Harrison
San Jose
SLO
Bosque Farms
Los Lunas
Valencia Clear
Reynolds Forest
Reynolds Cleared
Valencia Forest
Crawford
Sevilleta
Lemitar

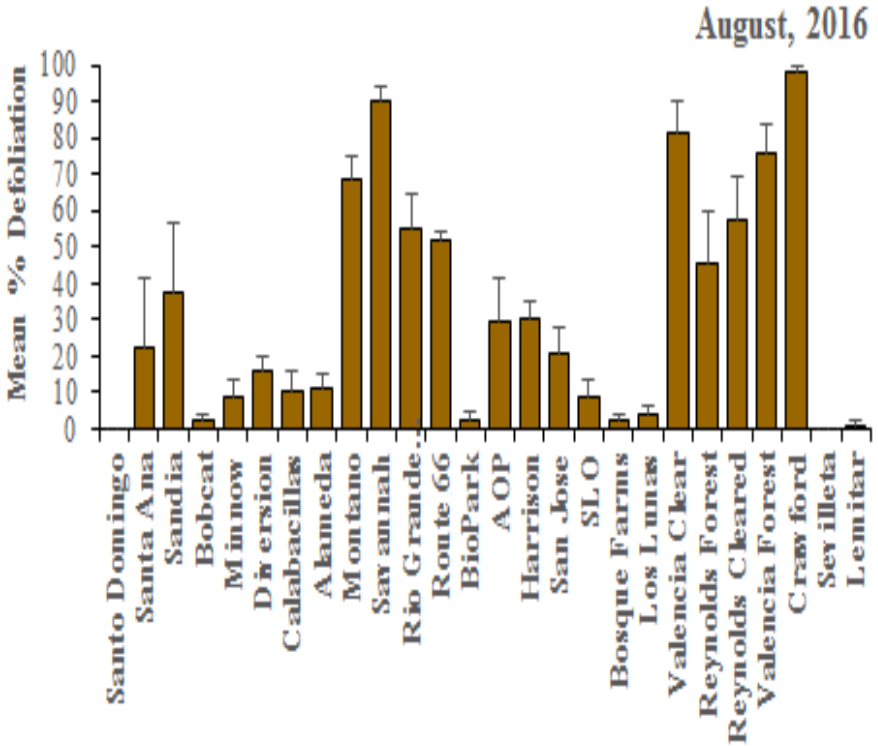

May, 2016
Mean % Defoliation
0
10
20
30
40
50
60
70
80
90
100

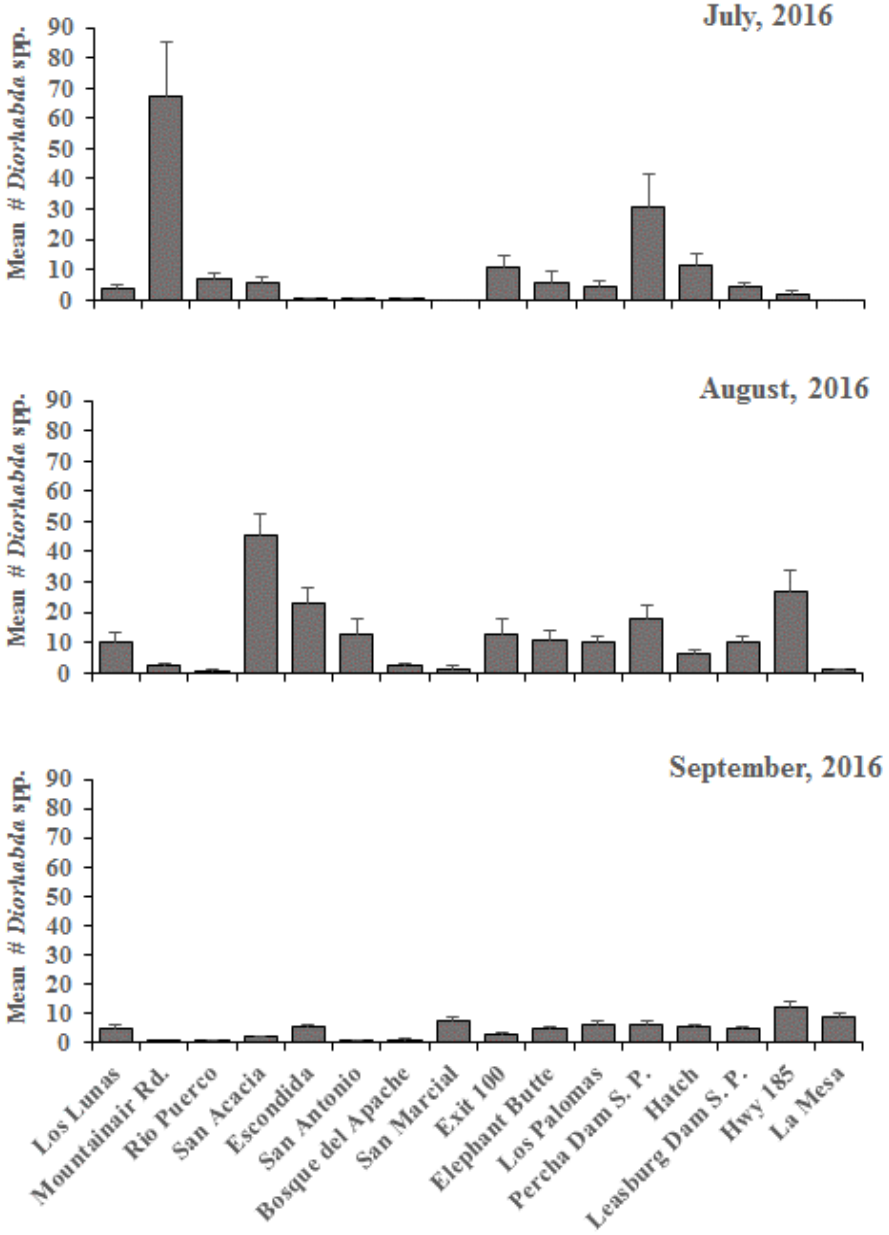

June, 2016
Mean % Defoliation
0
10
20
30
40
50
60
70
80
90
100
Santo Domingo
Santa Ana
Sandia
Bobcat
Minnow
Diversion
Calabacillas
Alameda
Montano
Savannah
Rio Grande...
Route 66
BioPark
AOP
Harrison
San Jose
SLO
Bosque Farms
Los Lunas
Valencia Clear
Reynolds Forest
Reynolds Cleared
Valencia Forest
Crawford
Sevilleta
Lemitar

