Surveys and Habitat Assessment of Endemic Insects at the Monahans Dune System

Final Report

Prepared for the

Texas Parks and Wildlife Department

by

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Scientific Collecting Permit #

Surveys and studies were conducted in accordance with scientific collecting permit 2013-05 issued by the Texas Parks and Wildlife Department.

Front cover images: Open dune at the Monahans Sandhills State Park and the regionally endemic scarab beetle, *Polyphylla monahanensis*.

Summary

This report provides information on a project initiated in March 2013 involving comprehensive insect surveys at the Monahans dune system in western Texas. Two additional reports submitted to TPWD in 2013 preceeded this final report and contain additional information on the project. In this report, we provide a synopsis of the locales, number of collected specimens and relative abundances, periods of emergences and extence of occurrences of nine focal insect species. For all focal species, baseline survey data (1) expands the information on temporal emergences, (2) expands county records and/or range extents, and (3) increases the number of known locales. New maps are provided showing the updated distributions of the nine focal species.

Species most in need of further studies because of smaller numbers of occurrences, abundances or with potentially restricted ranges include *Nicagus occultus*, *Trigonoscutoides texanus* and *Prionus spinnipenis*. Furthermore, the Jerusalem cricket *S. monahanensis* appears to be relatively abundant in the Monahans dune system; information on the genetic population structures of this species and its congeners would help to better understand its population conditions and potential intergrades among the Monahans-Mescalaro species of Jerusalem crickets.

In addition to new baseline data, two field studies and one laboratory study remain in process to date including (1) Associations of six different vegetation types on the occurrences and abundances of nine focal insects at the Monahans dune system (2) Insect community diversity across mesquite, shin oak and open sand dunes with a focus on endemic species of concern, and (3) Burrowing behavior of the Jerusalem cricket *Stenopelmatus monahanensis* across a sand-moisture gradient. This report will be supplemented by manuscripts and published articles from these additional studies.

The lack of data on larval occurrences and their habitat resources hindered our ability to assess habitat conditions and threats to the focal species. However, current field observations and historical accounts of surface water (ponds) at the Monahans Sandhills State Park suggest that compromised surface and ground water levels could act as major environmental stressors to the dune system. The vegetation type we classified as "remnant wetland valley" occurred throughout the Monahans sandhills; these are the habitats containing facultative and obligate wetland species (e.g., willows) that comprised the “ephemeral and permanent ponds” observed at Monahans Sandhills State Park as recent as the 1980s. Since March 2013, we have found only one small (1 m diameter) groundwater pool that completely dried in 2014. While populations of the focal species generally appear to be secure based on seasonal abundances, further prolonged drought and regional freshwater withdrawals could threaten populations. The sandhills provide a unique model system to study potential long-term changes to freshwater conditions, dune succession and

biotic change. This study provides baseline information to support future monitoring efforts of the insect communities at this extraordinary natural habitat in western Texas.

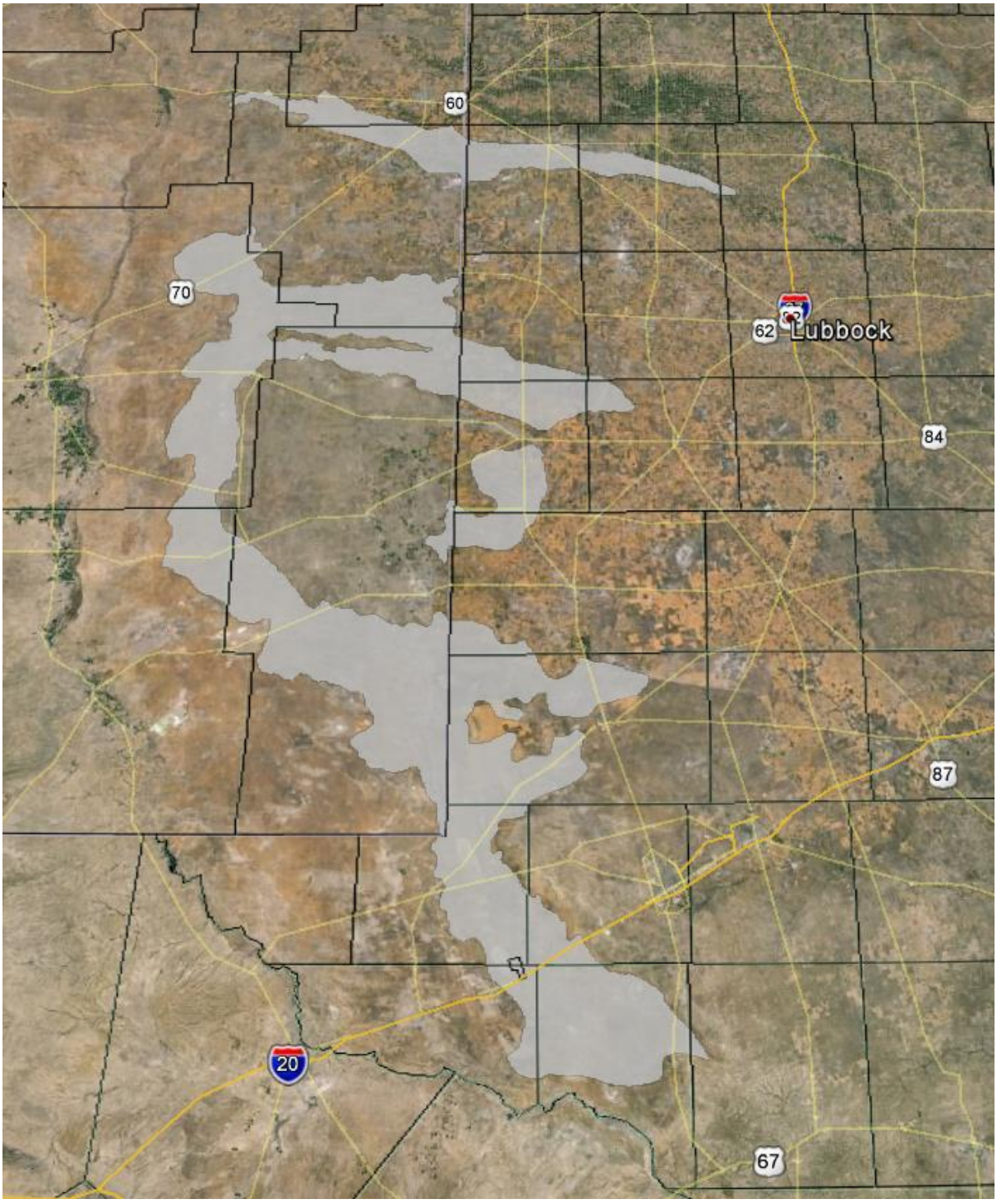


Figure 1. Location of the Shinnery Sands level IV ecoregion (Omernick and Griffith 2014), http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm. The Monahans Sandhills State Park is outlined in the shaded area at the bottom center of the figure, immediately north and adjacent to Interstate 20.

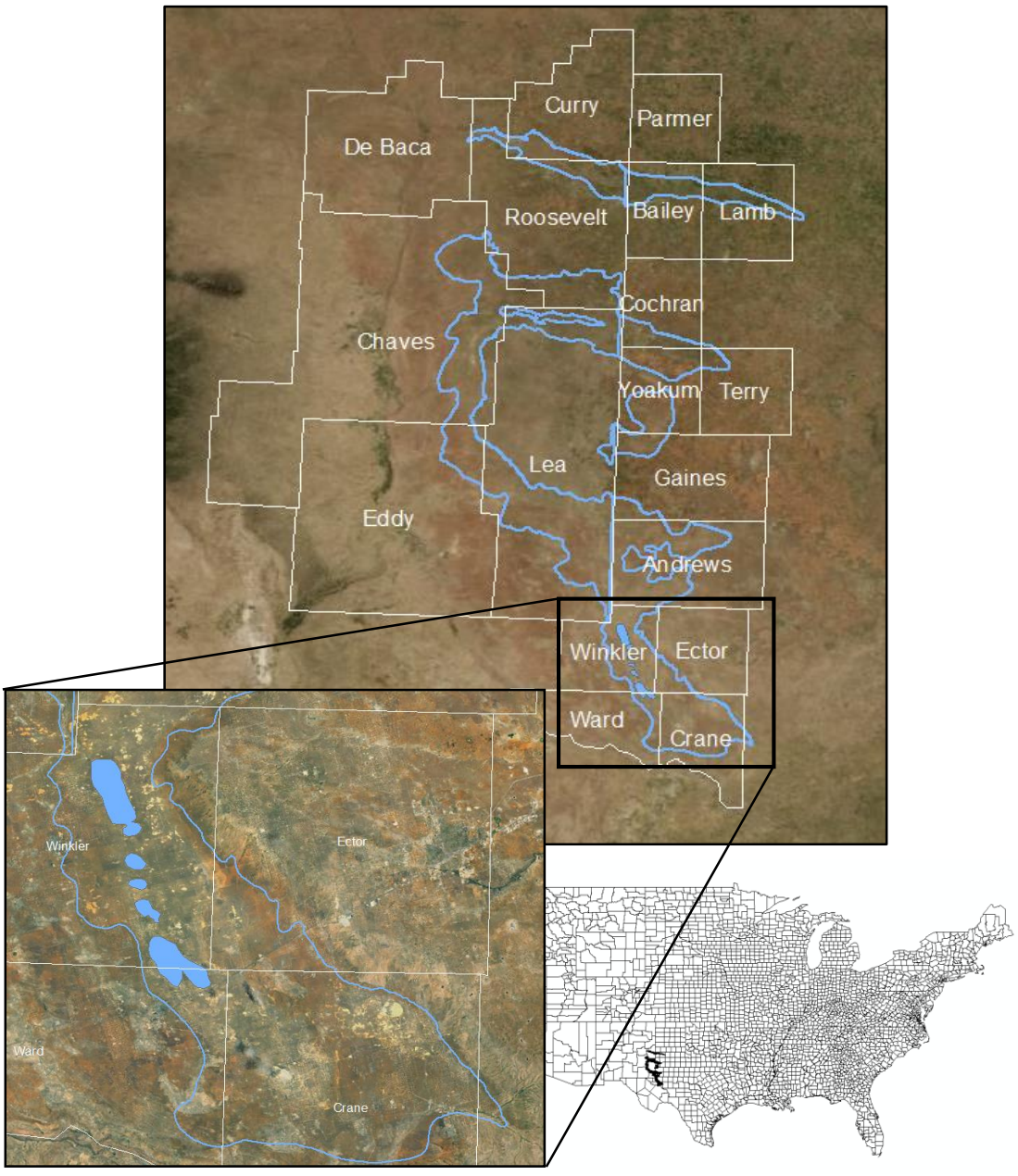


Figure 2. Location of the Shinnery Sands level IV Ecoregion (blue outline and black shade on US map) across western Texas and eastern New Mexico and the major open dunes of the Monahans dune system (blue patches, lower left).

Background and Objectives

The Monahans dune system is a series of open and vegetated sandhills occurring in western Texas and is part of a larger extensive sand dune system that included the Mescalaro sandhills primarily occurring in New Mexico. Together, the Monahans-Mescalaro sandhills comprise the Shinnery Sands Level IV Ecoregion (Figs. 1 and 2, Omernick and Griffith 2014, USEPA, 1999). Shin oak (*Quercus havardii*) is a major type of vegetation that covers the sandhills as low, often dense stands or at tops of coppice dune "islands."

The Monahans Dune System occurs near the southernmost extent of a vast dune and eolian sheet sand network that historically occupied an extensive area of the Great Plains (Muhs and Holliday 1995) and is the most active dune field of western Texas and the Great Plains (Holliday 2001). The currently stabilized sand dunes have experienced periods of activity (movement) historically as a results of aridity and episodic droughts. Rich and Stokes (2011) provide the most recent chronology of sedimentation on the Southern High Plains and Pecos River Valley and determined dune accretion began in the Pleistocene with more recent sequences of sedimentation and drought during the Holocene, the latest dune sedimentation occurring 890 – 830 years ago. Overall, eolian sedimentation and sand dune formation has been affected by changes in aridity in the Holocene, and major episodic periods of drought and its effect on stabilizing vegetation have probably played a major role in dune succession. In modern times, the dunes have been exposed to major landscape changes in the region associated with oil and gas development; these activities have intensified in recent years.

Despite being in a region of intense land-use activities and prolonged drought, the sandhills are home to a unique biodiversity, including endemic whipscorpions (Acre et al. 2012), scorpions (Sissom and Franke 1981), and the dunes sagebrush lizard, *Sceloporus arenicolus* (Degenhardt and Jones 1972, Smolensky and Fitzgerald 2011). Among the insect fauna, a total of nine species (Figs. 7-11, Table 1) are known to be regionally endemic, with more or less restricted distributions across the sandhills and some adjacent areas. These nine insects were the focus of our surveys and field studies.

In 2013, the Texas Parks and Wildlife Department funded a project to conduct surveys for these nine focal species. This report complements two previous reports with the same title submitted in 2013. Here, we provide data on occurrences and locales, seasonal emergences and abundances, and range extents for the nine focal insect species.

As guided by the conservation priorities and needs set forth by TPWD, the report herein addresses the following objectives:

a. Characterize, identify and survey potential habitat as well as previously known sites.
b. Collect site and population information using TXNDD forms.

c. Submit report on status and threat updates, TXNDD forms, and GIS data/shapefiles.

Our approach to field surveys included the following general objectives: (1) Conduct seasonal surveys of the sandhills for the nine focal species, (2) Determine habitat associations of the nine focal species, (3) Assess threats associated with the nine focal species and their habitat, and (4) Compile data from our surveys with other regional museums and universities. Three additional studies were conducted in 2014 and are currently in process: (1) Associations of six different vegetation types on the occurrences and abundances of nine focal insects at the Monahans sand dune system (2) Insect diversity across mesquite, shin oak and open sand dunes with a focus on endemic species of concern, and (3) Burrowing behavior of the Jerusalem cricket *Stenopelmatus monahanensis* across a sand-moisture gradient.

Additional products from this project include (1) a checklist of plants from Monahans at SEINET (http://swbiodiversity.org/portal/index.php, where all the plant photographs will eventually be placed), (2) a continuing project to catalog the arthropod collections from Monahans at the TTU Museum (SCAN, http://scan1.acis.ufl.edu/) and (3) a repository of tissue for DNA preservation - All nine species have tissue or whole specimens held in cold storage (-80°C) at the Natural Science Research Laboratory at the Museum of Texas Tech University. In addition to the focal species, numerous other species collected from the Monahans sandhills are preserved in cold storage.

Table 1. Conservation targets - nine focal insect species.

		Current Status		Current Abundance Ranking	
Scientific Name	Common Name	Federal	State	Global	State
Anomala suavis	Scarab beetle			G1*	S1*
Epitragosoma arenaria	Darkling beetle			G2G3*	S2S3*
Nicagus occultus	Stag beetle			G2*	S2*
Polyphylla monahansensis	Scarab beetle			G2*	S1*
Polyphylla pottsorum	Scarab beetle			G2*	S1*
Prionus arenarius	Longhorned beetle			G1*	S1*
Prionus spinipennis	Longhorned beetle			G1*	S1*
Stenopelmatus monahansensis	Monahans Jerusalem cricket			G1*	S1*
Trigonoscutoides texanus	Weevil			G2	S2

Species Photos

Figure 3. *Epitragosoma arenaria* Brown and Triplehorn (Brown and Triplehorn 2001) (Coleoptera: Tenebrionidae, a darkling beetle) on *Panicum* grasses.

Figure 4. *Stenopelmatus monahanensis* Stidham and Stidham (Stidham and Stidham 2001) (Orthoptera: Stenopelmatidae, a Jerusalem cricket)

Figure 4, continued. *Stenopelmatus monahanensis* burrowing (top left) and tracks in sand.

Figure 5. *Prionus arenarius* Hovore (Hovore 1981) (Coleoptera: Cerambycidae, a longhorned beetle)

Figure 6. *Prionus spinnipenis* Hovore and Turnbow (Hovore and Turnbow 1984) (Coleoptera: Cerambycidae, a longhorned beetle)

(No photo)

Figure 7. *Anomala suavis* Potts (Potts 1976) (Coleoptera: Scarabaeidae, a scarab beetle)

Figure 8. *Polyphylla monahanensis* Hardy and Andrews (Hardy and Andrews 1978) (Coleoptera: Scarabaeidae, a scarab beetle)

Figure 9. *Polyphylla pottsorum* Hardy and Andrews (Hardy and Andrews 1978) (Coleoptera: Scarabaeidae, a scarab beetle)

Figure 10*. Nicagus occultus* Paulsen and Smith (Paulsen and Smith 2005) (Coleoptera: Lucanidae, a small stag beetle)

Figure 11. *Trigonoscutoides texanus* O'Brien (O'Brien 1977) (Coleoptera: Curculionidae, a weevil)

Surveys and Field Studies

Overview of Survey Methods - In March 2013, we began placing trap stations throughout Monahans Sandhills State Park. By April of 2013, seven trap stations were established (Fig. 12), each consisting of one solar powered UV light trap (Fig. 13), a Townes trap and pitfall traps. Collections from these stations occurred more or less biweekly to monthly and the seven stations were in operation through December 2013. Beginning in January 2014, one trap station was left at its original location (Site C) and we re-established trap stations within three distinct habitat types: mesquite, shin oak, and open sand dunes (Fig. 27). In addition to the semi-permanent trapping stations, numerous opportunistic collecting events involving UV lights and survey walks along open and vegetated dunes were conducted during routine collecting trips. All focal species from these studies and all nonfocal by-catch are stored at the Natural Science Research Laboratory at the Museum of Texas Tech University.

During the heavy seasonal emergences of several of the focal species in 2014 (i.e. May - August), we established a transect of UV light traps within the boundaries of the Shinnery Sands ecoregion from Bailey and Lamb Counties, TX to Ward County, TX. Multiple UV light traps (range 4 - 7 traps) were used on five different dates during this period to determine species distributions across latitudinal gradients across the sandhills in western Texas. Results and analyses of this study are forthcoming.

In 2014, six different habitat types were classified (dominant shin oak, coppice shin oak, mixed vegetation, dominant Panicum grasses, depositional vegetative valleys and remnant wetland valleys) and pitfall trapping was conducted from 18 transects (Fig. 28, n = 3 per habitat type) over a period of two months. The goal of this study was to determine habitat affinity using only pitfalls and therefore reducing the

potential effect of UV lights on pitfall trap captures at our trapping stations. Results and analyses of this field study are forthcoming.

Records were compiled from our current surveys, literature, personal communication and from the Texas A&M University Insect Collection and the Brackenridge Field Laboratory at the University of Texas. For most of the records GPS points were available and species occurrences were plotted as a shapefile in ArcMap. After plotting distributional records, Geospatial Modelling Environment (Beyer 2012, Version 0.7.3.0) was used to create minimum convex polygons for using all available points for each species. Convex polygons were then converted to KML files, imported to Google Earth Pro, and areas of each polygon was determined (Extent of occurrences in km^2, Table 2).

The following synopsis of species information gives known locales, current numbers of specimens from our surveys, extent of occurrences (EOO), and monthly periods of emergences for the nine focal species. These are further summarized in Table 2. In addition, we provide brief notes on habitat, behaviors, morphology and distributions. Appended with this report includes GIS shapefiles for each species, photos of each species and a database of species occurrences and locales with GPS information (WGS84 datum). A manuscript containing updated distributional records and EOOs will be submitted as a supplement to this report.

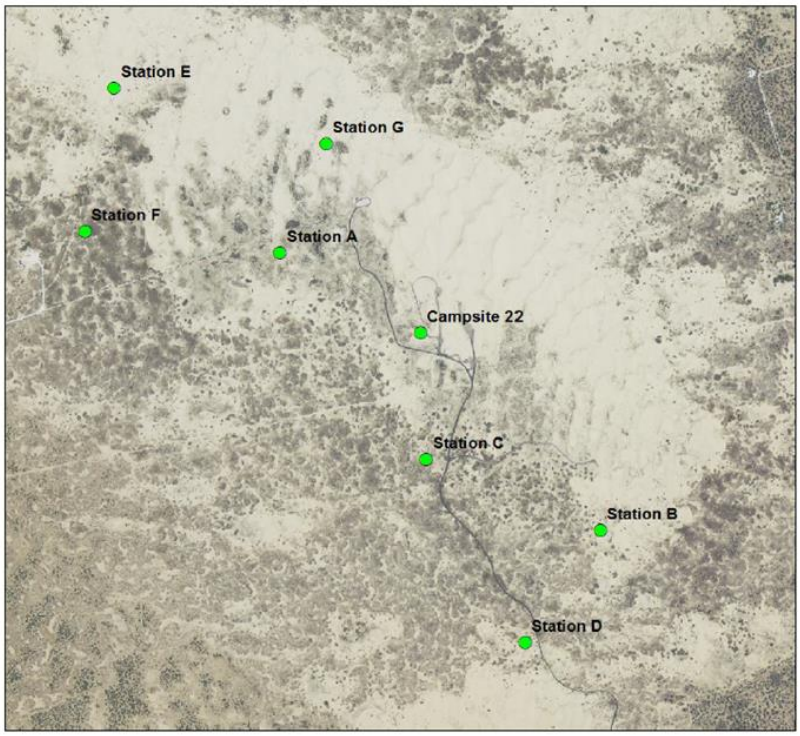


Figure 12. Monahans Sandhills State Park showing the locations of seven trap stations. Campsite 22 is shown for reference.

Figure 13. Solar-powered UV bucket light trap. These traps in addition to Townes traps and pitfall traps were established at each of the seven trapping stations (A-G) shown in Figure 12.

Survey Results and Notes

Locales are occurrences in more or less proximity; some locales are simply different locations within a relatively small area that could be considered one locale (i.e., the campground area at Monahans Sandhills State Park). Locales provided in Table 2 include all locales witih different spatial locations (i.e., GPS points). Otherwise, locales can be discerned based on distributional maps provided in Figs. 14-22 and information from our database and TXNDD forms.

Stenopelmatus monahanensis (Jerusalem cricket) - Known from 30 locales. To date, we have 361 specimens from our current study. Individuals were collected either by trapping or by hand in every month of the year and were particularly easy to collect at nights in the fall, as they were often encountered on top of the sand surface walking about. Dry pitfall traps during these nights in the fall were also effective at trapping live specimens. It is uncertain whether *S. monahanensis* is endemic to only the Monahans sandhills; D. Weissman (Univ. Cal., pers. comm.) suggested it is not as he has collected individuals from both the Monahans and Mescalaro sandhills. Further, individuals showing an intermediate color form between the light *S. monahanensis* and the dark *S. mescalaroensis* have been found co-occurring with these species (D. Weissman, pers. comm.)

Epitragosoma arenaria (Tenebrionid beetle) – Known from 18 locales. To date, we have 452 specimens from our current study. Individuals were collected primarily by hand and occurred in pitfalls and UV light trap incidentally. This is a late summer and fall emerging species. Individuals were observed to aggregate in relatively large numbers at the top of flowering heads of *Panicum* grasses. Before periods of flower bloom, individuals were mostly located in leaf axils on the lower parts of the grass stems. Preliminary data suggests that populations could be linked to the phenology of flowering *Panicum*, yet numerous individuals were also collected from other flowering plants; however, this mostly occurred outside of the major blooming period of

the *Panicum* grasses. Furthermore, the highest densities of individuals were observed on grass "islands," which were patches of *Panicum* grasses (only) on open dune ridges.