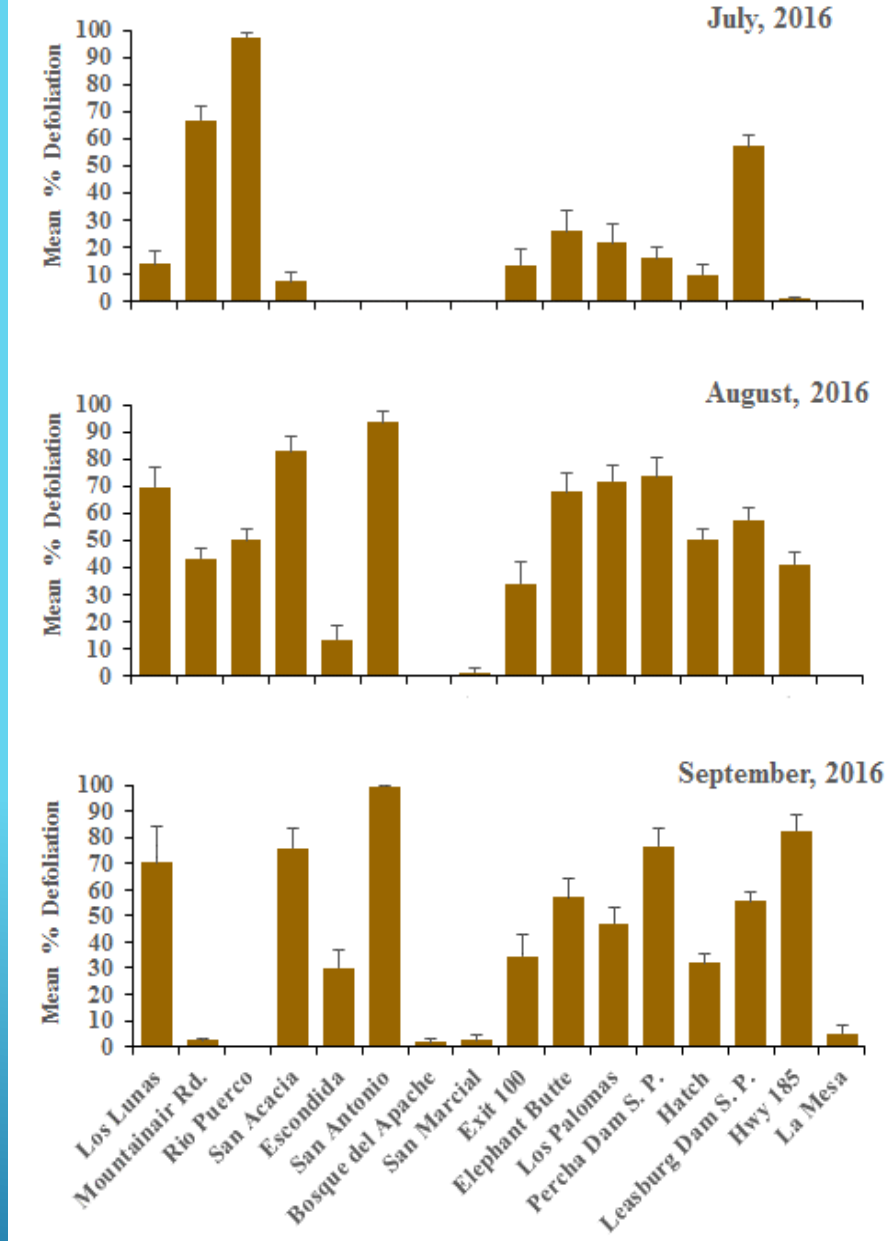

July, 2016
Mean # Diorhabda spp.
0
10
20
30
40
50
60

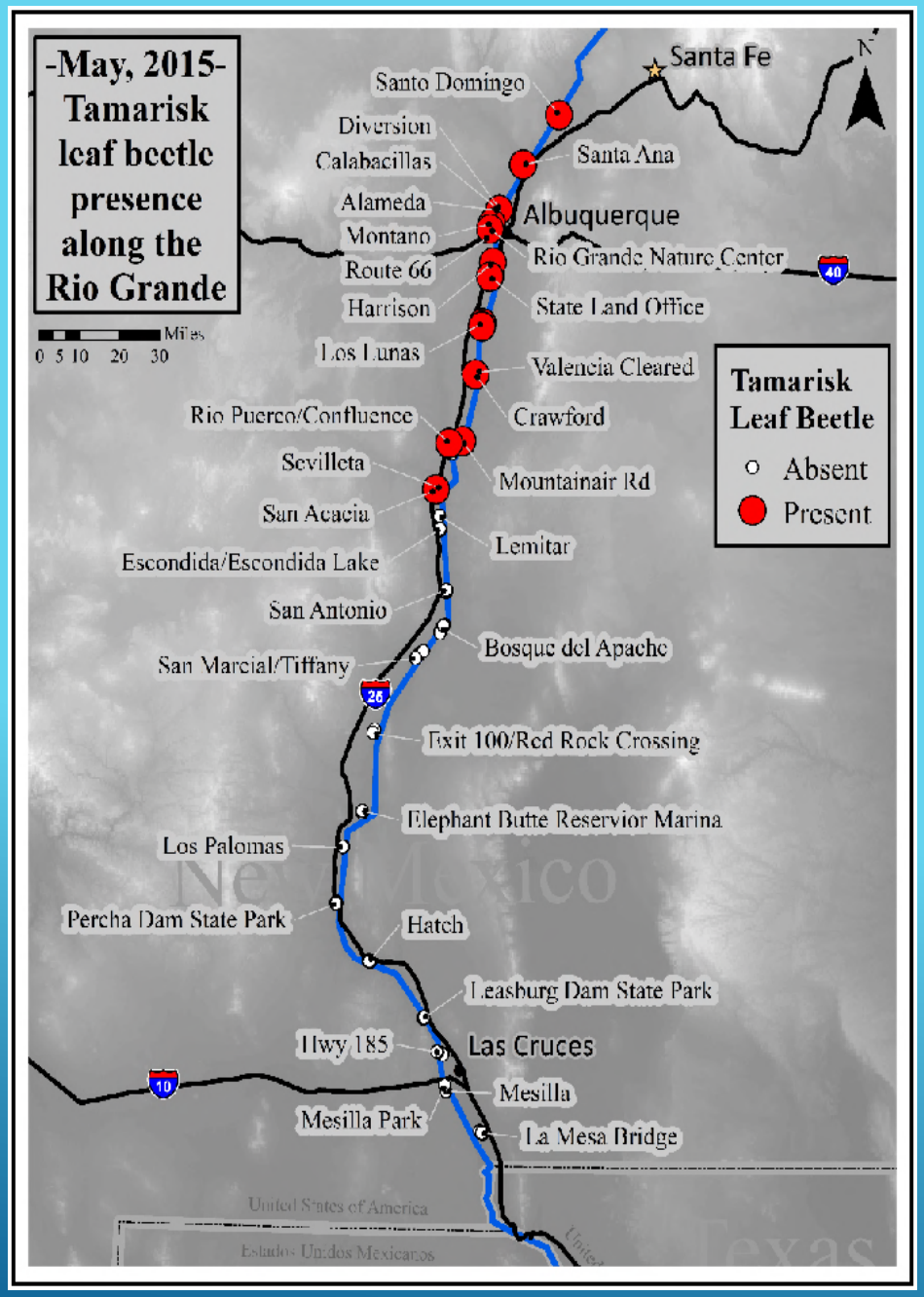

July, 2016
Mean % Defoliation
0
10
20
30
40
50
60
70
80
90
100

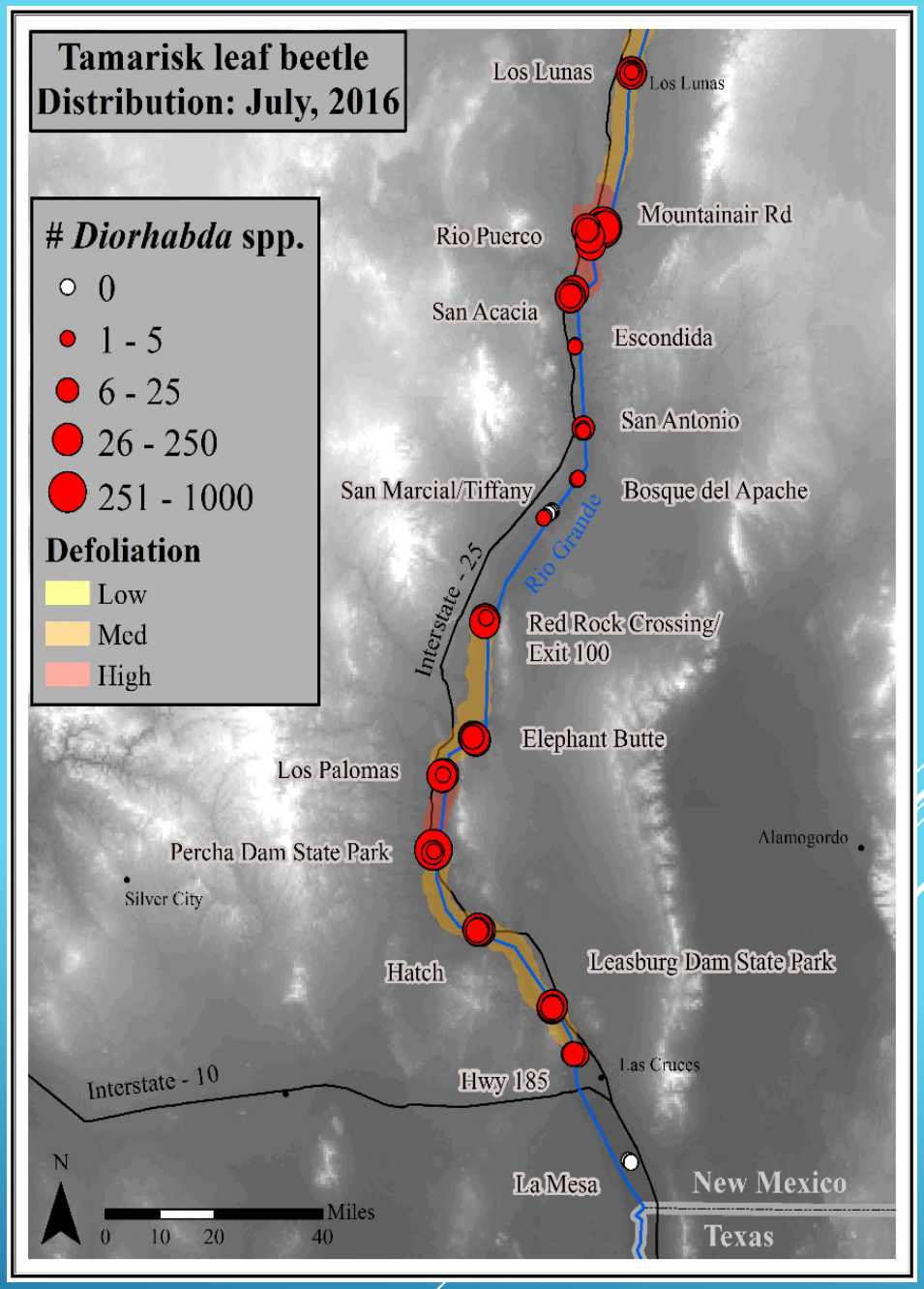

August, 2016
Mean # Diorhabda spp.
0
10
20
30
40
50
60
Santo Domingo
Santa Ana
Sandia
Bobcat
Minnow
Diversion
Calabacillas
Alameda
Montano
Savannah
Rio Grande
Route 66
BioPark
AOP
Harrison
San Jose
SLO
Bosque Farms
Los Lunas
Valencia Clear
Reynolds Forest
Reynolds Cleared
Valencia Forest
Crawford
Sevilleta
Lemitar

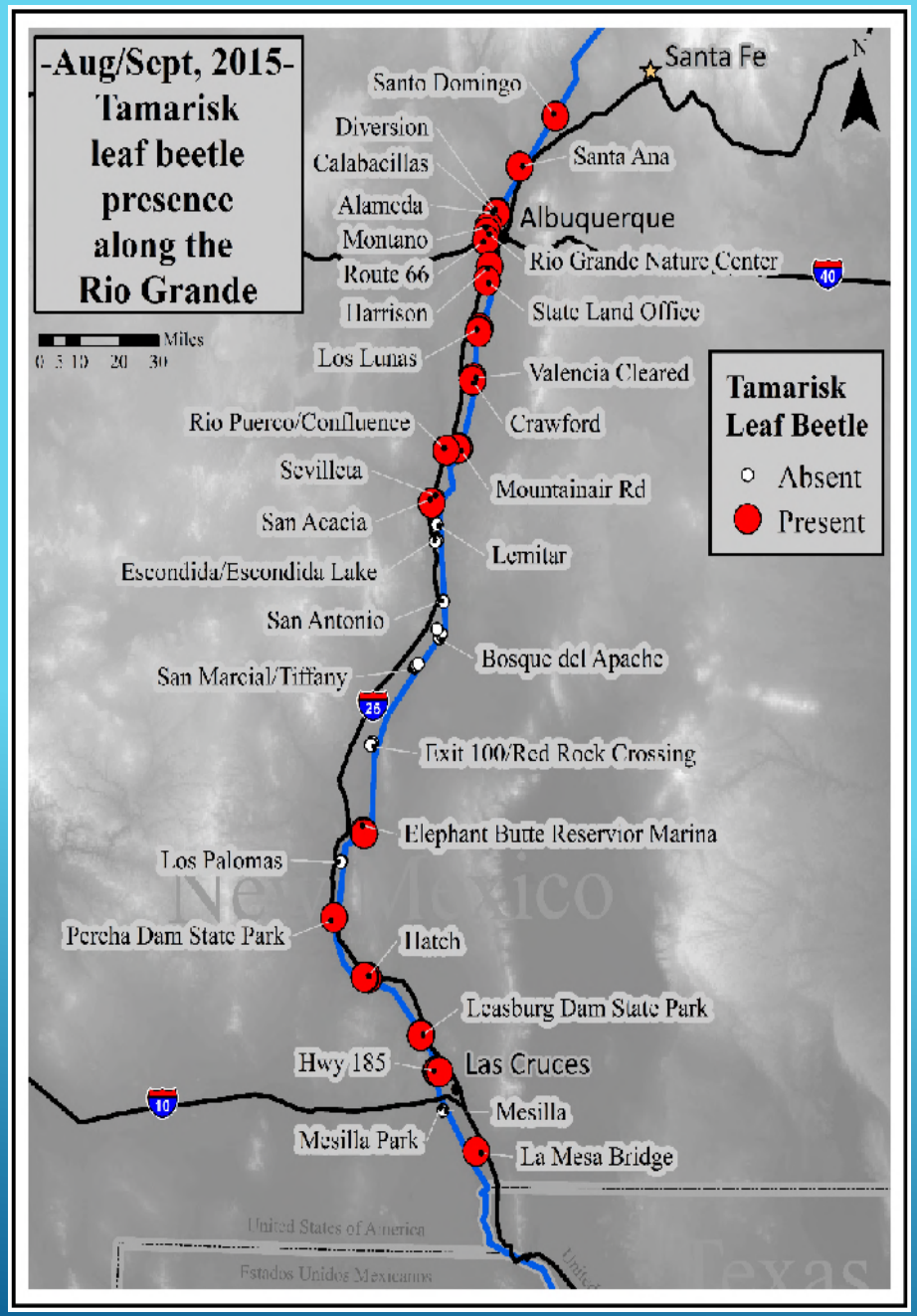

August, 2016
Mean % Defoliation
0
10
20
30
40
50
60
70
80
90
100
Santo Domingo
Santa Ana
Sandia
Bobcat
Minnow
Diversion
Calabacillas
Alameda
Montano
Savannah
Rio Grande
Route 66
BioPark
AOP
Harrison
San Jose
SLO
Bosque Farms
Los Lunas
Valencia Clear
Reynolds Forest
Reynolds Cleared
Valencia Forest
Crawford
Sevilleta
Lemitar

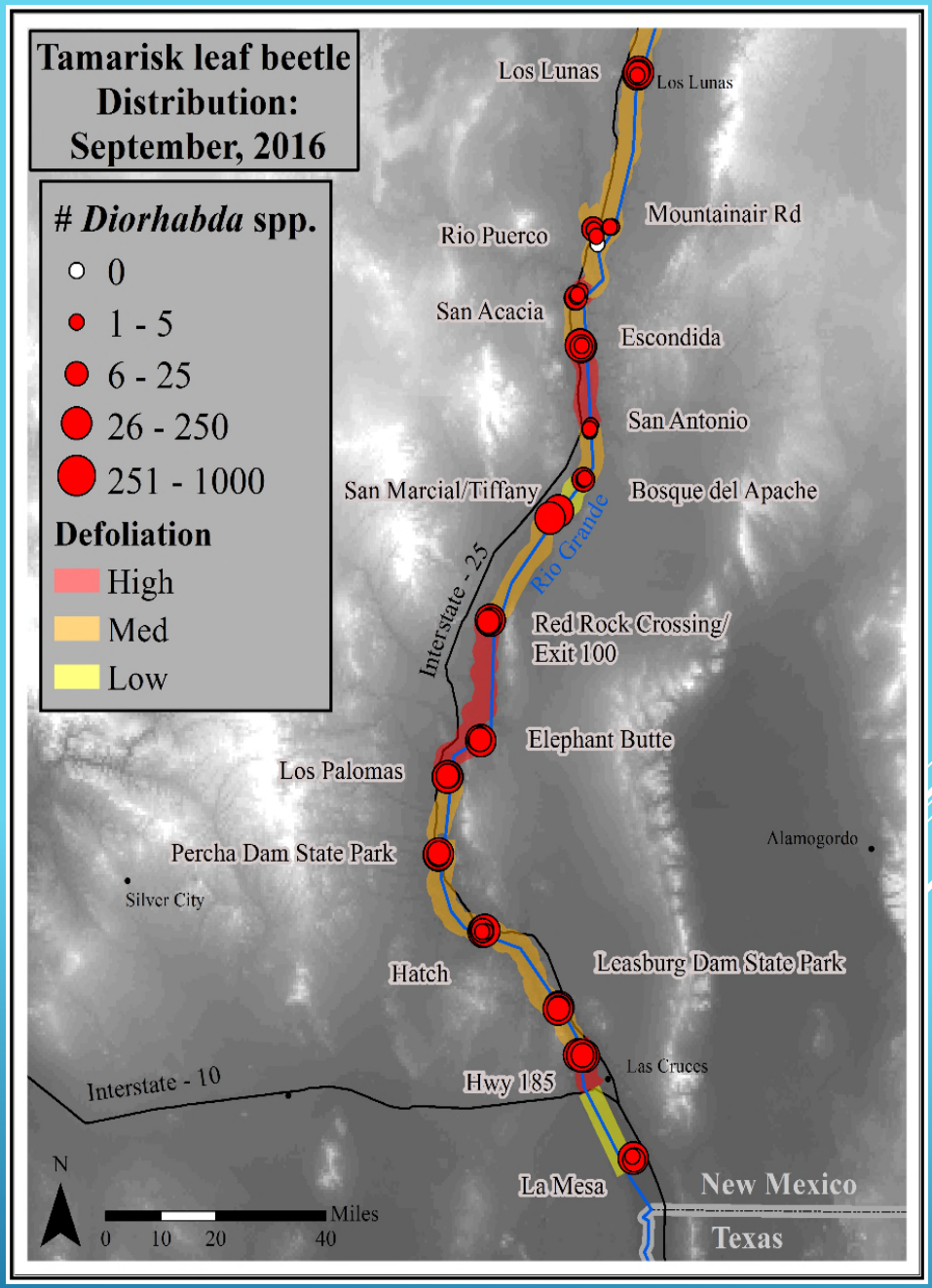

July, 2016
August, 2016
September, 2016
Mean # Diorhabda spp.
Los Lunas
Mountainair Rd.
Rio Puerco
San Acacia
Escondida
San Antonio
Bosque del Apache
San Marcial
Exit 100
Elephant Butte
Los Palomas
Percha Dam S. P.
Hatch
Leasburg Dam S. P.
Hwy 185
La Mesa

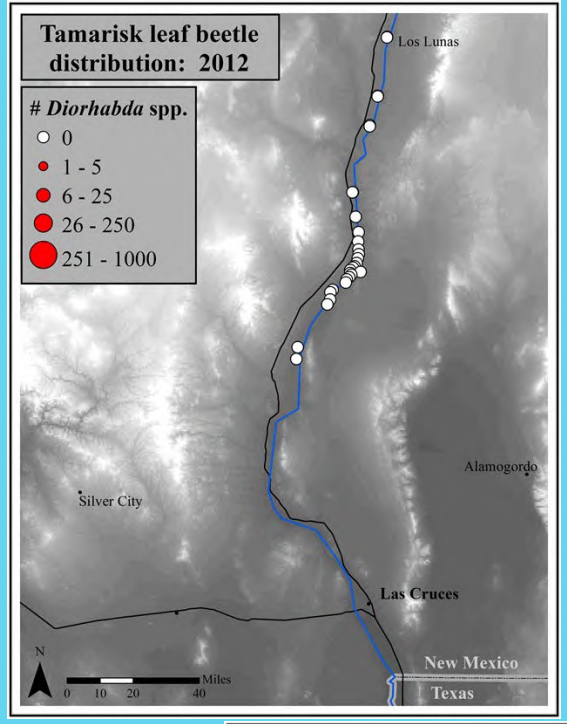

July, 2016
August, 2016
September, 2016
Mean % Defoliation
Los Lunas
Mountainair Rd.
Rio Puerco
San Acacia
Escondida
San Antonio
Bosque del Apache
San Marcial
Exit 100
Elephant Butte
Los Palomas
Percha Dam S. P.
Hatch
Leasburg Dam S. P.
Hwy 185
La Mesa