Prionus arenarius (Long horned beetle) – Known from 27 locales. To date, we have 753 specimens from our current study. Individuals were collected primarily by UV light and with pitfall traps. Despite numerous observations of individuals during the daylight and at night on the sand surface, they did not burrow readily and walked indiscriminately during our observations. This species is likely distributed throughout the Shinnery Sands ecoregion, yet we collected zero specimens during our light trapping efforts on multiple dates along a 300 km transect from Muleshoe, TX to Monahans, TX. However, *P. arenarius* has been collected at light as far northwest as Portales, NM within the Shinnery Sands region (D. Pollock, pers. comm.). In addition, one record in the TAMU collection has a locale of Terrell Co., TX, which is a location relatively far south from the Shinnery Sands and Monahans dunes. Further systematic light trap sampling throughout the Shinnery Sands would provide more accurate range information for this species and others.

Prionus spinnipenis (Long-horned beetle) - Known from only 9 locales. To date, we have 36 specimens from our current study. Individuals were collected primarily by UV light and with pitfall traps. Adults were observed to be active at UV lights from July through November, although two individuals were collected in May in 2013. This species appears to be relatively less abundant and likely with more of a restricted range than its congener *P. arenarius*.

Polyphylla pottsorum (Scarab beetle) - Known from only 41 locales. To date, we have 5148 specimens from our current study. Individuals were collected primarily by UV light and with pitfall traps. This species could be the most broadly distributed of all the focal species. Two outlying records from Hemphill Co., TX and Santa Cruz Co., AZ were not included in the calculation of the extent of occurrence for this species; if those specimens are indeed *P. pottsorum*, its EOO is greatly expanded from the TX panhandle to southern Arizona.

Polyphylla monahanensis (Scarab beetle) - Known from only 39 locales. To date, we have 4273 specimens from our current study. Individuals were collected primarily by UV light and with pitfall traps. This is an abundant species across the Monahans dune system, collected from May through December. Polyphylla monahanensis likely has a more restricted range than its congener *P. pottsorum*.

Anomala suavis (Scarab beetle) - Known from only 40 locales. To date, we have 3182 specimens from our current study. Individuals were collected primarily by UV light and by hand on open dunes. This species is abundant from May through September. Individuals are often found aggregating on open dunes and associated vegetation. Upon examination of individuals collected from local aggregations, two different morphospecies have repeatedly been observed. While *A. suavis* has the coloration noted in the description of this species (Potts 1976), including an entirely dark pronotum and darkened sutural margins on the elytra, the other species has lighter markings, with pronotum coloration with more or less two distinct longitudinal, thin dark bands not reaching the posterior margin of the pronotum. While this coloration matches that of the congener *A. antennata*, the specimens do not key out to this species. Further examination of specimens

and particularly the genitalia are needed to better understand this potential variation within *A. suavis* populations.

Nicagus occultus (Small stag beetle) - Known from only 19 locales. To date, we have 23 specimens from our current study. Individuals were collected primarily by hand on open dunes. *Nicagus* was previously known from Ward and Winkler Co., TX. Historical collections in the Monahans Sandhills State Park were from open dune areas near the campground. From the current study, we additionally collected *N. occultus* from several other locations across the park, especially more northerly areas from the park campground-recreation area. *Nicagus occultus* appears to have the shortest period of emergence of all the focal species and likely the most restricted range. However, during their emergence adults can be easily observed on open dunes. Further surveys across open dune habitats across the Monahans sandhills are needed to more accurately define the range of this species.

Trigonoscutoides texanus (Weevil) - Known from only 27 locales. To date, we have 92 specimens from our current study. Individuals were collected primarily by pitfall traps and by hand on open dunes from March through July. On several occassions, *T. texanus* was collected at the same open dune crests as *N. occultus*. Both of these small species occurred on the open dunes in very strong winds, even found crawling towards the crests of open dunes.

Table 2. Summary of locales, abundances, extent of occurrence and emergence periods for the nine focal insect species at the Monahans sandhills.

Species	# Locales from all known records (Records from TTU current surveys in parentheses*)	# Specimens from current surveys	Extent of occurrence based on known records to date (km^2)	Period of emergence (month of first and last trap catches from current surveys)
Stenopelmatus monahanensis	30 (28)	361	97	Jan. – Dec.
Epitragosoma arenaria	18 (11)	452	1483	July – Dec.
Prionus arenarius	27 (21)	753	541	April - July
Prionus spinnipenis	9 (7)	36	51	
Anomala suavis	40 (23)	3182	8366	May – Sept.
Polyphylla monahanensis	39 (23)	4273	3403	May – Dec.
Polyphylla pottsorum	41 (20)	5148	8980	May – Aug.
Nicagus occultus	19 (14)	23	284	May - June
Trigonoscutoides Texanus	27 (22)	92	99	March - July

* Surveys conducted from March 2013 to August 2014

Discussion

Based on the numbers of individuals collected and the relatively small area surveyed among the entire sandhills region, many of the focal species are probably secure at present. More surveys are needed at additional locations throughout the sandhills to determine if these numbers can be extrapolated to the broader sandhill region. The lack of individuals collected at UV lights places along a 300 km latitudinal transect from Muleshoe, TX to the Monahans sandhills suggests that populations are likely concentrated closer to the Monahans dune system, an area with more open sand than the remainder of the Shinnery Sands ecoregion. We expected to collect individuals with UV lights from the broad Shinnery Sands region in Cochran and Yoakum Counties in western Texas, but that was not the case. Populations could depend on the availability of open sand habitat, which is largely absent from the Shinnery Sands regions outside of the Monahans dunes. Moreover, individuals collected further from the Monahans dune system occur in areas of the Mescalaro sandhills in New Mexico. Therefore, either population expansions or relict subpopulations seem to be along the Monahans-Mescalaro major corridor rather than from Monahans across the sandhill "fingers" that extend from east-central New Mexico into western Texas.

Species that should receive additional study because of smaller relative occurrences, abundances or with potentially restricted ranges include *Nicagus occultus*, *Trigonoscutoides texanus* and *Prionus spinnipenis*. Furthermore, the Jerusalem cricket *S. monahanensis* appears to be rather common at the Monahans dunes. Preliminary data from transect sampling (Fig. 28) shows that *S. monahanensis* was the most frequently collected species in pitfall traps and occurred within all vegetation types. However, information on the genetic population structures of this species and its congeners would help to better understand its population conditions and potential intergrades among the Monahans-Mescalaro systems.

The lack of data on larval occurrences and their habitat resources hindered our ability to assess habitat conditions and threats to the focal species. However, current field observations and historical accounts of surface water (ponds) at the Monahans Sandhills State Park suggest that compromised surface and ground water levels could act as major environmental stressors to the dune system. The vegetation type we classified as "remnant wetland valley" occurred throughout the Monahans sandhills; these are the habitats containing facultative and obligate wetland species (e.g., willows) that comprised the “ephemeral and permanent ponds” observed at Monahans Sandhills State Park as recent as the 1980s (Plate I, Machenburg 1984). Since March 2013, we have found only one small (1 m diameter) groundwater pool that completely dried in 2014. While populations of the focal species generally appear to be secure based on seasonal abundances, further prolonged drought and regional freshwater withdrawals could threaten populations.

Muh and Holliday (1995) suggest that based on drought episodes in the 18th century and models predicting significant increases in temperature and decreases in precipitation (e.g. Muhs and Maat 1993), the potential for reactivation of dunes in the future is high. Rich and Stokes (2011) suggest that the variety of deposits on the Southern High Plains comprise a system very important for understanding environmental change. Intensification in oil and gas development and agricultural practices on the Southern High Plain over the past century have changed landscapes and groundwater levels of the Ogallala aquifer (Allen et al. 2005, Smolensky and Fitzgerald 2011). These changes suggest that the dune systems could be in a current state of rapid change. Aside from direct negative effects from land and resource management, it is possible that continued increases in aridity and drought episodes today will lead to loss of dune-stabilizing vegetation, increased eolian sedimentation, and thus threaten the survival of these endemic, sand-obligate insects. Understanding current conditions of the flora and fauna of these systems provides benchmarks at which to measure potential future change in addition to providing a means to investigate past conditions involving the adaptation and evolution of this unique fauna and the succession of its sand-dominant ecosystem. We suggest that coupling information on sedimentation and the succession of dune habitats (e.g. Rich and Stokes 2011) with an understanding of evolutionary mechanisms acting on this unique biodiversity would enhance our understanding of environmental change and responsible land management in the region. The sandhills provide a unique model system to study potential long-term changes to freshwater conditions, dune succession and biotic change. This study provides baseline information to support future monitoring efforts of the insect communities at this extraordinary natural habitat in western Texas.

Species Distribution Maps

Figure 14. *Anomala suavis*

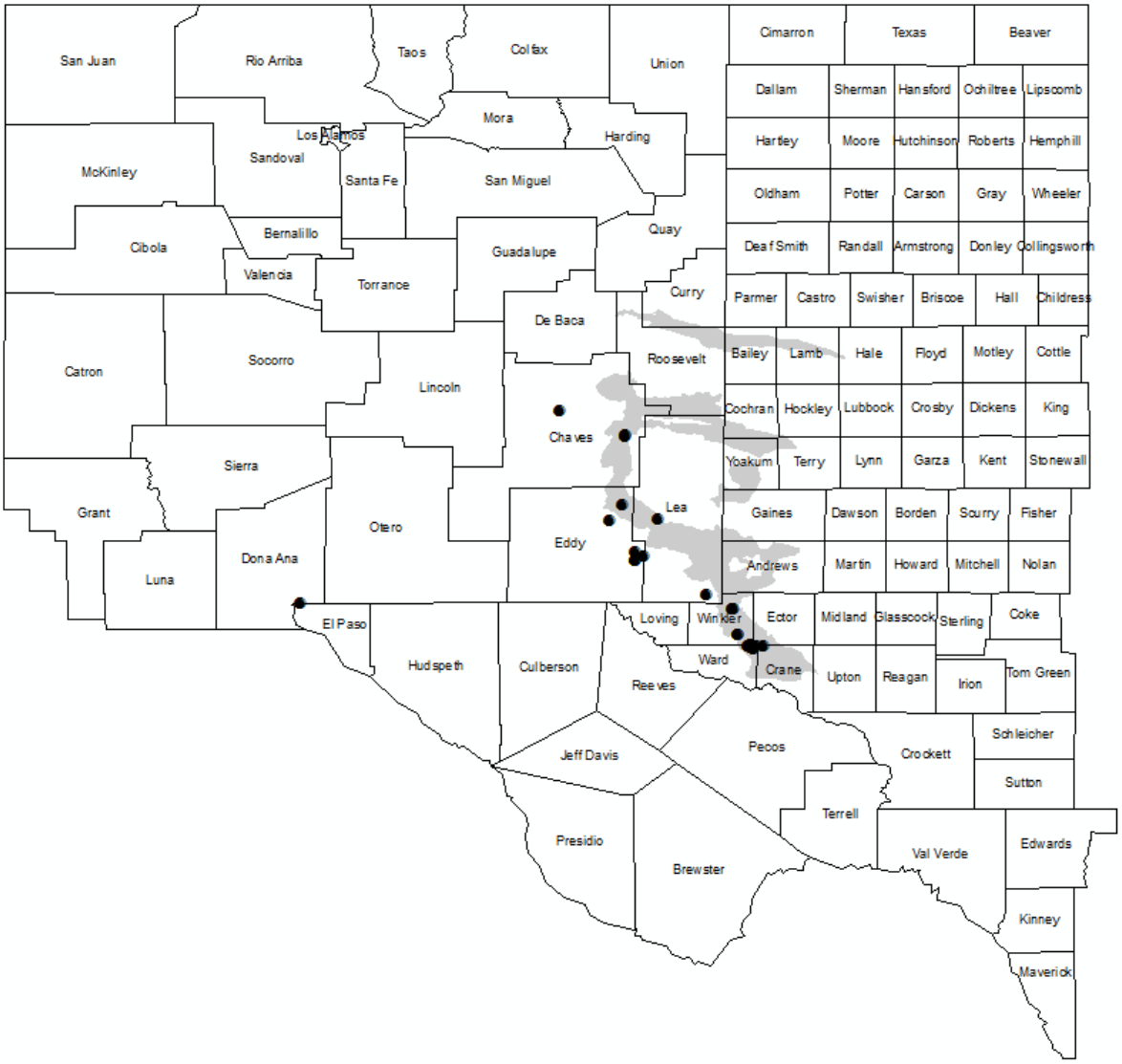


Figure 15. *Polyphylla pottsorum*

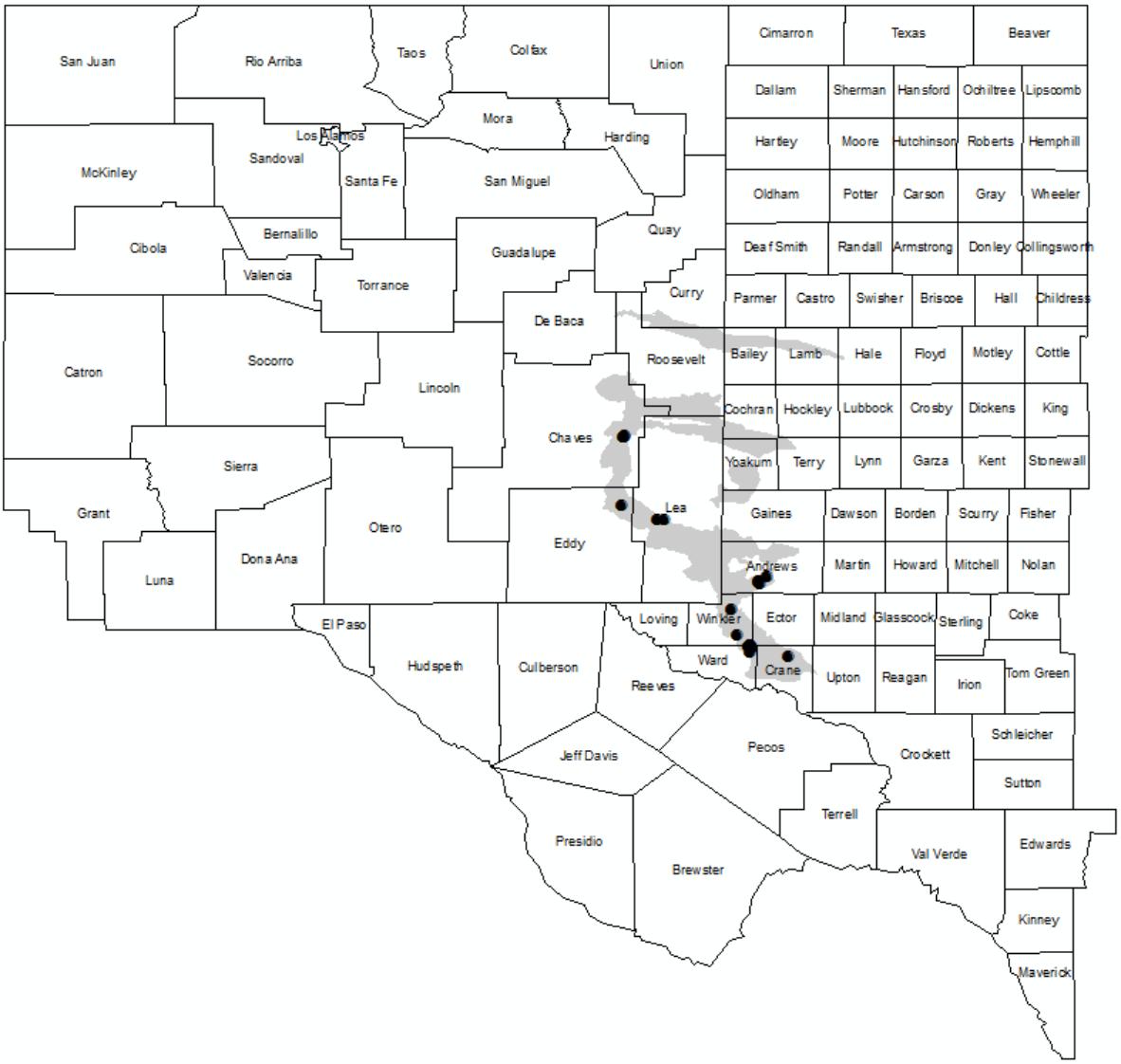


Figure 16. *Polyphylla monahanensis*

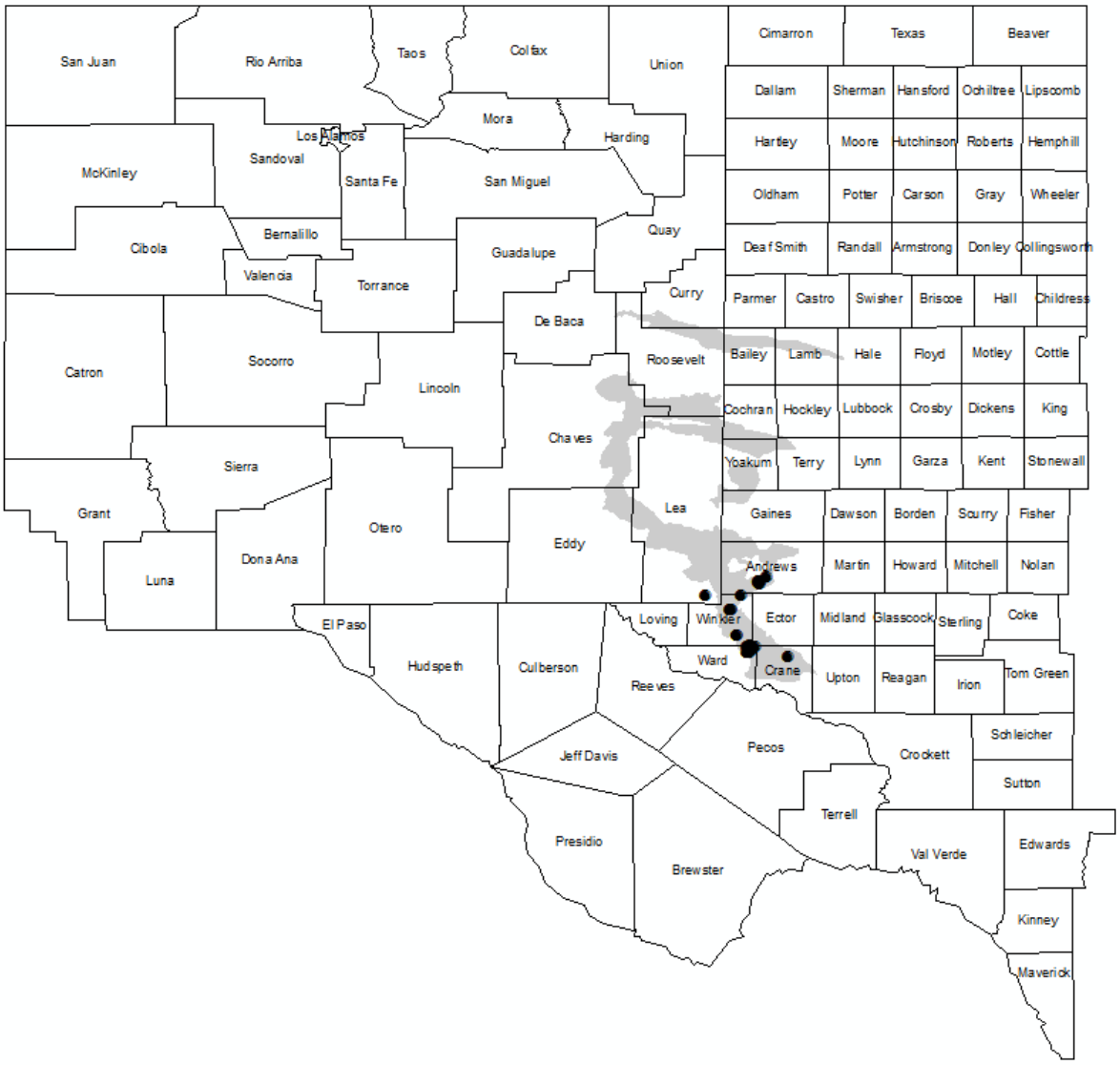