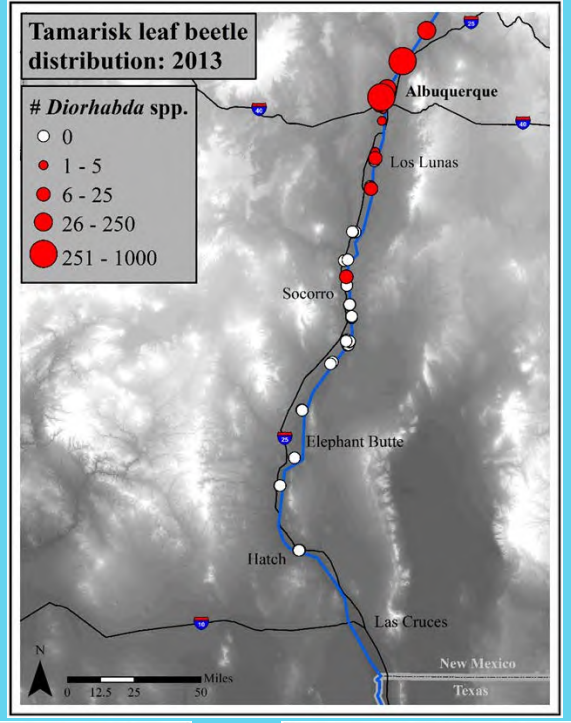

-May, 2015-
Tamarisk leaf beetle presence along the Rio Grande
Santa Fe
Santo Domingo
Diversion
Calabacillas
Santa Ana
Alameda
Albuquerque
Montano
Rio Grande Nature Center
Route 66
Harrison
State Land Office
Los Lunas
Valencia Cleared
Rio Puerco/Confluence
Crawford
Sevilleta
Mountainair Rd
San Acacia
Lemitar
Escondida/Escondida Lake
San Antonio
Bosque del Apache
San Marcial/Tiffany
Exit 100/Red Rock Crossing
Elephant Butte Reservior Marina
Los Palomas
Percha Dam State Park
Hatch
Leasburg Dam State Park
Hwy 185
Las Cruces
Mesilla
Mesilla Park
La Mesa Bridge
Miles
0 5 10 20 30
Tamarisk Leaf Beetle
Absent
Present
New Mexico
Texas
United States of America
Estados Unidos Mexicanos

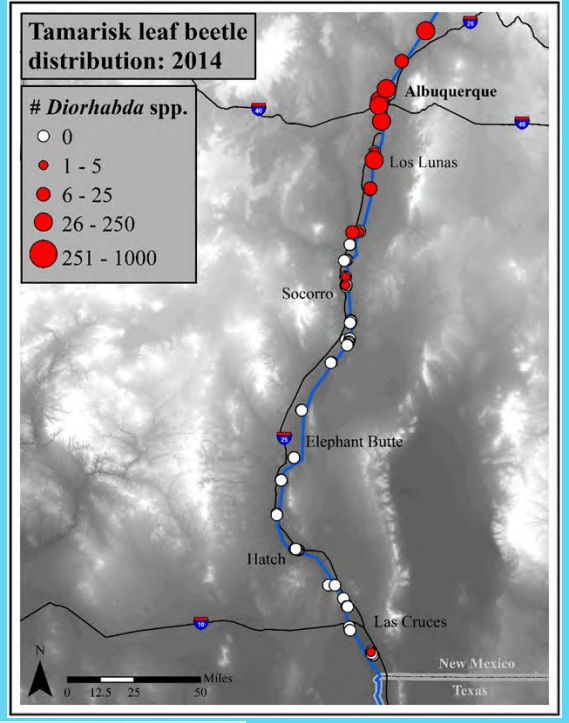

Tamarisk leaf beetle Distribution: July, 2016
Diorhabda spp.
0
1 - 5
6 - 25
26 - 250
251 - 1000
Defoliation
Low
Med
High
Los Lunas
Mountainair Rd
Rio Puerco
San Acacia
Escondida
San Antonio
San Marcial/Tiffany
Bosque del Apache
Interstate - 25
Rio Grande
Red Rock Crossing/ Exit 100
Elephant Butte
Los Palomas
Alamogordo
Percha Dam State Park
Silver City
Hatch
Leasburg Dam State Park
Las Cruces
Interstate - 10
Hwy 185
La Mesa
N
Miles
0 10 20 40
New Mexico
Texas

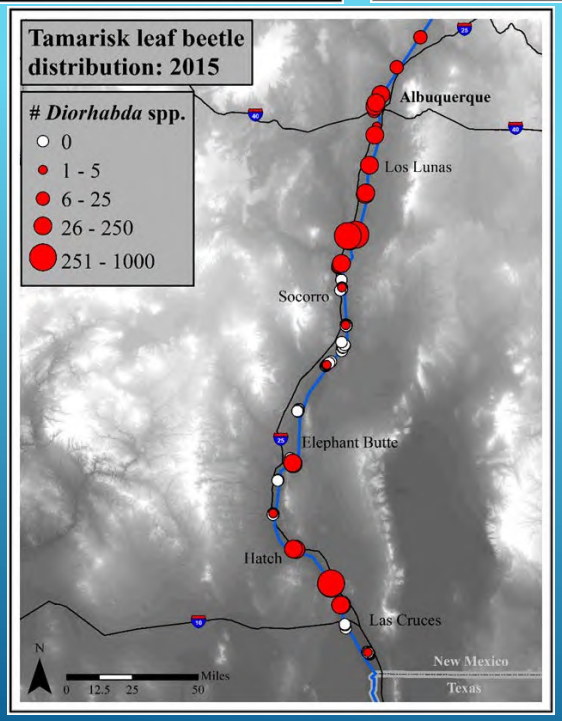

-Aug/Sept, 2015-
Tamarisk
leaf beetle
presence
along the
Rio Grande
Miles
0 5 10 20 30
Santa Fe
N
Santo Domingo
Diversion
Calabacillas
Santa Ana
Alameda
Albuquerque
Montano
Rio Grande Nature Center
Route 66
Harrison
State Land Office
Los Lunas
Valencia Cleared
Rio Puerco/Confluence
Crawford
Sevilleta
Mountainair Rd
San Acacia
Lemitar
Escondida/Escondida Lake
San Antonio
Bosque del Apache
San Marcial/Tiffany
25
Exit 100/Red Rock Crossing
Elephant Butte Reservior Marina
Los Palomas
Percha Dam State Park
Hatch
Leasburg Dam State Park
Hwy 185
Las Cruces
10
Mesilla
Mesilla Park
La Mesa Bridge
Tamarisk
Leaf Beetle
Absent
Present
United States of America
Estados Unidos Mexicanos
New Mexico
Texas

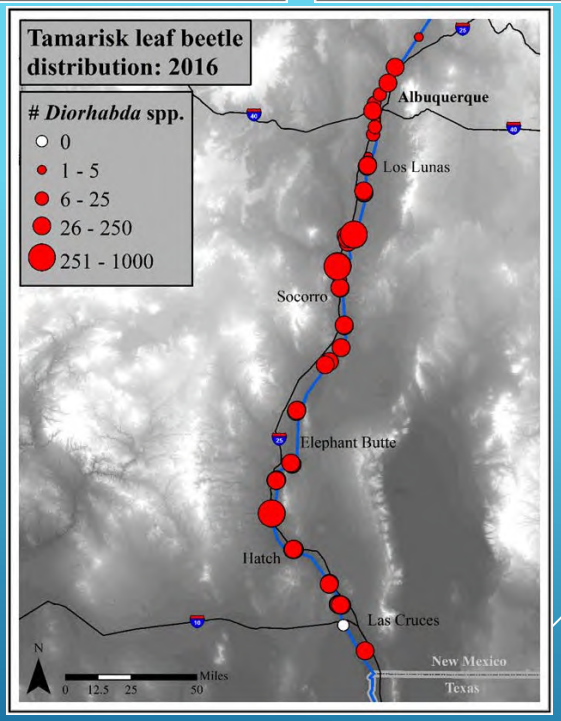

Tamarisk leaf beetle
Distribution:
September, 2016
Diorhabda spp.
0
1 - 5
6 - 25
26 - 250
251 - 1000
Defoliation
High
Med
Low
Los Lunas
Los Lunas
Mountainair Rd
Rio Puerco
San Acacia
Escondida
San Antonio
San Marcial/Tiffany
Bosque del Apache
Rio Grande
Interstate - 25
Red Rock Crossing/
Exit 100
Elephant Butte
Los Palomas
Alamogordo
Percha Dam State Park
Silver City
Hatch
Leasburg Dam State Park
Las Cruces
Hwy 185
Interstate - 10
N
Miles
0 10 20 40
La Mesa
New Mexico
Texas


Tamarisk leaf beetle distribution: 2012
Diorhabda spp.
0
1 - 5
6 - 25
26 - 250
251 - 1000
Los Lunas
Alamogordo
Silver City
Las Cruces
New Mexico
Texas
N
0 10 20 40 Miles


Tamarisk leaf beetle distribution: 2013
Diorhabda spp.
0
1 - 5
6 - 25
26 - 250
251 - 1000
Albuquerque
Los Lunas
Socorro
Elephant Butte
Hatch
Las Cruces
New Mexico
Texas
N
0 12.5 25 50 Miles


Tamarisk leaf beetle distribution: 2014
Diorhabda spp.
0
1 - 5
6 - 25
26 - 250
251 - 1000
Albuquerque
Los Lunas
Socorro
Elephant Butte
Hatch
Las Cruces
New Mexico
Texas
N
0 12.5 25 50 Miles


Tamarisk leaf beetle distribution: 2015
Diorhabda spp.
0
1 - 5
6 - 25
26 - 250
251 - 1000
Albuquerque
Los Lunas
Socorro
Elephant Butte
Hatch
Las Cruces
New Mexico
Texas
N
0 12.5 25 50 Miles


Tamarisk leaf beetle distribution: 2016
Diorhabda spp.
0
1 - 5
6 - 25
26 - 250
251 - 1000
Albuquerque
Los Lunas
Socorro
Elephant Butte
Hatch
Las Cruces
New Mexico
Texas
N
0 12.5 25 50 Miles

2016 Tamarisk Defoliation

- **The average tamarisk defoliation rate at all sites from July to September increased on average each month by $\bar{x}$ = 26.8 ± 6.2% per month.**

- **The average percent of tamarisk canopies defoliated by tamarisk leaf beetles at all sites monitored by EcoPlateau Research between Los Lunas – La Mesa, NM averaged 37.9 ± 8.2% from July to August, however, declined to 8.9 ± 5.0% from August to September.**

Tracking Tamarisk Defoliation, Refoliation and Mortality by Tamarisk Leaf Beetle

- **Tamarisk leaf beetles are having an impact on tamarisk in regions where they have defoliated trees multiple times.**
- **Trees are defoliated and then refoliate by utilizing stored carbohydrates which may then be depleted leading to branch die-back or even mortality (Hudgeons et al 2007).**
- **Impacts include:**
- **Decrease in canopy cover, plant density, flowering that have experienced multiple defoliations (Nagler et al. 2014, Hultine et al. 2015, Louden unpublished data).**

2015-2016 Tamarisk Mortality

Tamarisk mortality was evaluated by recording the percent of the canopy tree that were observed as dead branches vs. living green foliated branches. While this is not a gauge of true mortality, it is a way to gauge the impact of tamarisk leaf beetle herbivory on the health and overall condition of tamarisk in relation to canopy cover, and above root living biomass.

- **The mean percent of tamarisk canopies that were comprised of dead branches (measure of mortality) in 2016 ($\bar{x}$ = 18.7%), was significantly greater at sites previously defoliated in September, 2015 ($\bar{x}$ = 7.6%; $t_{(14)}$ = 3.45, $p < 0.01$).**
- **The percentage of dead branches in tamarisk across all sampling sites where defoliation was observed was 11% greater 2016 than in areas defoliated previously in 2015.**

MORTALITY RATES AND CAUSES

- **Beetle release sites in Nevada tamarisk mortality reached 80% after 9 years of repeated defoliations while at a nearby site mortality only reach 20% after seven years of defoliations (Dudley and Bean 2012).**
- **Virgin River in Nevada and Arizona, examining 900 trees, revealed 10% tamarisk mortality after three years of defoliation (Hultine et al 2015) while tamarisk mortality at monitoring sites in western Colorado ranged from no mortality up to 52% mortality after 4-7 defoliation cycles (Louden, unpublished observations).**

Causes of Mortality:

- **Variation in mortality rates between sites has been attributed to variable soil salinity (Hultine et al 2015).**
- **Variable susceptibility of individual trees has been linked to genetically based differences in growth rates with faster growing trees being more susceptible to beetle induced mortality (Hultine et al 2013).**

Rio Grande River/Rio Puerco River Confluence

July, 2016

August, 2016

September, 2016

Bosque del Apache

July, 2016


August, 2016


September, 2016


Las Palomas

July, 2016

August, 2016

September, 2016

Leasburg Dam State Park

July, 2016


August, 2016


September, 2016

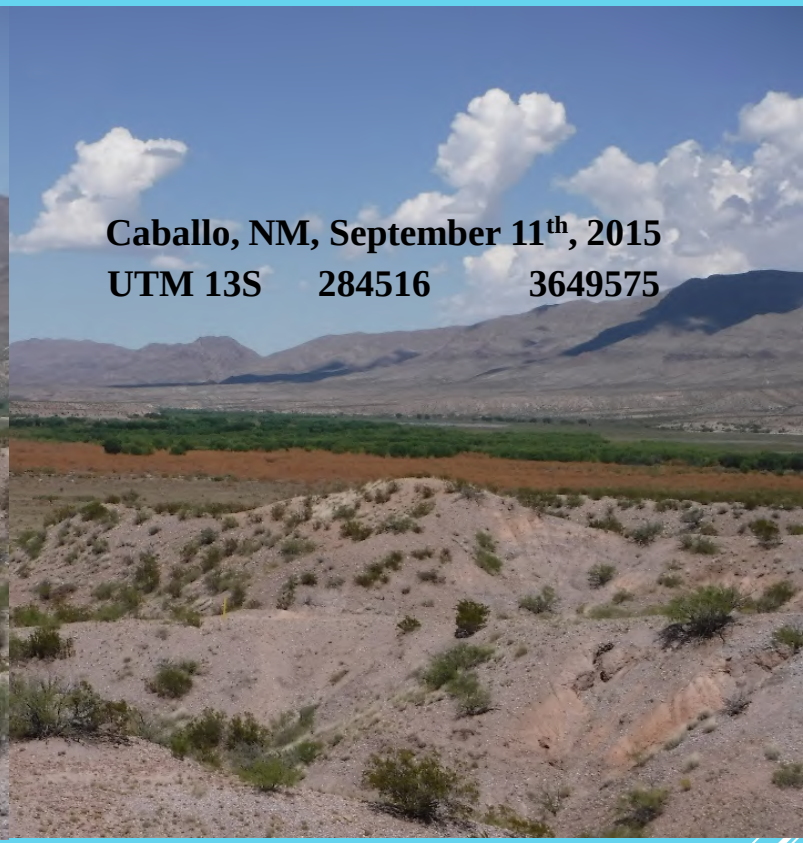

La Mesa

July, 2016

August, 2016

September, 2016


Caballo, NM, July 18th, 2015
UTM 13S 284516 3649575


Caballo, NM, September 11th, 2015
UTM 13S 284516 3649575

Tamarisk Leafhoppers and Tamarisk Weevils Affects on Tamarisk Habitat

Splendid tamarisk weevil

- **Weevils feed on tamarisk foliage (leaf tips) and may attain high enough densities to cause visible damage to trees. The adults can be found on tamarisk plants both earlier and later in the season than beetle adults.**