Figure 17. *Prionus arenarius*

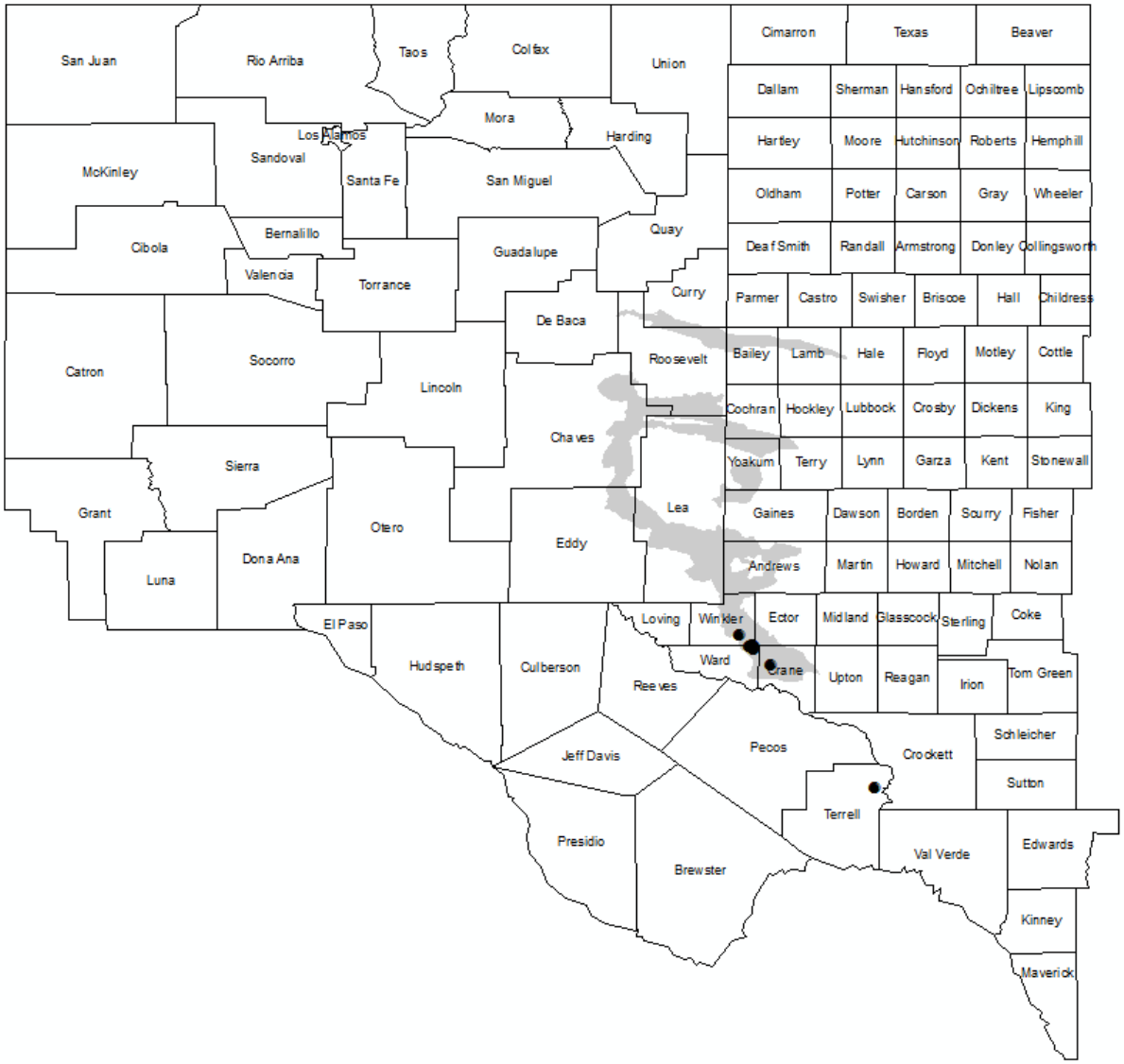


Figure 18. *Prionus spinnipenis*

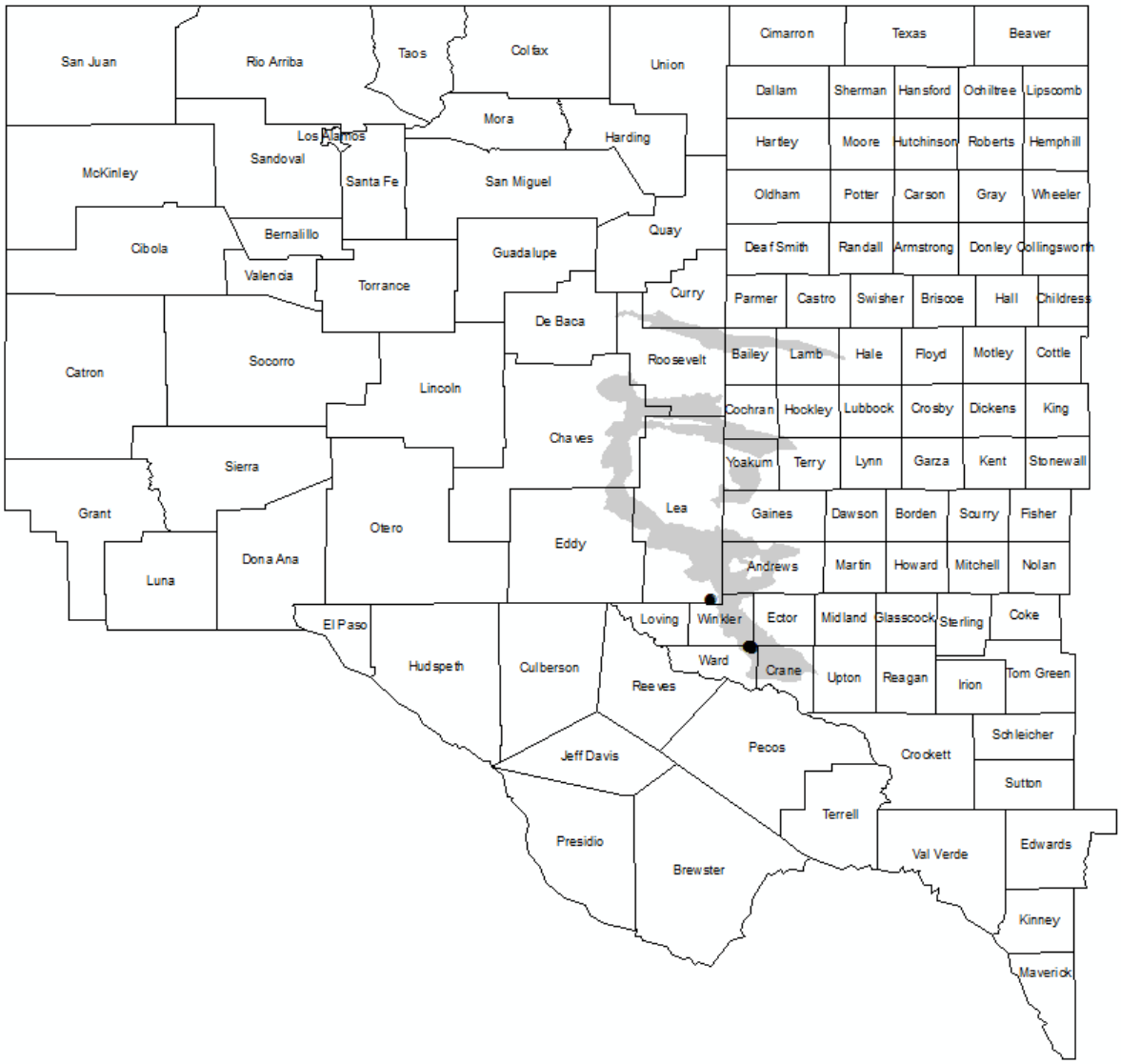


Figure 19. *Trigonoscutoides texanus*

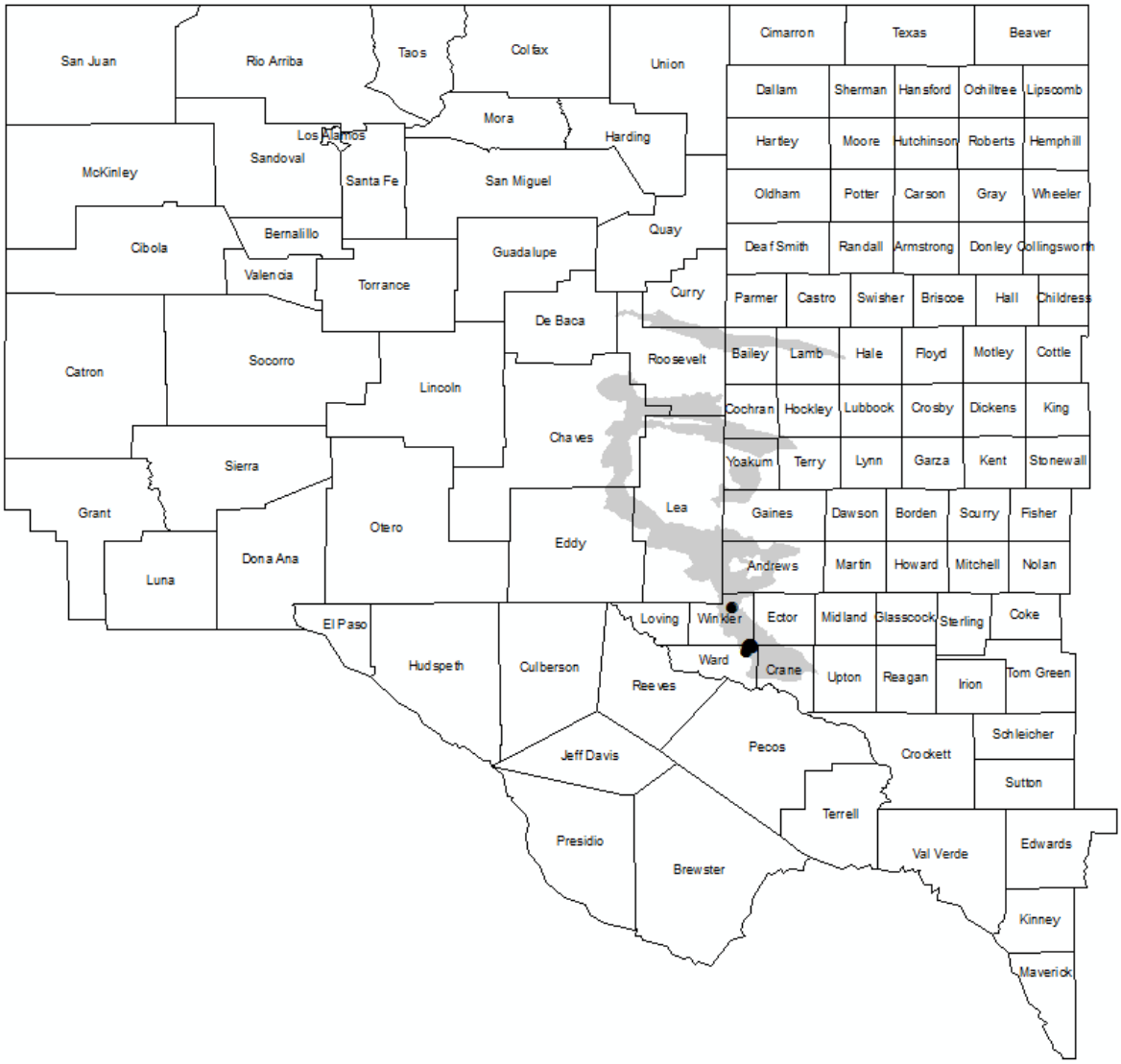


Figure 20. *Epitragosoma arenaria*

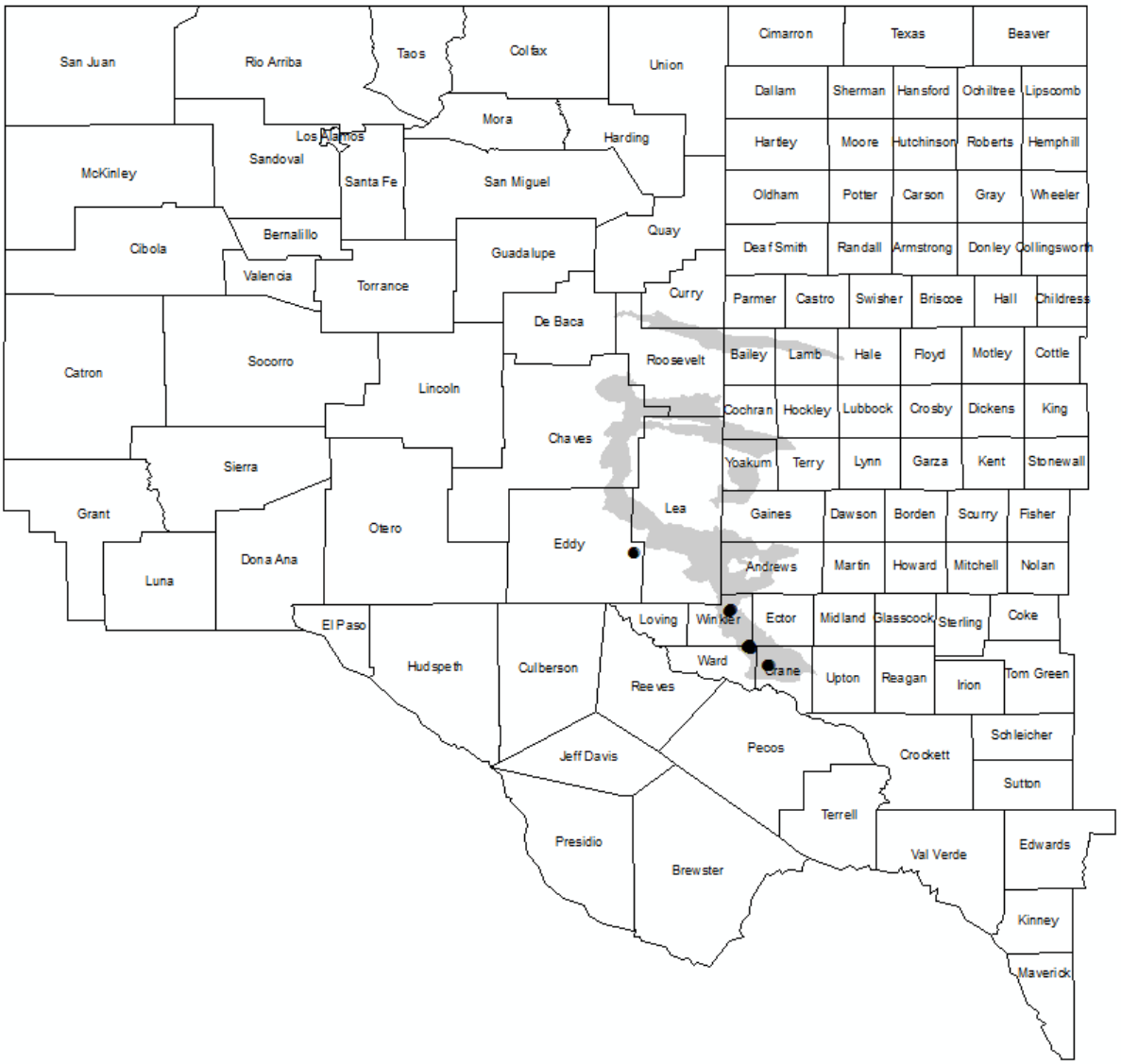


Figure 21. *Stenopelmatus monahanensis*

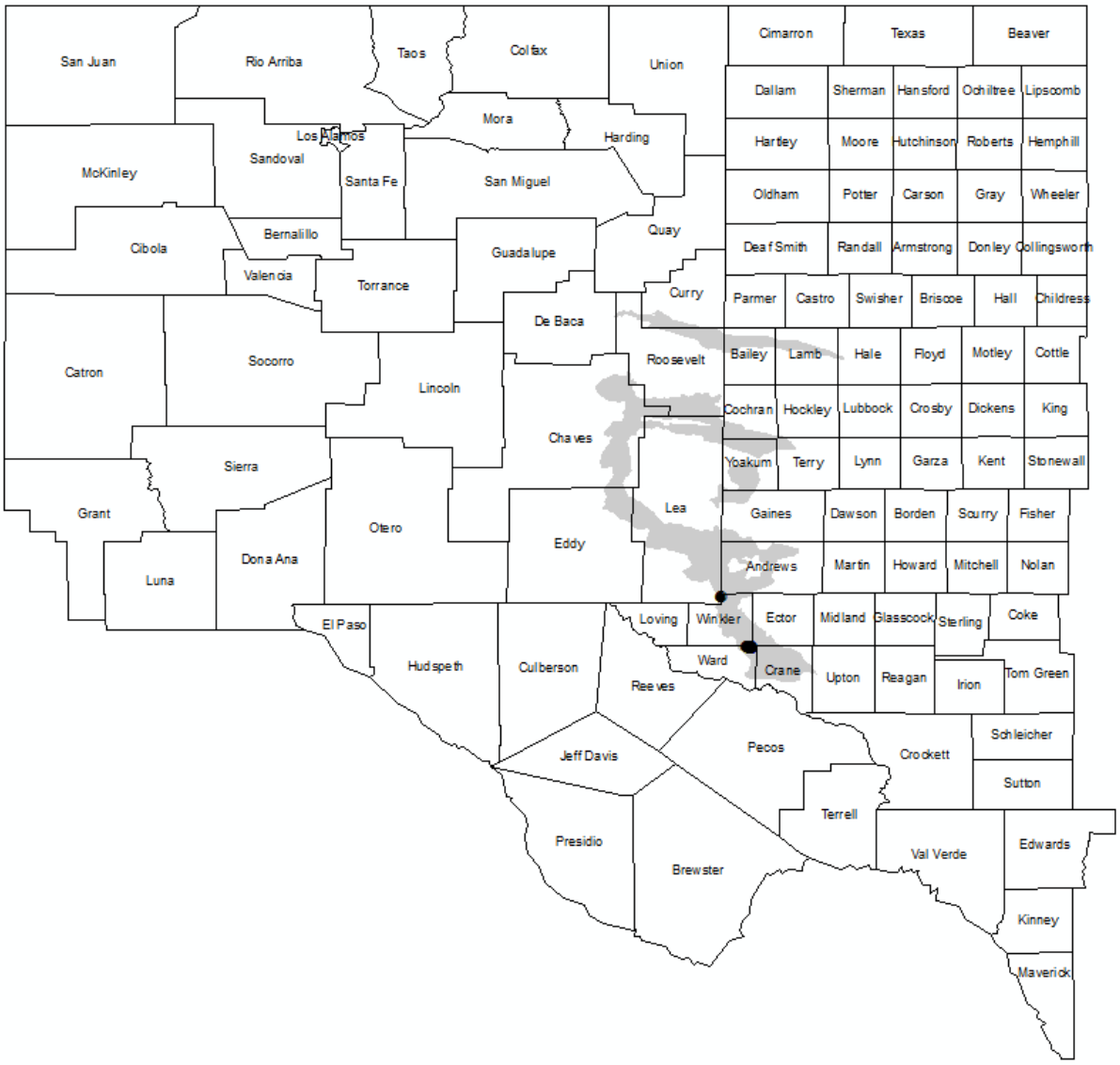
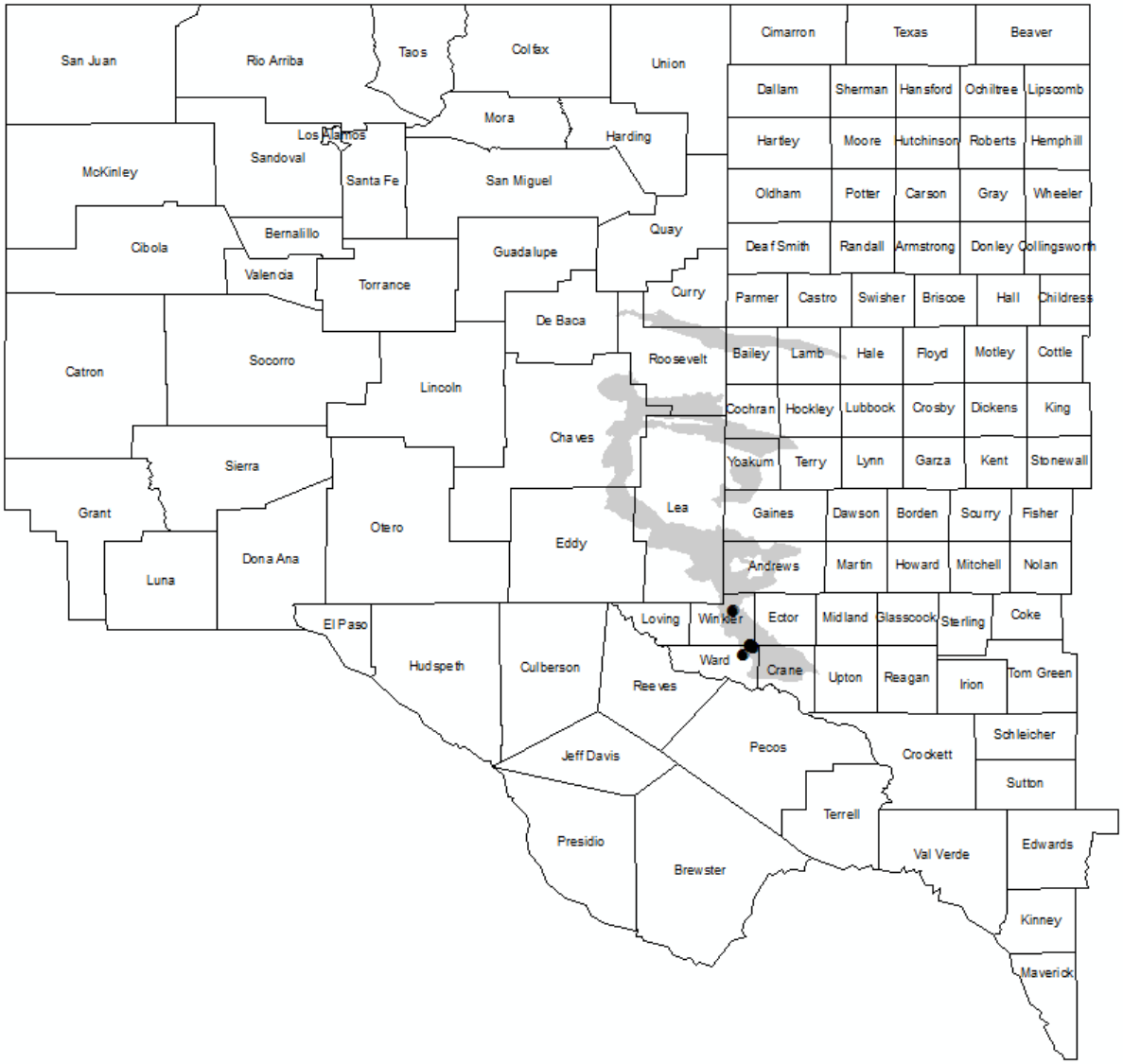
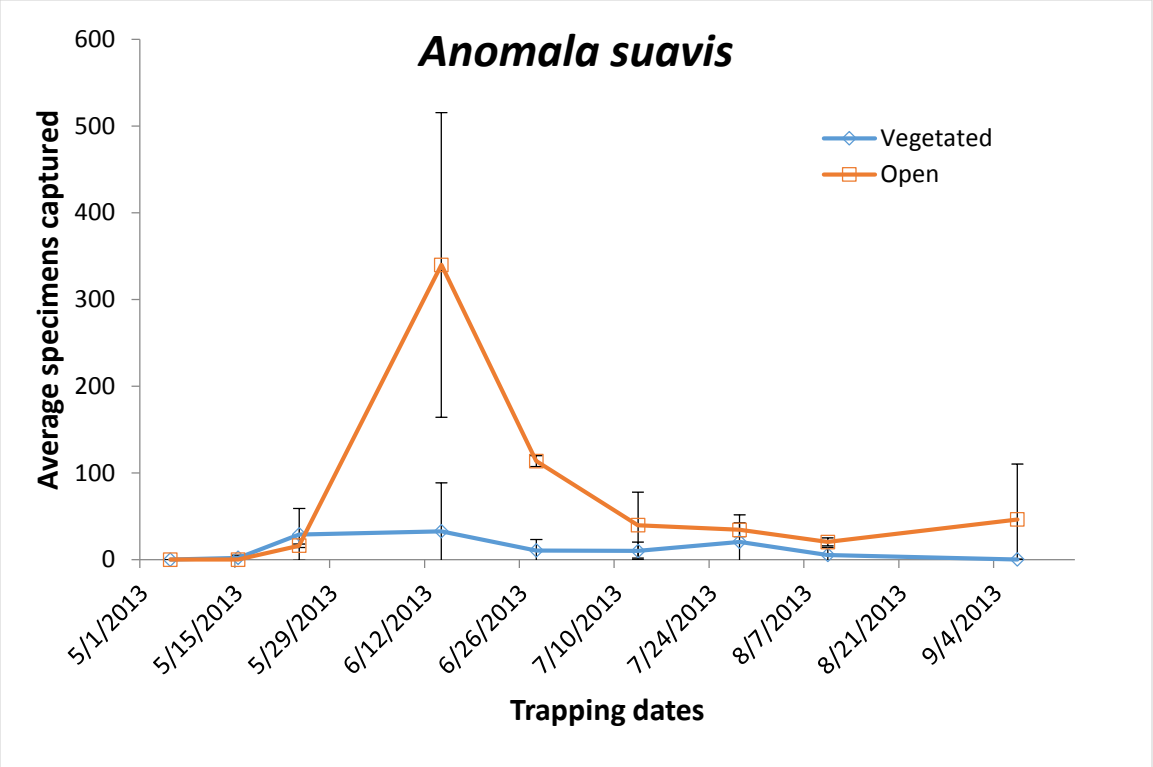