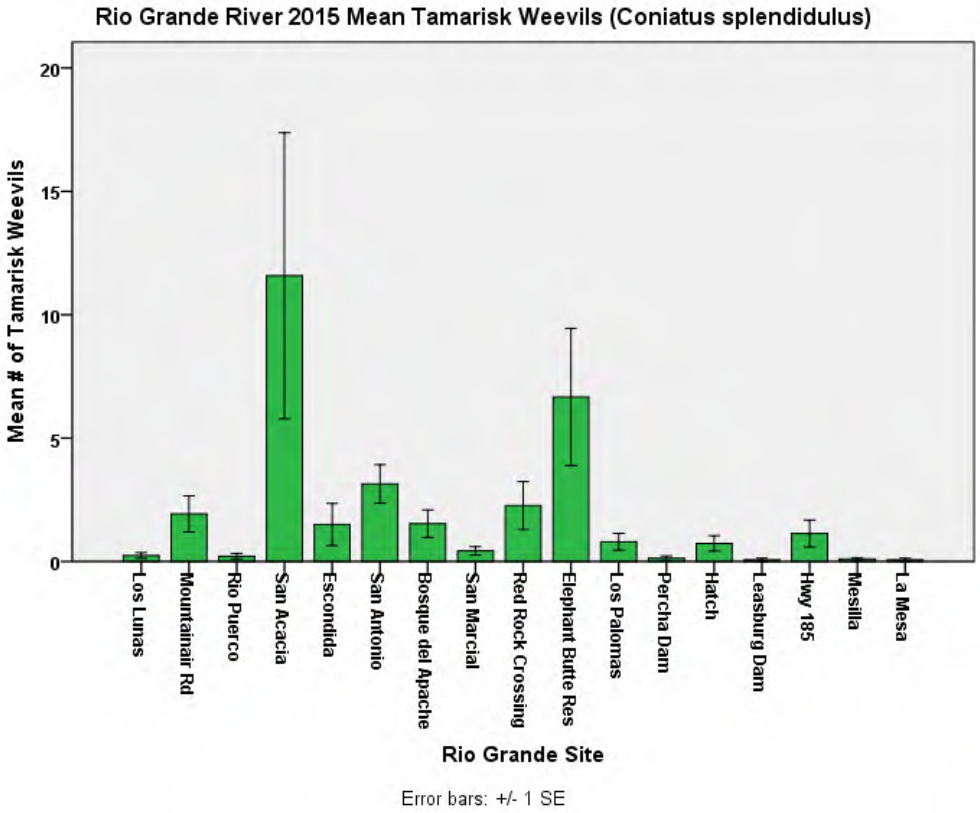
- **Need to know more about these weevils and their impact on tamarisk and interactions with Tamarisk Leaf Beetle.**

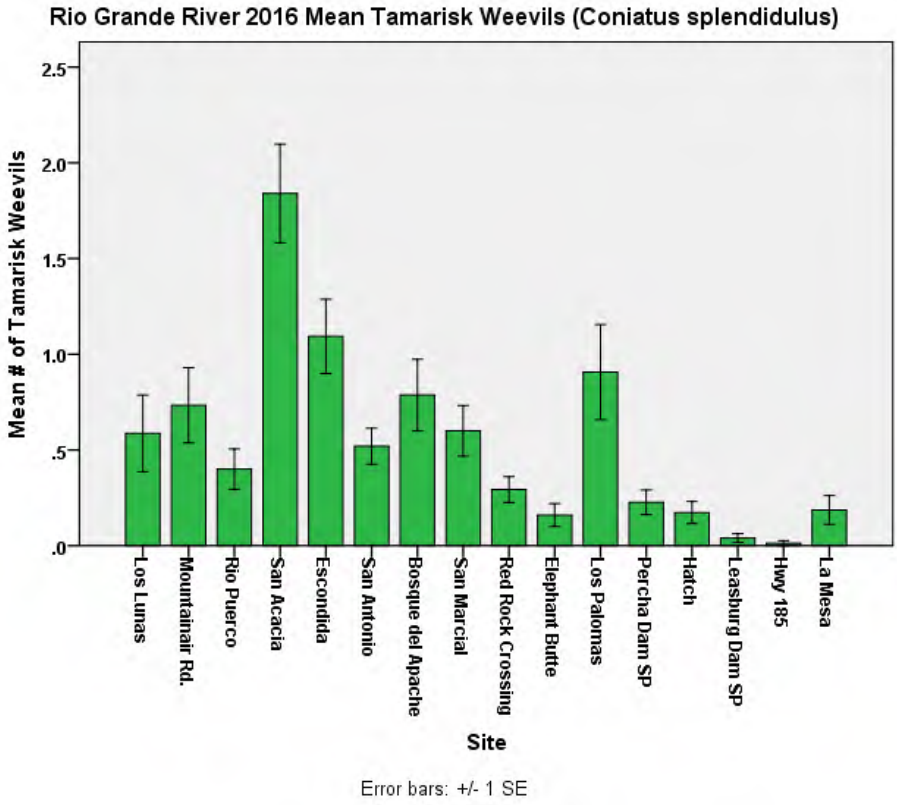
Tamarisk leafhopper

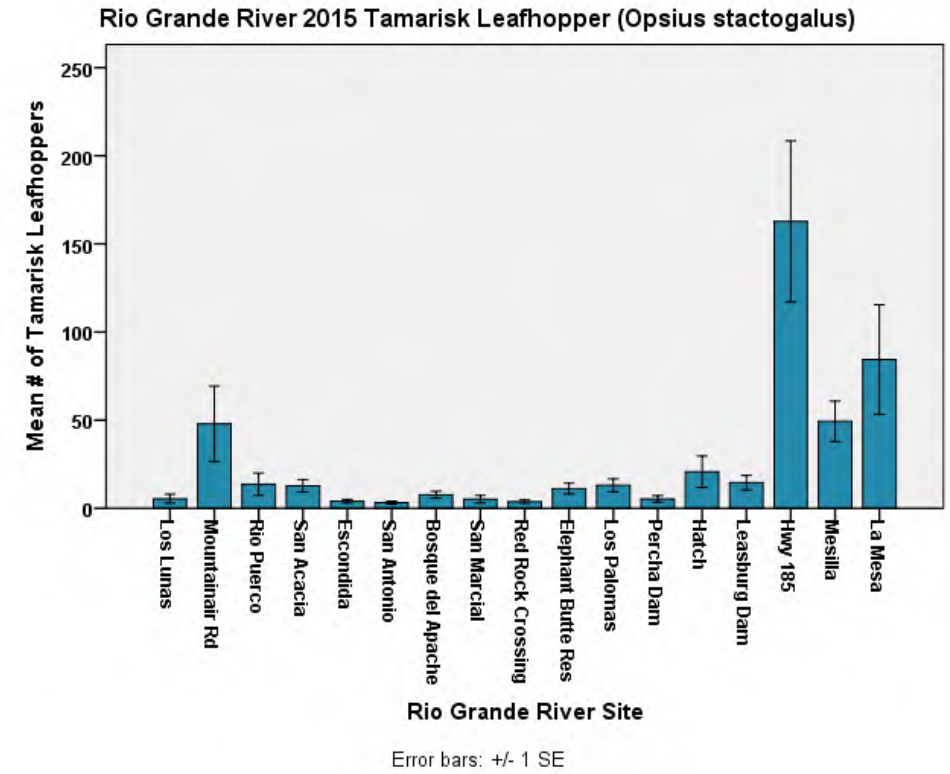
- **Discoloration of plant tissue including leaves and stems as carbohydrates and other phloem nutrients are extracted by leafhopper.**

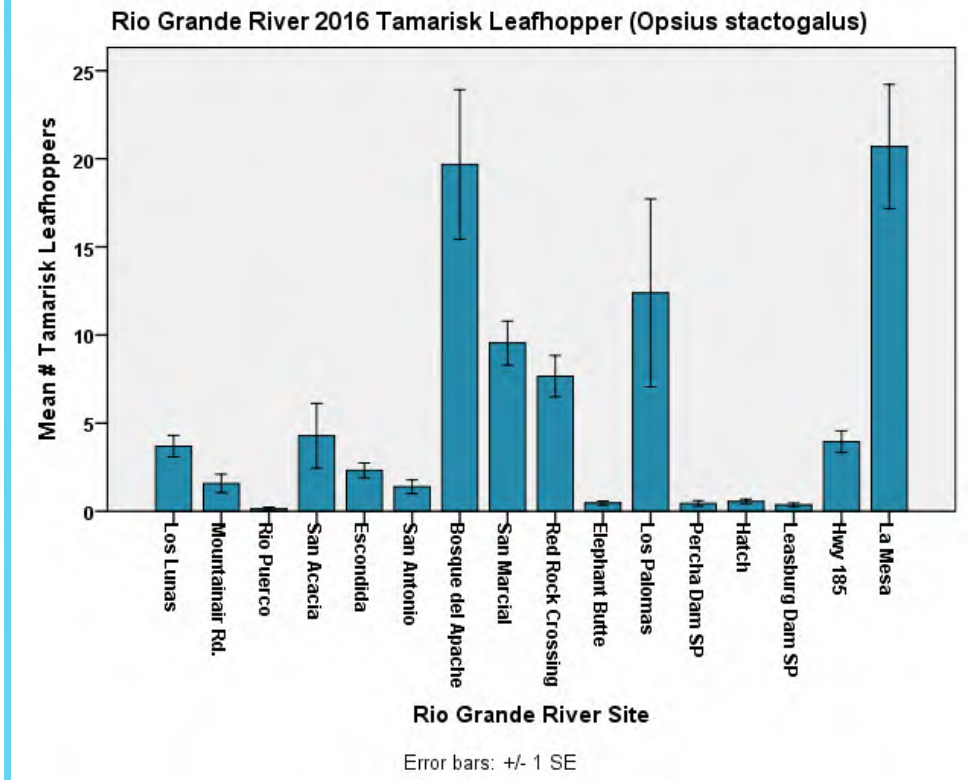
- **Stem growth was reduced on caged tamarisk plants when fed upon by large numbers of leafhoppers.**

- **Can reduce the growth of tamarisk due to the feeding imposed by increase populations.**


Rio Grande River 2015 Mean Tamarisk Weevils (Coniatus splendidulus)
Mean # of Tamarisk Weevils
20
15
10
5
0
Los Lunas
Mountainair Rd
Rio Puerco
San Acacia
Escondida
San Antonio
Bosque del Apache
San Marcial
Red Rock Crossing
Elephant Butte Res
Los Palomas
Percha Dam
Hatch
Leasburg Dam
Hwy 185
Mesilla
La Mesa
Rio Grande Site
Error bars: +/- 1 SE


Rio Grande River 2016 Mean Tamarisk Weevils (Coniatus splendidulus)
Mean # of Tamarisk Weevils
2.5
2.0
1.5
1.0
.5
.0
Los Lunas
Mountainair Rd.
Rio Puerco
San Acacia
Escondida
San Antonio
Bosque del Apache
San Marcial
Red Rock Crossing
Elephant Butte
Los Palomas
Percha Dam SP
Hatch
Leasburg Dam SP
Hwy 185
La Mesa
Site
Error bars: +/- 1 SE

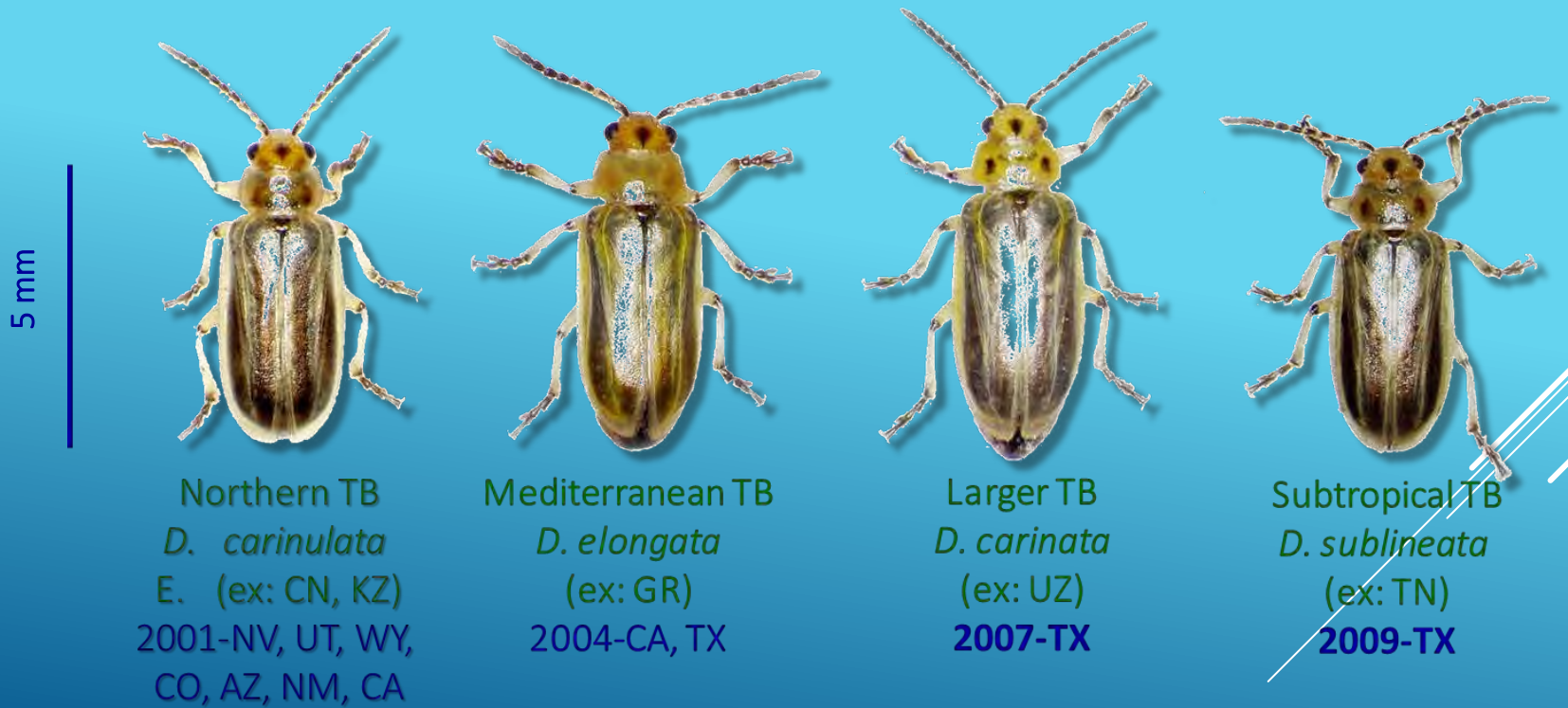

Rio Grande River 2015 Tamarisk Leafhopper (Opsius stactogalus)
Mean # of Tamarisk Leafhoppers
250
200
150
100
50
0
Los Lunas
Mountainair Rd
Rio Puerco
San Acacia
Escondida
San Antonio
Bosque del Apache
San Marcial
Red Rock Crossing
Elephant Butte Res
Los Palomas
Percha Dam
Hatch
Leasburg Dam
Hwy 185
Mesilla
La Mesa
Rio Grande River Site
Error bars: +/- 1 SE