Figure 22. *Nicagus occultus*





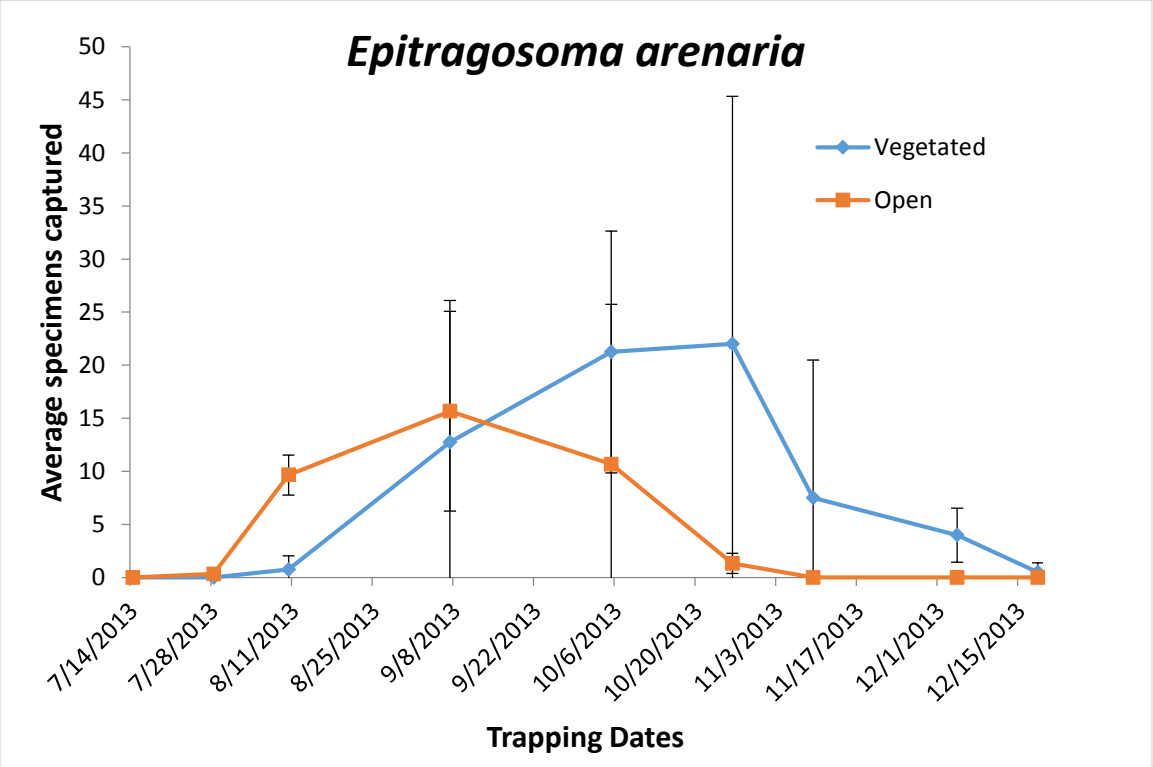
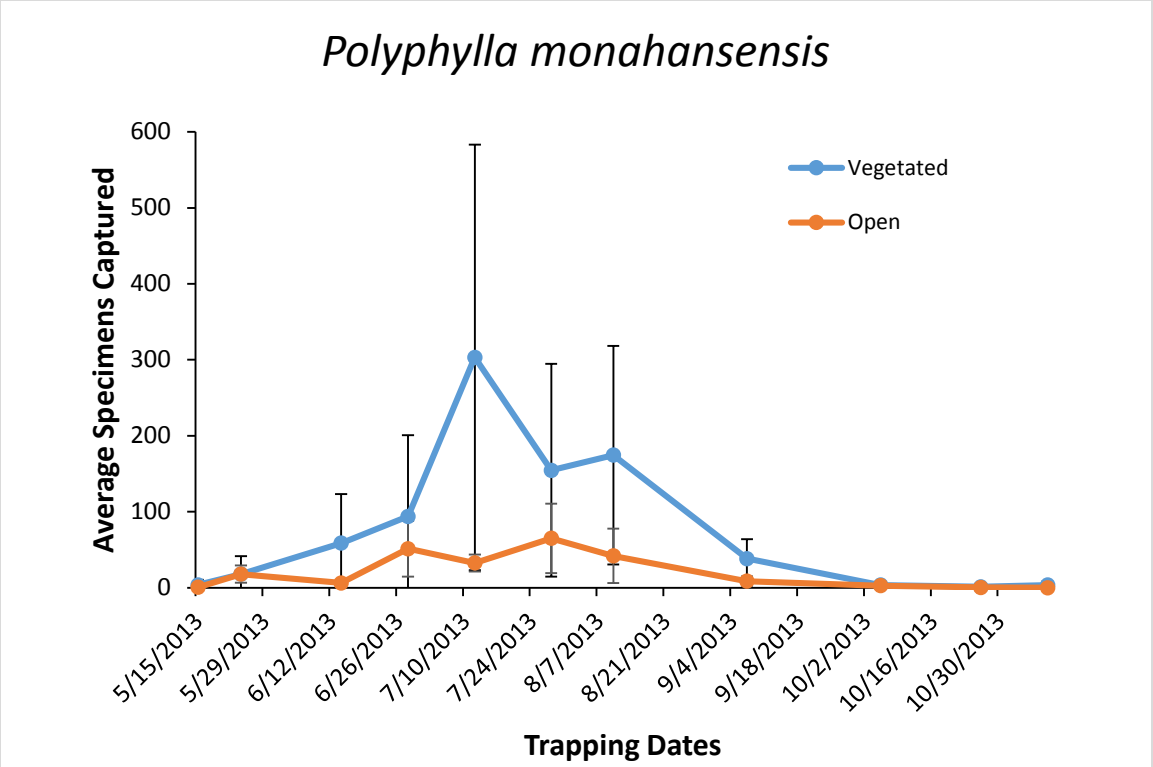


Figure 23. Seasonal emergences of *Anomala suavis* and *Epitragosoma arenaria* in 2013 among open and vegetated dunes.



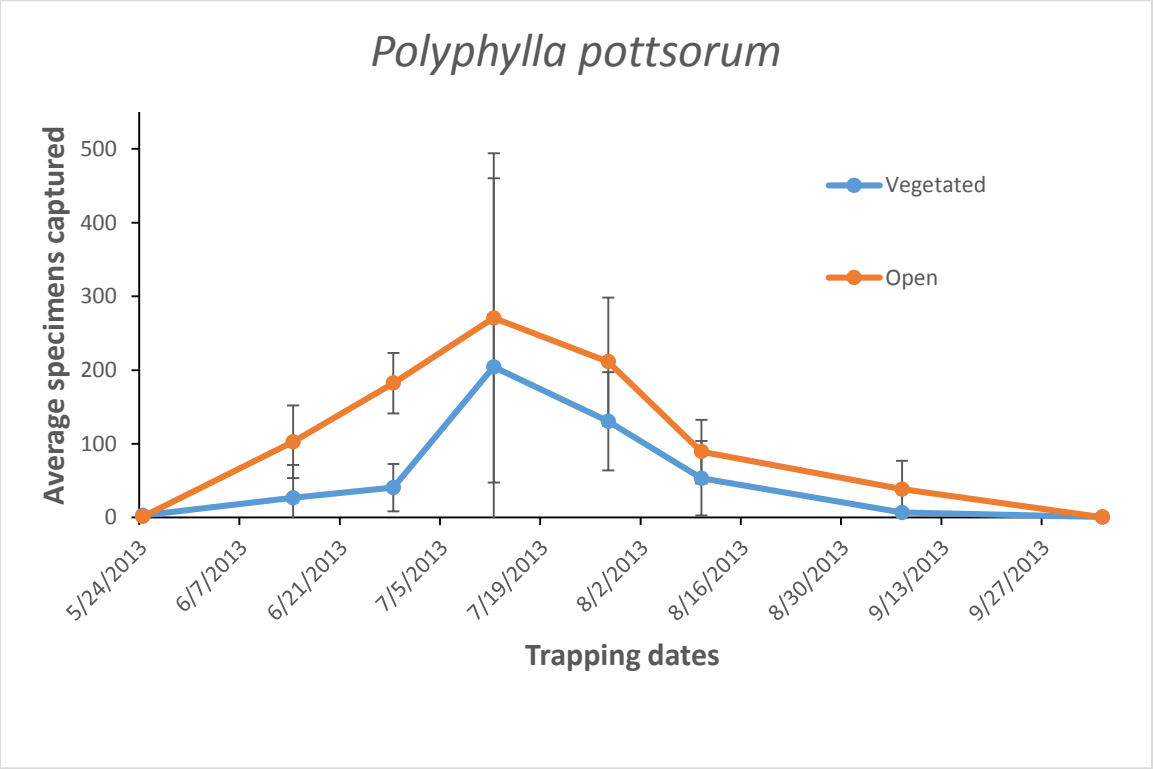
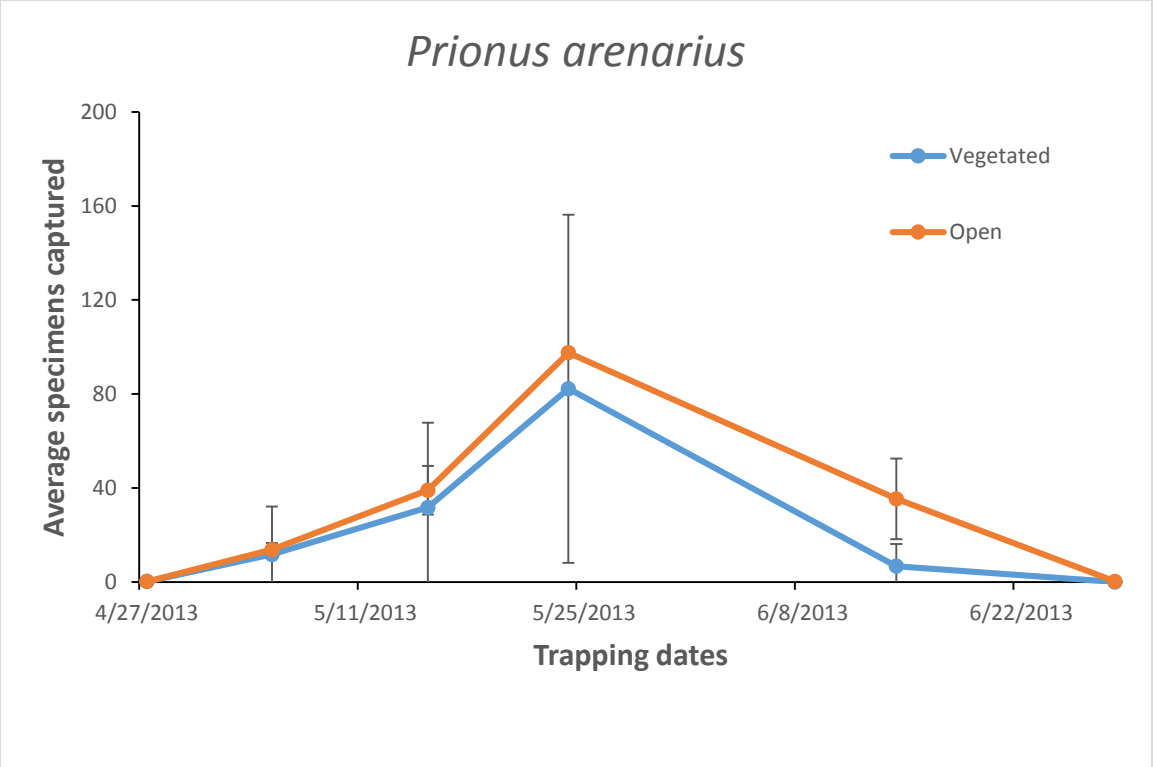


Figure 24. Seasonal emergences of *Polyphylla monahanensis* and *Polyphylla pottsorum* in 2013 among open and vegetated dunes.