Rio Grande River 2016 Tamarisk Leafhopper (Opsius stactogalus)
Mean # Tamarisk Leafhoppers
25
20
15
10
5
0
Los Lunas
Mountainair Rd.
Rio Puerco
San Acacia
Escondida
San Antonio
Bosque del Apache
San Marcial
Red Rock Crossing
Elephant Butte
Los Palomas
Percha Dam SP
Hatch
Leasburg Dam SP
Hwy 185
La Mesa
Rio Grande River Site
Error bars: +/- 1 SE

Molecular Analysis of Tamarisk Leaf Beetle Populations

Examine tamarisk leaf beetle species at the genetic level, we proposed to look at the four species of *Diorhabda* populating the regions surrounding the Rio Grande Watershed. These species include:

- **Northern tamarisk leaf beetle (*Diorhabda carinulata*) located in Nevada, Utah, Wyoming, Colorado, Arizona, New Mexico and California,**
- **Mediterranean tamarisk leaf beetle (*Diorhabda elongata)* located in Texas and New Mexico,**
- **Larger tamarisk leaf beetle (*Diorhabda carinata)* located in Texas, and**
- **Subtropical tamarisk leaf beetle (*Diorhabda sublineata*) located in Texas.**



Genetic Sampling

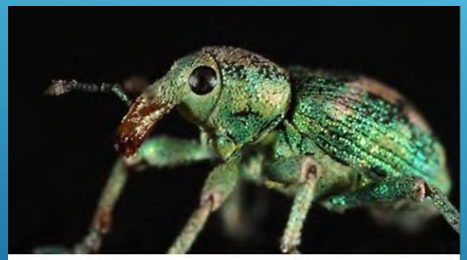
To determine species and possible hybridization, 15 sites were chosen between Los Lunas, NM - La Mesa, NM. Five specimens were collected at each of the 15 sites.

Individual TLB and tamarisk weevils were collected and placed in vials with 95% alcohol and kept in a cooler.

DNA was extracted from all adult specimens (78 *Diorhabda* and 32 *Coniatus*) using DNeasy Blood and Tissue DNA extraction kit (Qiagen Corp, Valencia, CA) following their modified protocol for insect cells. For extractions only head and the thorax was used; the abdomens were saved in 70% ethanol at -20°C for further morphological identification.

Mitochondrial Cytochrome C Oxidase Subunit 1 (CO1) Sequence was used to identify the species designation of the TLB (*Diorhabda* spp.). Since CO1 is a maternally inherited gene it only provides the maternal lineage of the individuals rather than their possible hybridization status.

The CO1 sequence was used to identify tamarisk weevil (*Coniatus spp.)* specimens



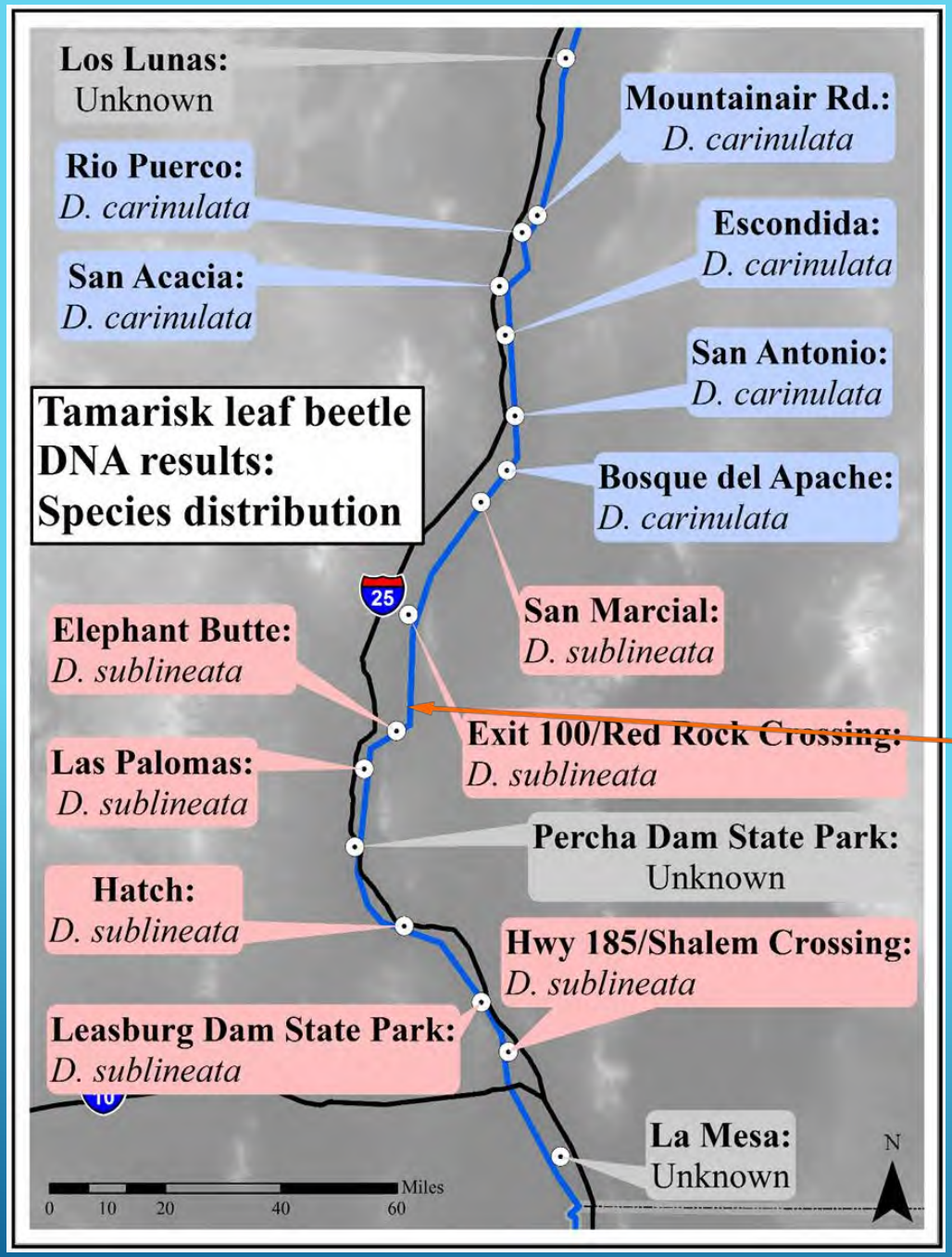
Splendid tamarisk weevil

Unknown introduction. First published occurrence in NV, 2011 (Eckberg and Foster 2011). Earlier accounts in AZ. Eats shoot tips.

Distribution of TLB (*Diorhabda* spp.) according to 2016 genetic results along the Rio Grande in New Mexico.

- Northern tamarisk leaf beetle (*D. carinulata*) were found between Mountainair Rd., NM and Bosque del Apache, NM

- Subtropical tamarisk leaf beetle (*D. sublineata*) were found between San Marcial, NM and Highway 185/Shalem Crossing, NM.



HYBRIDIZATION

- James Tracy, Department of Entomology, Texas A&M examined TLB morphology in order to determine species and hybridization.
- He found that the subtropical tamarisk beetle (*D. sublineata)* displayed 8% - 10% hybridization characters of Mediterranean tamarisk beetle (*D. elongate)* at sites surrounding Elephant Butte Reservoir (J. Tracey pers. comm).
- These two species of beetles have been shown to readily hybridize (Bean et al. 2013).

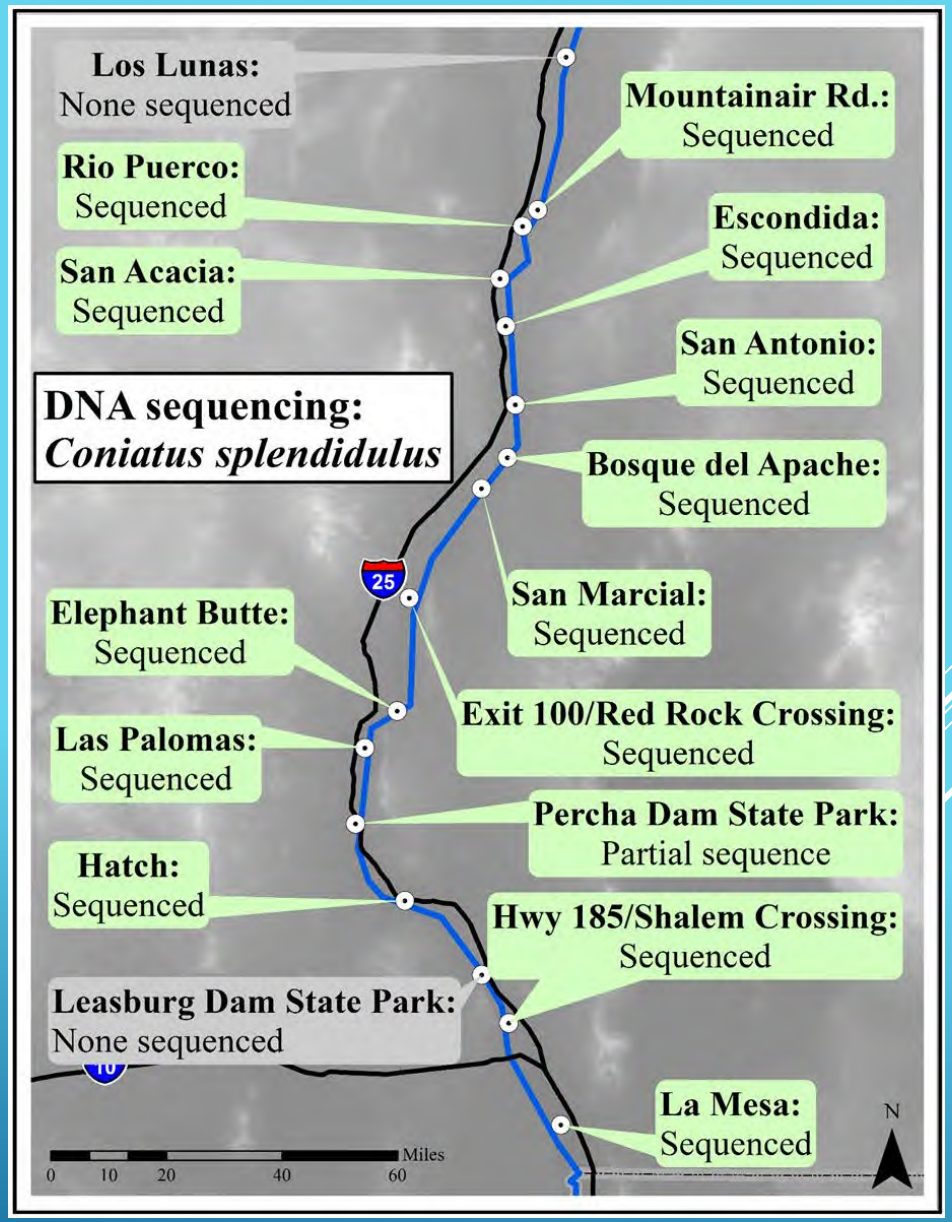
Distribution of splendid tamarisk weevil (*Coniatus splendidulus*) genetic results along the Rio Grande in New Mexico, August 2016.

Splendid tamarisk weevil

Unknown introduction. First published occurrence in NV, 2011 (Eckberg and Foster 2011). Earlier accounts in AZ. Eats shoot tips.

- **Our *Coniatus* specimen sequences displayed perfect alignment with the previously sequenced specimens collected in North America suggesting that they belong to the same species, most likely splendid tamarisk weevil (*Coniatus splendidulus*).**

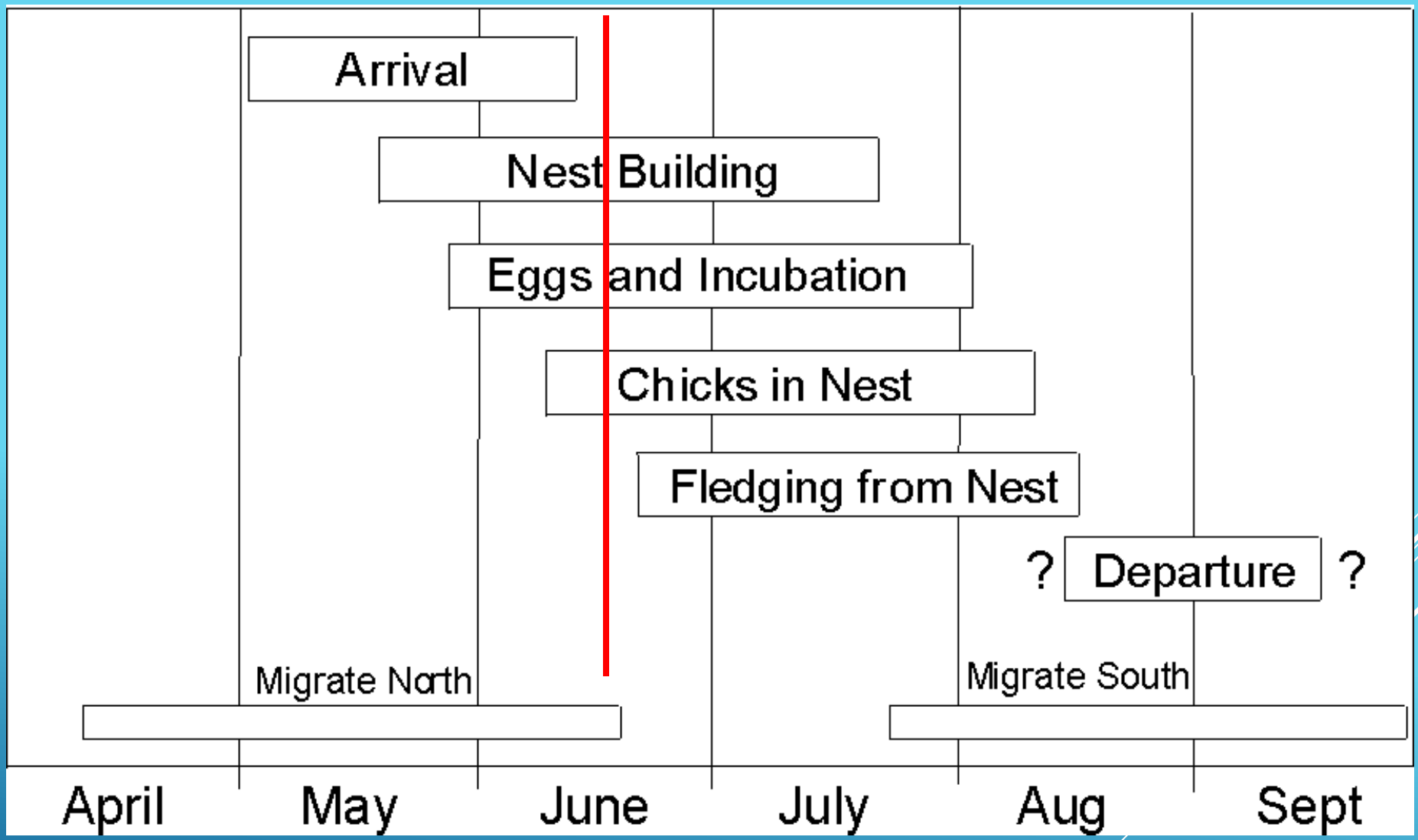
- **These results confirm that the splendid tamarisk weevil is the species distributed at all sites sampled on the Rio Grande River, NM in 2016**



Possible Effects of Defoliation on Birds

- **Increased visibility → risk of depredation and brood parasitism**
- **Unfavorable microclimate**
  - **Temperatures at unshaded nests may reach highs (41°C = 106°F) sufficient to kill embryos**
  - **Adults expend energy to moderate temp at nest (shading)**
    → attract attention to the nest

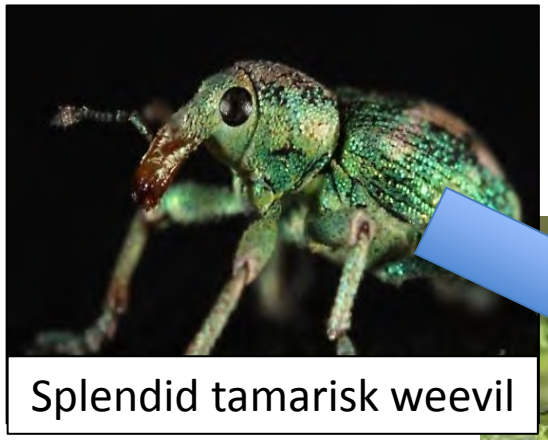
Nest chronology and timing of defoliation



Research Questions

1. **Population study: What are patterns of avian richness and abundance at sites that vary in amount of tamarisk and amount of defoliation by the tamarisk leaf beetle (TLB)?**

2. **Diet study: How does diet of breeding birds differ within and among areas with different abundances of TLB and other tamarisk associated insects?**



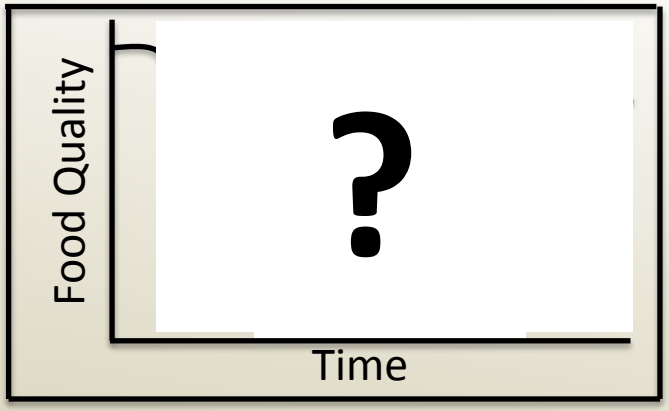
Splendid tamarisk weevil

?

Native Birds

Tamarisk leaf beetle

Tamarisk leafhopper




STUDY AREA
VIRGIN RIVER
Desert Springs, AZ
Beaver Dam, AZ
Big Bend, AZ
Mesquite, NV
Gold Butte, NV
Mormon Mesa, NV
10.00 mi
Image Landsat
Google earth

2013 Site Characteristics

>75% Dead Tamarisk – Mormon Mesa

>75% Live Tamarisk – Gold Butte/Desert Springs

>75% Native – Beaver Dam

50% Native 50% Tamarisk mix – Mesquite

Methods – point counts

6-12 Points per site (8 minutes per point)

Methods – Insect sweeps

Adopted from Tamarisk Coalition/ USDA Sweep protocol

Sweeps conducted at every point count
after point count observations

Methods – Bird feces collection

Target netted – Lucy's warbler (LUWA), Abert's towhee (ABTO), yellow warbler (YEWA), and Bewick's wren (BEWR)

THREE LIFE-STAGES OF THE TAMARISK LEAF BEETLE (*DIORHABDA CARINULATA*)

A. **FIRST INSTAR LARVA.**
B. **THIRD INSTAR LARVAE.**
C. **ADULT BEETLE**

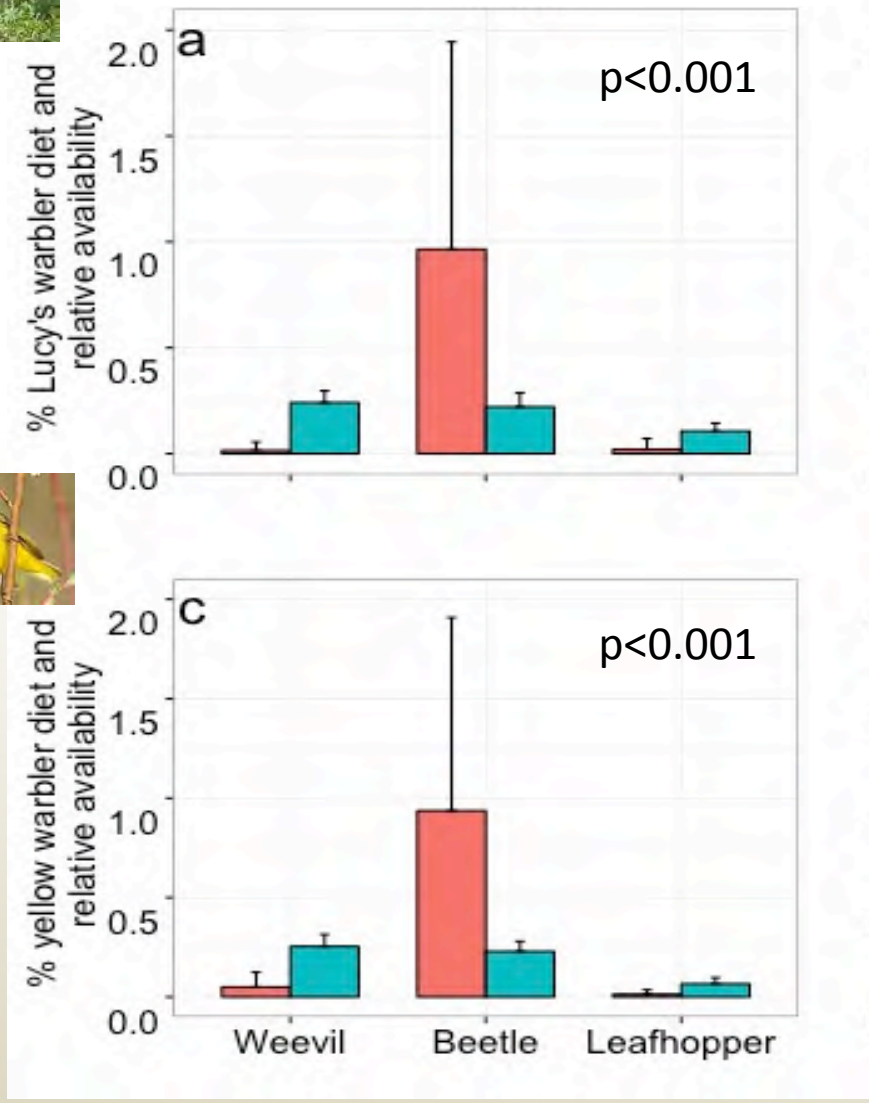
Tamarisk Leafhopper (*Opsius stactogalus*

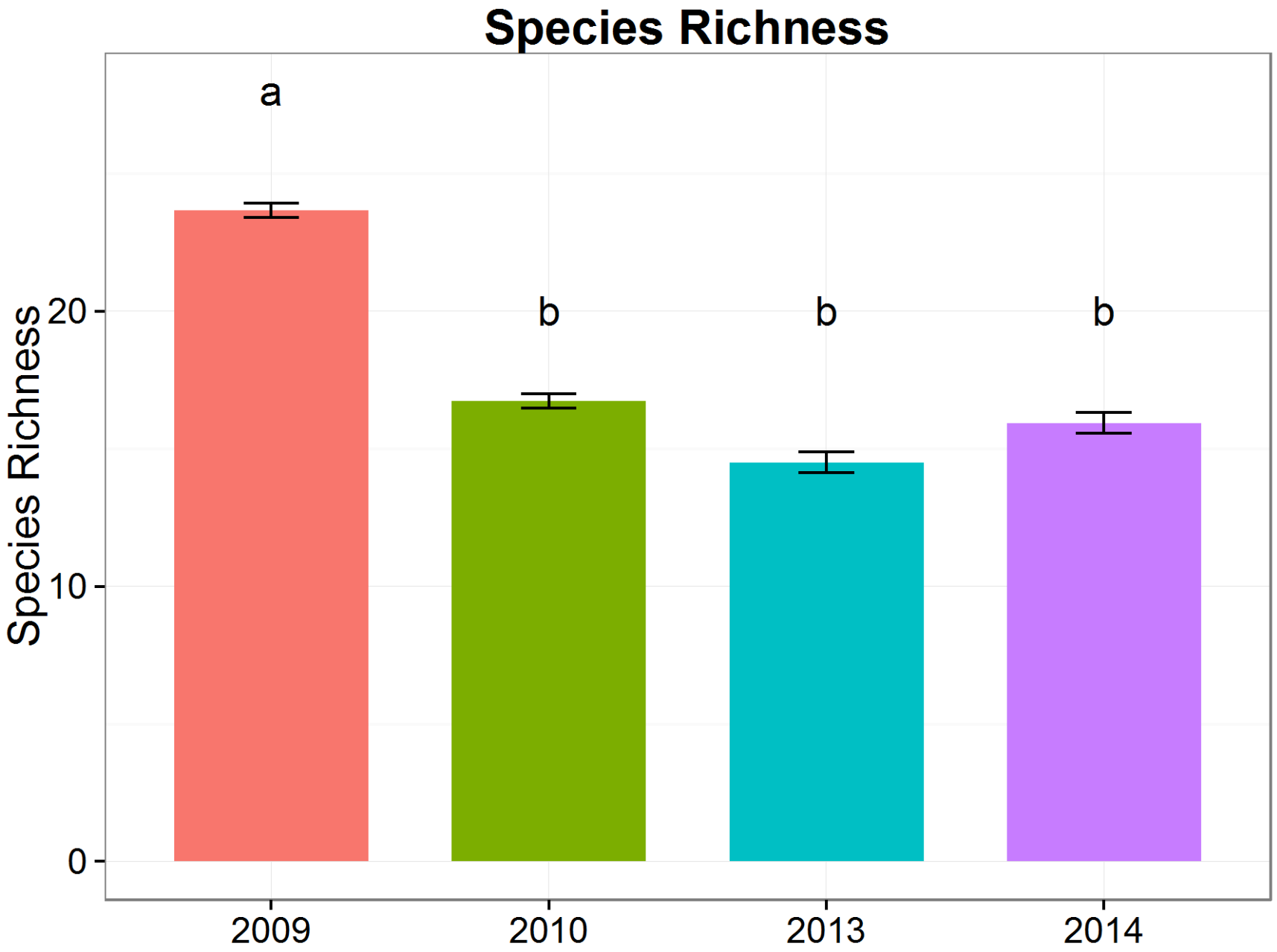
Splendid Tamarisk Weevils (*Coniatus splendidulus*)

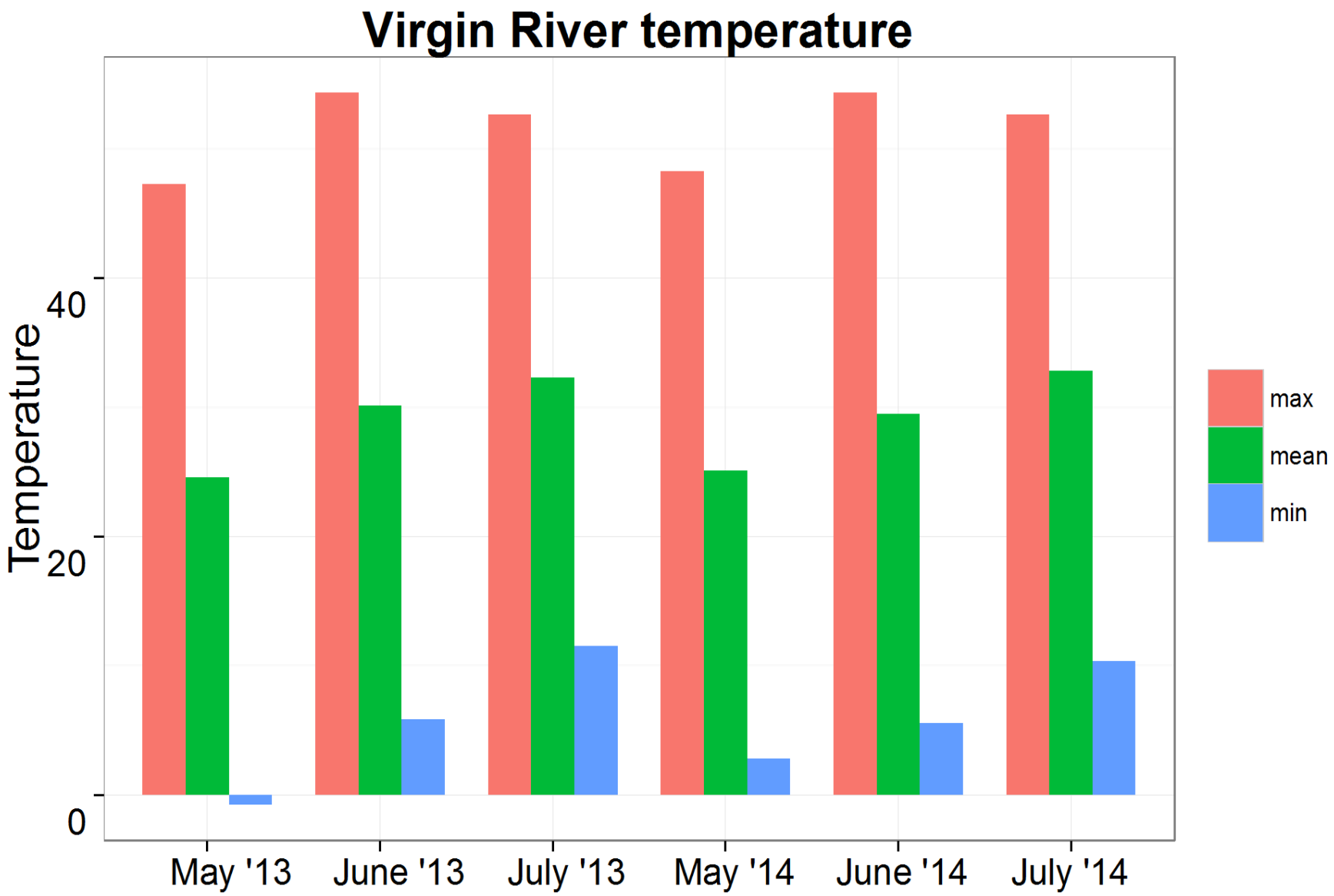
Weevil eaten most frequently

Weevils and leafhoppers are preferred food

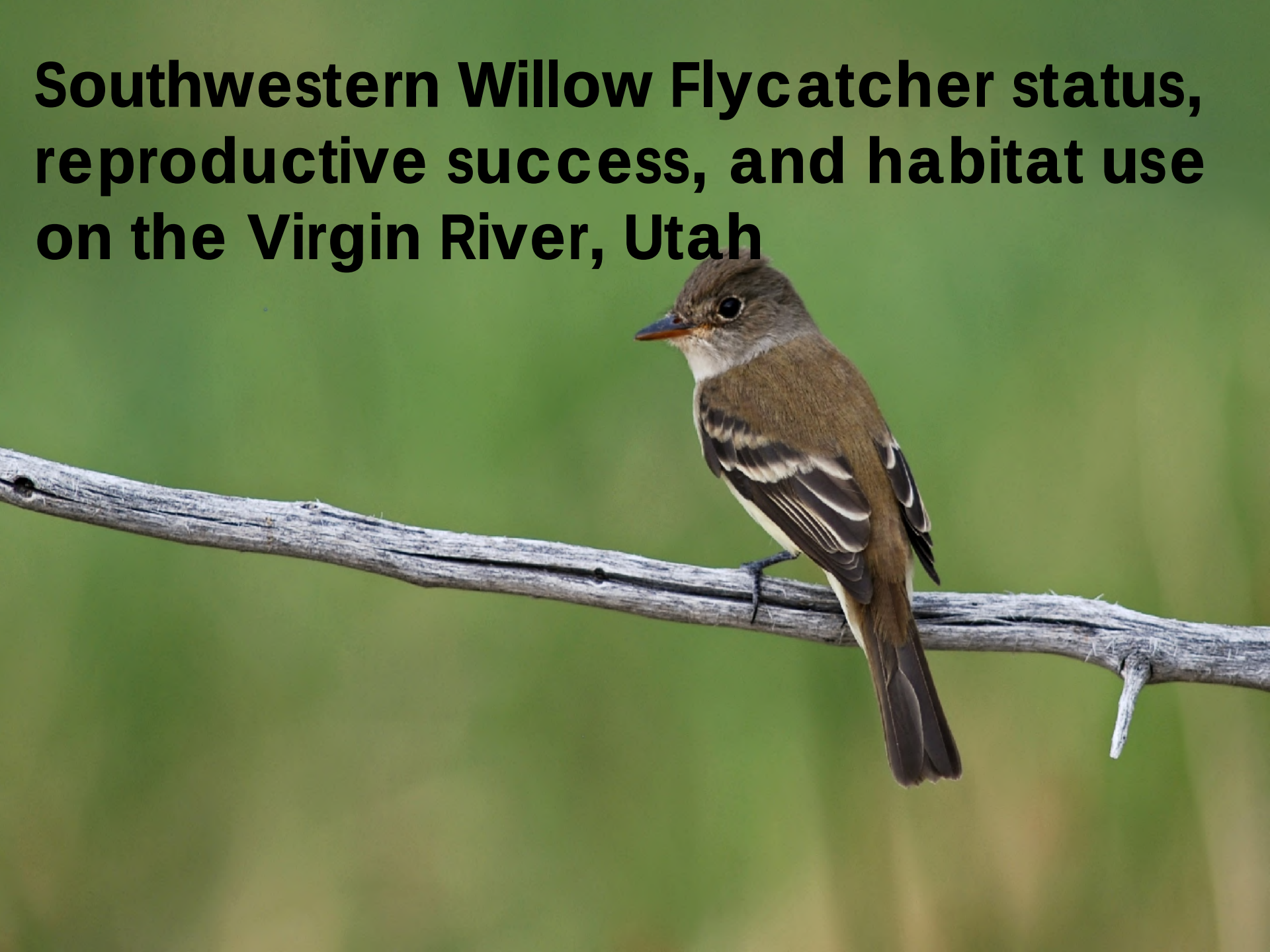
Tamarisk habitat

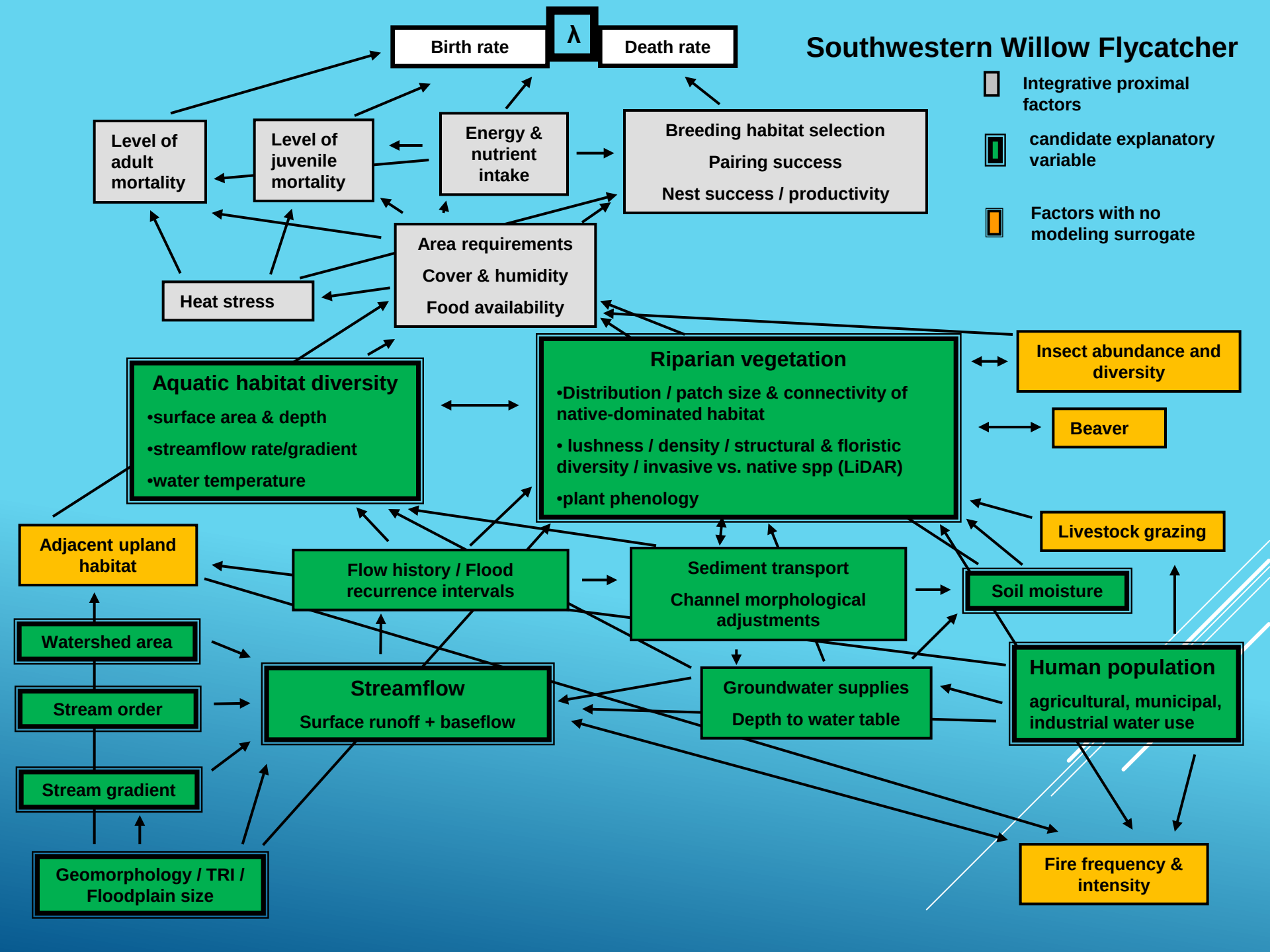


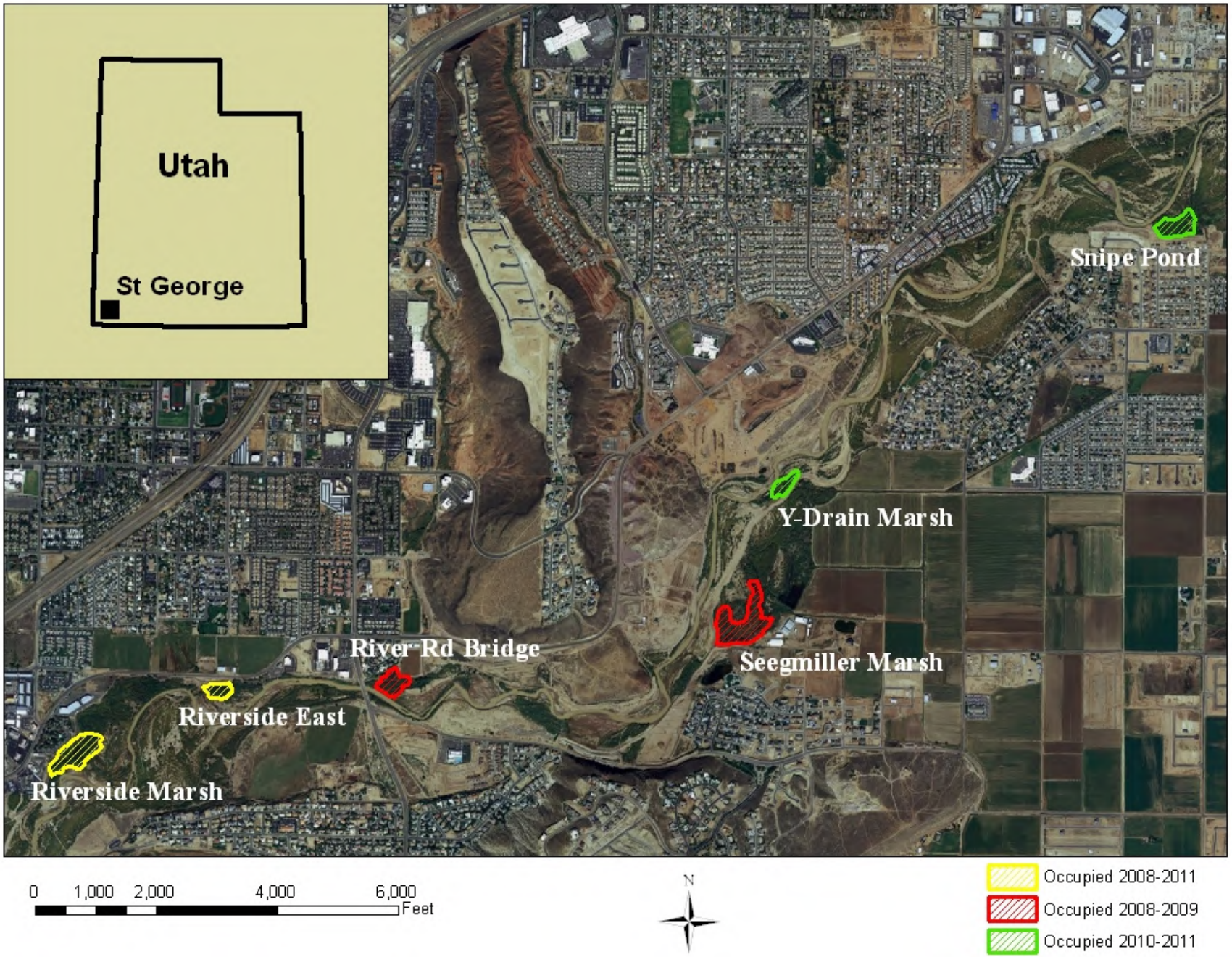

Species Richness
Species Richness
20
10
0
a
b
b
b
2009
2010
2013
2014


Virgin River temperature
Temperature
40
20
0
May '13
June '13
July '13
May '14
June '14
July '14
max
mean
min

Southwestern Willow Flycatcher status, reproductive success, and habitat use on the Virgin River, Utah




Southwestern Willow Flycatcher
Integrative proximal factors
candidate explanatory variable
Factors with no modeling surrogate
Birth rate
λ
Death rate
Level of adult mortality
Level of juvenile mortality
Energy & nutrient intake
Breeding habitat selection
Pairing success
Nest success / productivity
Area requirements
Cover & humidity
Food availability
Heat stress
Aquatic habitat diversity
•surface area & depth
•streamflow rate/gradient
•water temperature
Riparian vegetation
•Distribution / patch size & connectivity of native-dominated habitat
• lushness / density / structural & floristic diversity / invasive vs. native spp (LiDAR)
•plant phenology
Insect abundance and diversity
Beaver
Livestock grazing
Adjacent upland habitat
Flow history / Flood recurrence intervals
Sediment transport
Channel morphological adjustments
Soil moisture
Watershed area
Stream order
Stream gradient
Streamflow
Surface runoff + baseflow
Groundwater supplies
Depth to water table
Human population
agricultural, municipal, industrial water use
Geomorphology / TRI / Floodplain size
Fire frequency & intensity

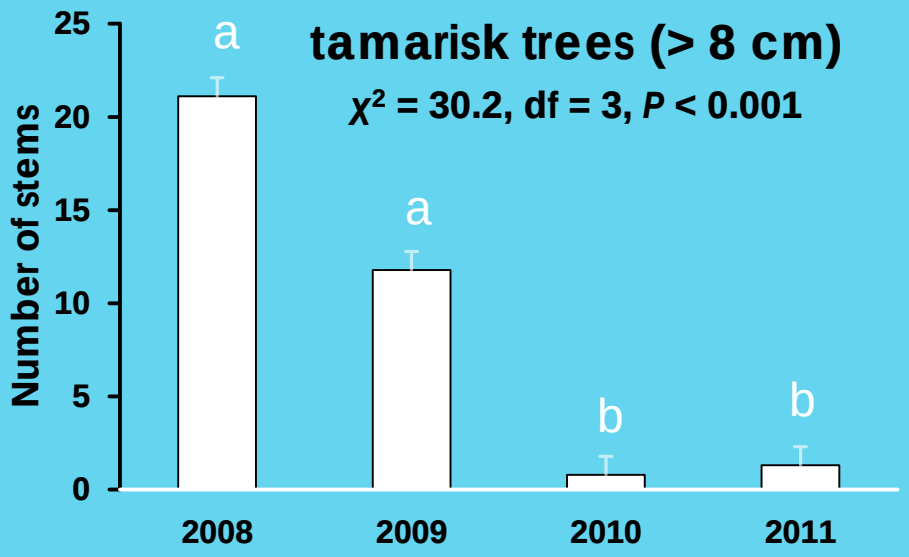

Utah
St George
Snipe Pond
Y-Drain Marsh
Seegmiller Marsh
River Rd Bridge
Riverside East
Riverside Marsh
0 1,000 2,000 4,000 6,000
Feet
N
Occupied 2008-2011
Occupied 2008-2009
Occupied 2010-2011

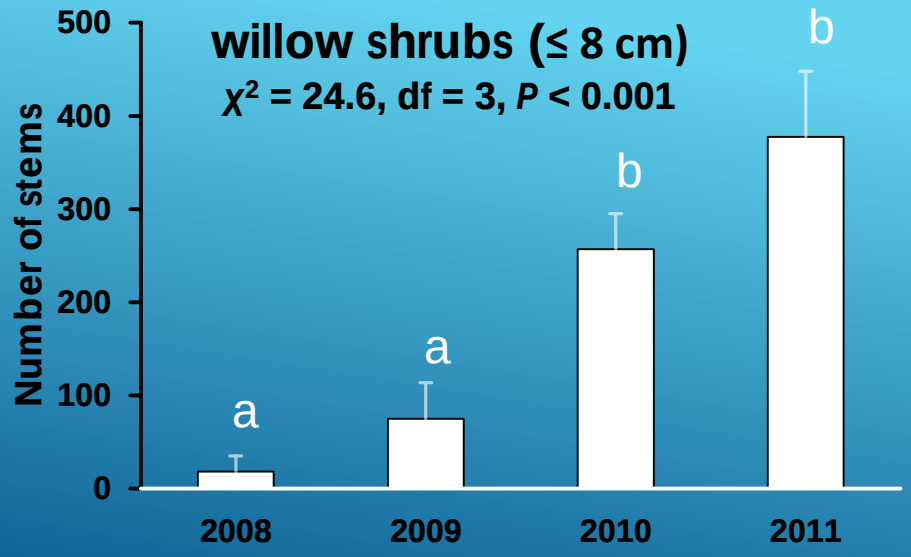
Tamarisk Leaf Beetles (*Diorhabda carinulata*) in St George

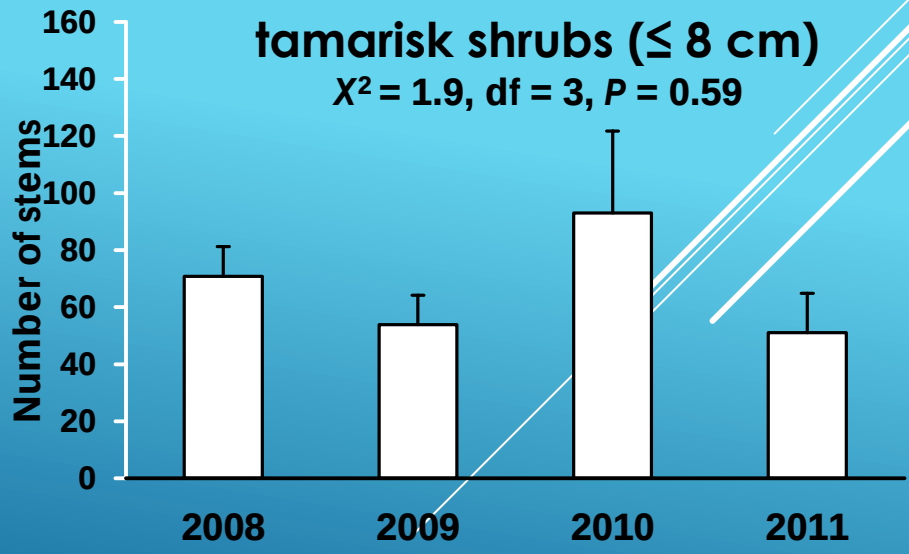
- Introduced in 2006

- Tamarisk defoliation:
  - 2008: August, *after* SWFL breeding
  - 2009: June
  - 2010: June
  - 2011: late July
  - 2012: late July

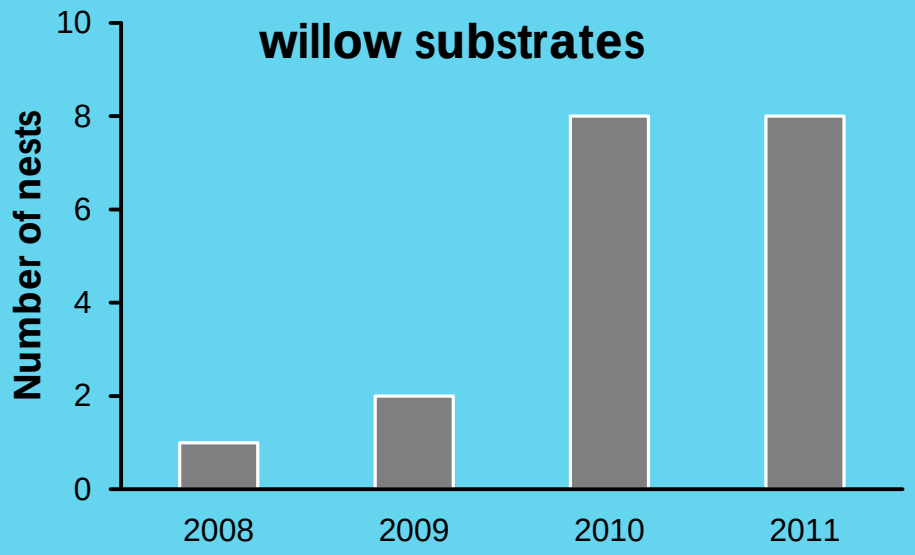
Habitat use shifted between 2009 & 2010

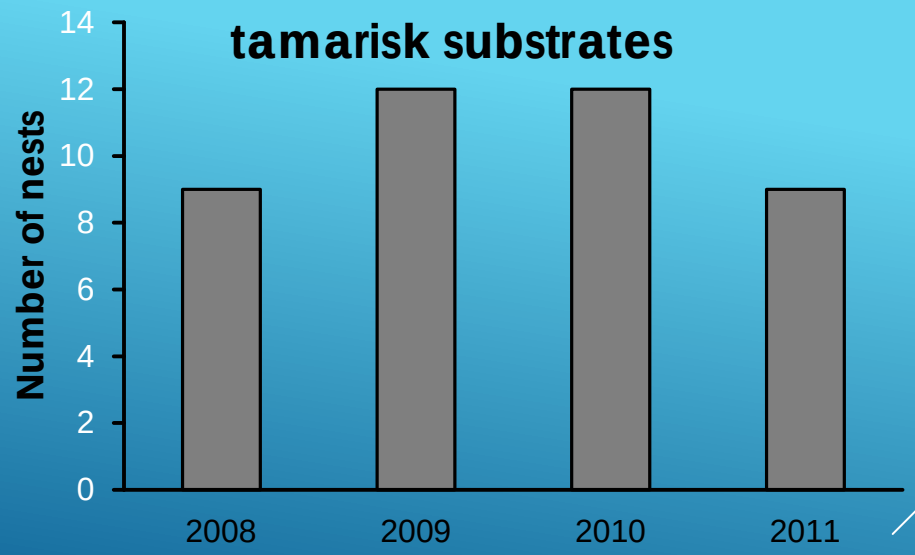






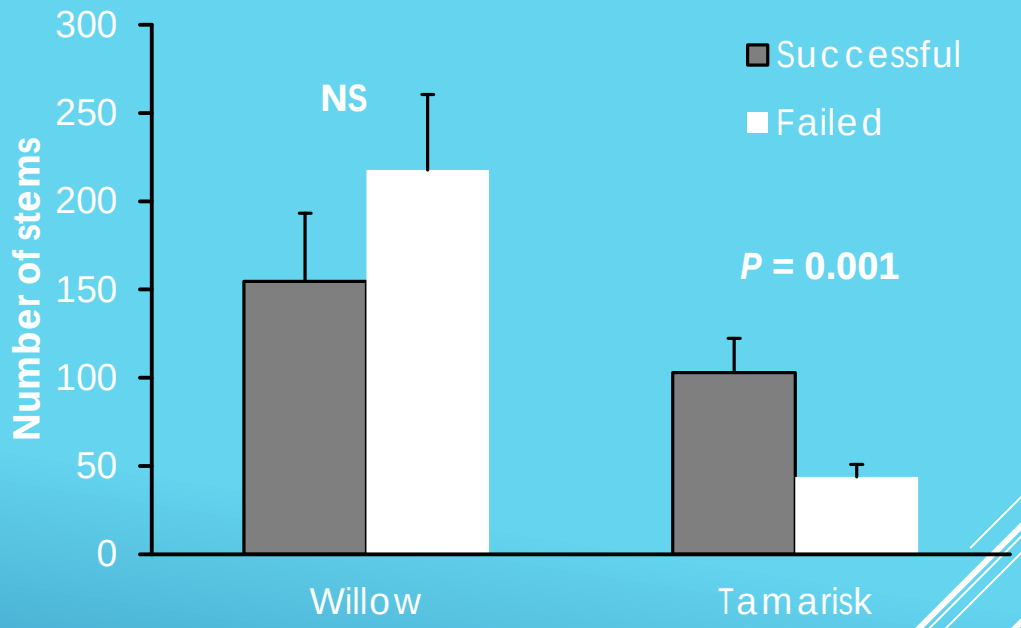
Nest substrate use shifted between 2009 & 2010





Nest success habitat-mediated (2010-2012)?

Nests more likely to fledge with higher tamarisk shrub density



Virgin River, UT Restoration Sites (Dobbs et al. 2013)

SWFL - 2013

Site	# active nest	# successful nest	Apparent nest success	Mayfield nest success	# parasitized nests	Parasitized	# depredated nest	Depredated
Riverside Marsh	2	2	100%	100%	0	0%	0	0%
Riverside East	1	1	100%	100%	0	0%	0	0%
Y-Drain Marsh	7	5	71%	60%	2	29%	2	29%
Total	10	8	80%	75%	2	20%	2	20%

YWAR - 2013

Site	# active nest	# successful nest	Apparent nest success	Mayfield nest success	# parasitized nests	Parasitized	# depredated nest	Depredated
Riverside Marsh	2	0	0%	0%	2	100%	1	50%
Riverside East	3	0	0%	15%	2	67%	2	67%
Y-Drain Marsh	11	2	18%	3%	6	55%	2	18%
Total	16	2	13%	4%	10	63%	5	31%

Habitat restoration and enhancement

-Tamarisk shrubs valuable when mixed with native vegetation

-Reduce tamarisk density by 60-70 %
  -Prioritize tamarisk trees for removal
  -Leaving tamarisk shrubs in understory

-Replant thinned areas with mix of native species that provide understory structure
  -e.g., Goodding's willow, seep-willow

RESTORATION

- Protect the current breeding sites.
- Restoration/enhancement of former breeding sites.
- Larger-scale restoration in vicinity of current breeding sites.
- Time-scale; beetles are affecting breeding sites now, and restoration likely to take several years.
- In other flycatcher breeding areas, restoration/enhancement should start several years in advance of anticipated beetle arrival.