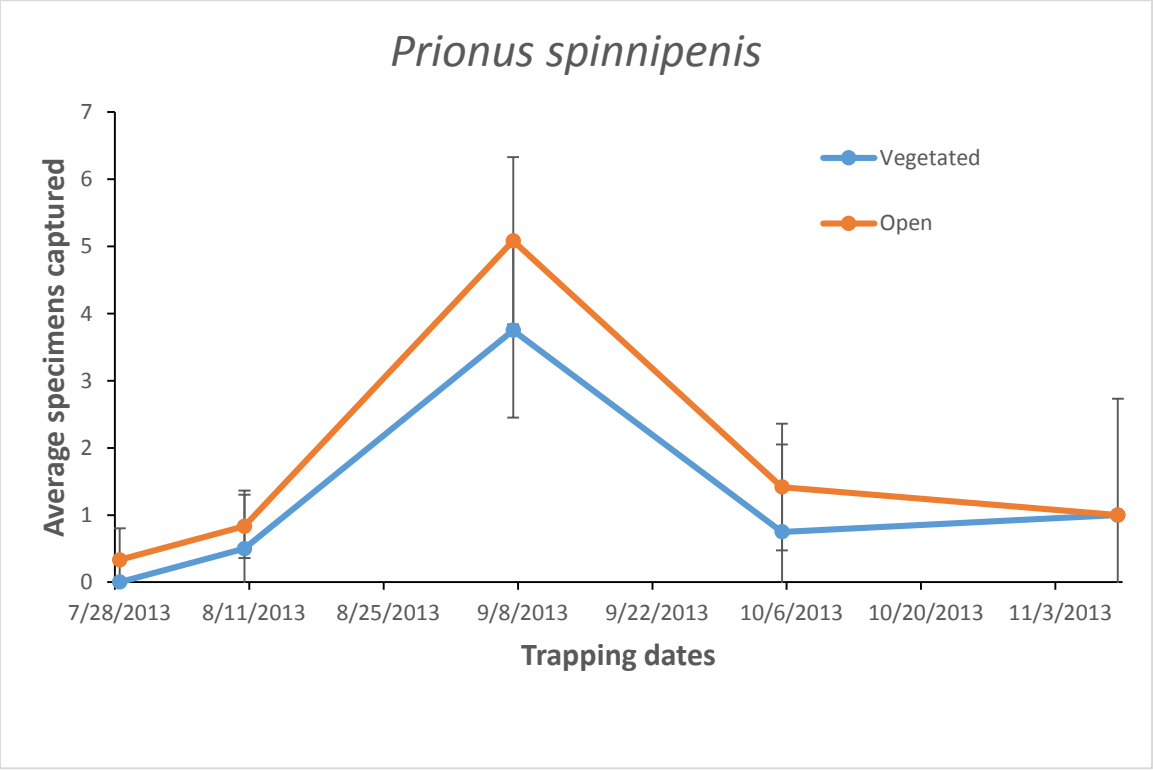
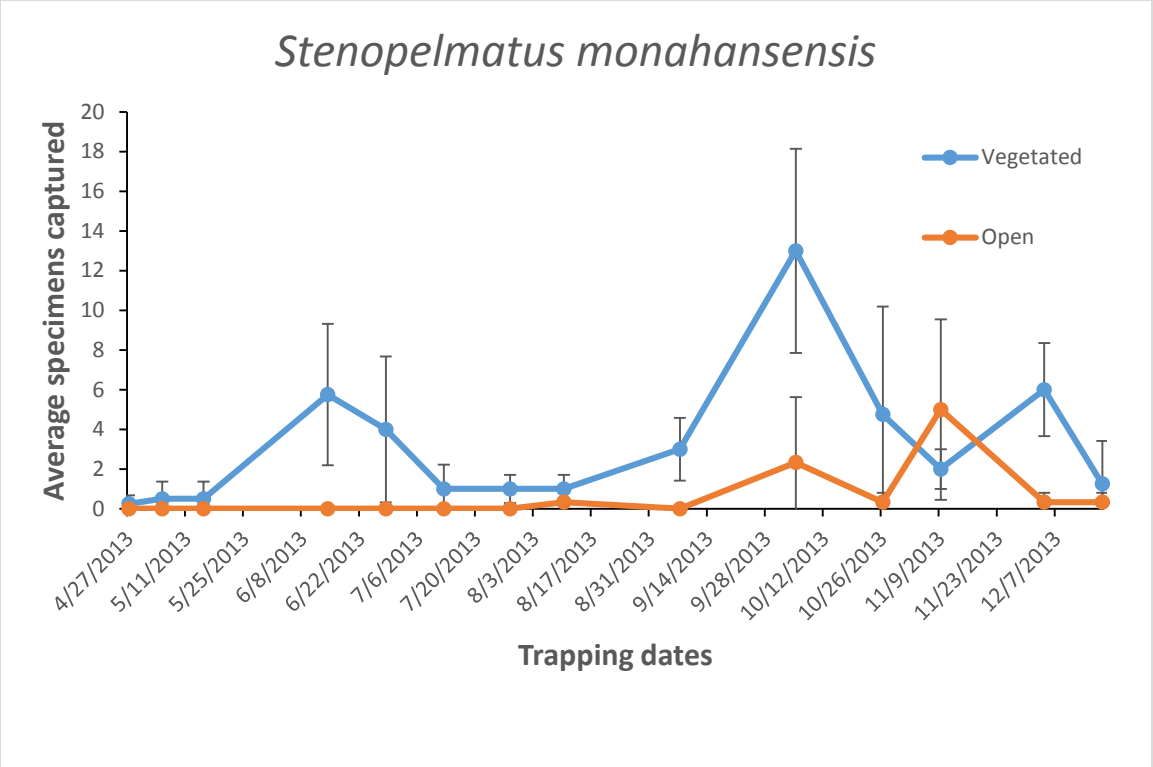


Figure 25. Seasonal emergences of *Prionus arenarius and Prionus spinnipenis* in 2013 among open and vegetated dunes.



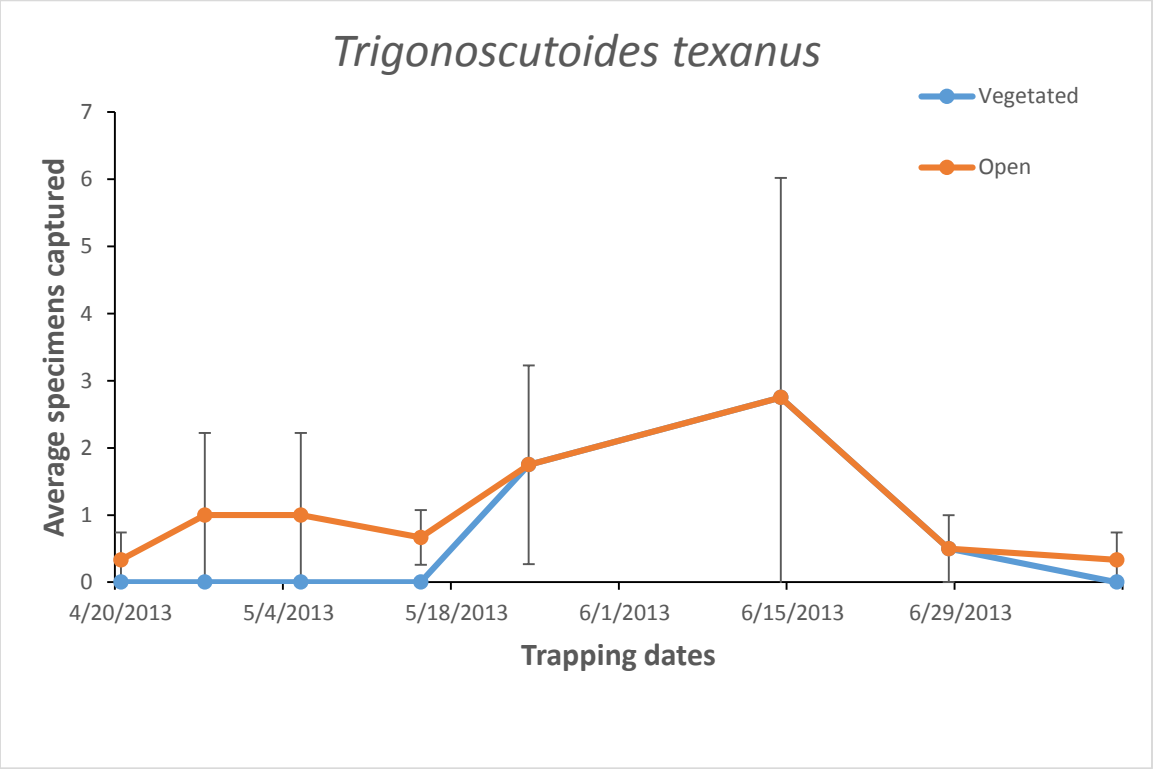


Figure 26. Seasonal emergences of *Stenopelmatus monahanensis* and *Trigonoscutoides texanus* in 2013 among open and vegetated dunes.

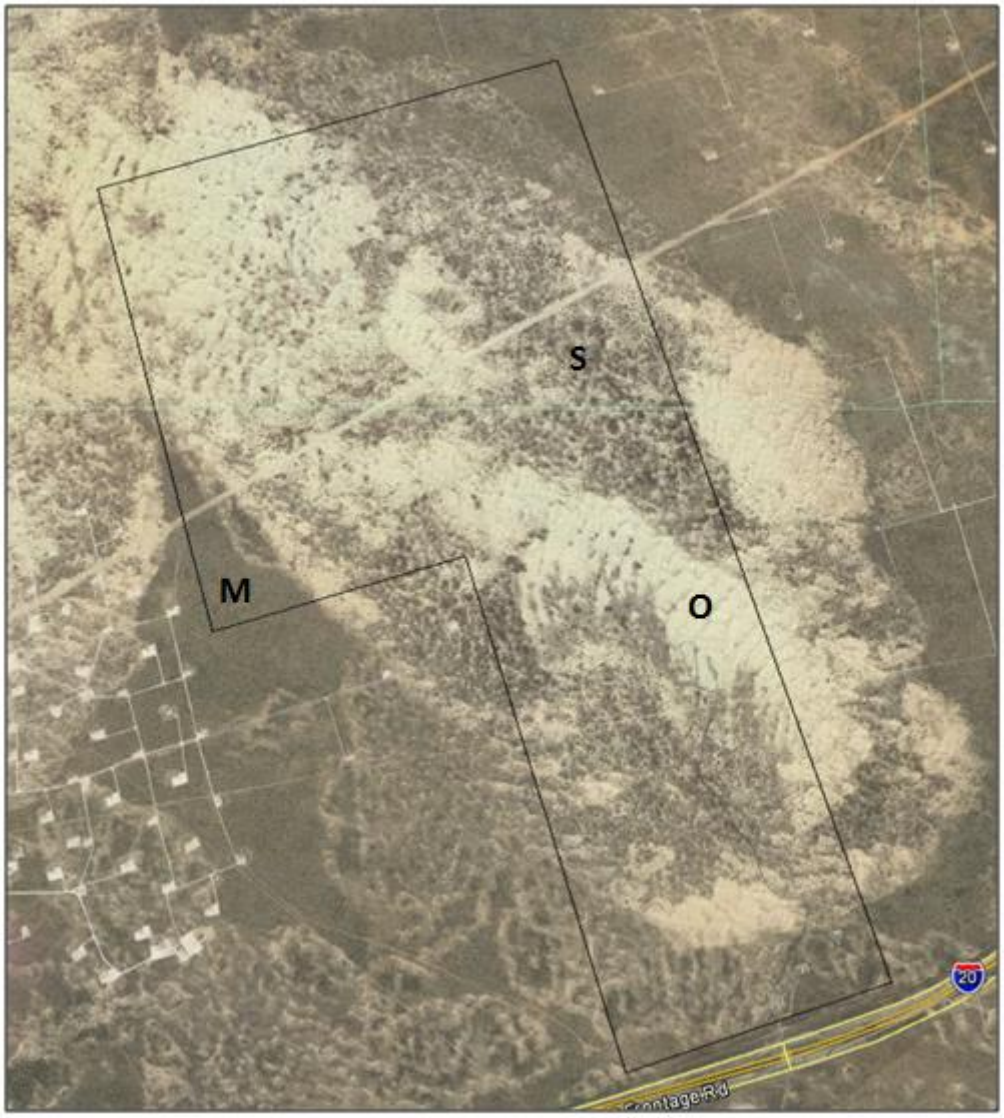


Figure 27. The Monahans Sandhuills State Park (outline) showing locations of three different habitats (M, S, O) for a field study to determine focal species occurrences and community diversity among mesquite, shin oak and open sand dunes.

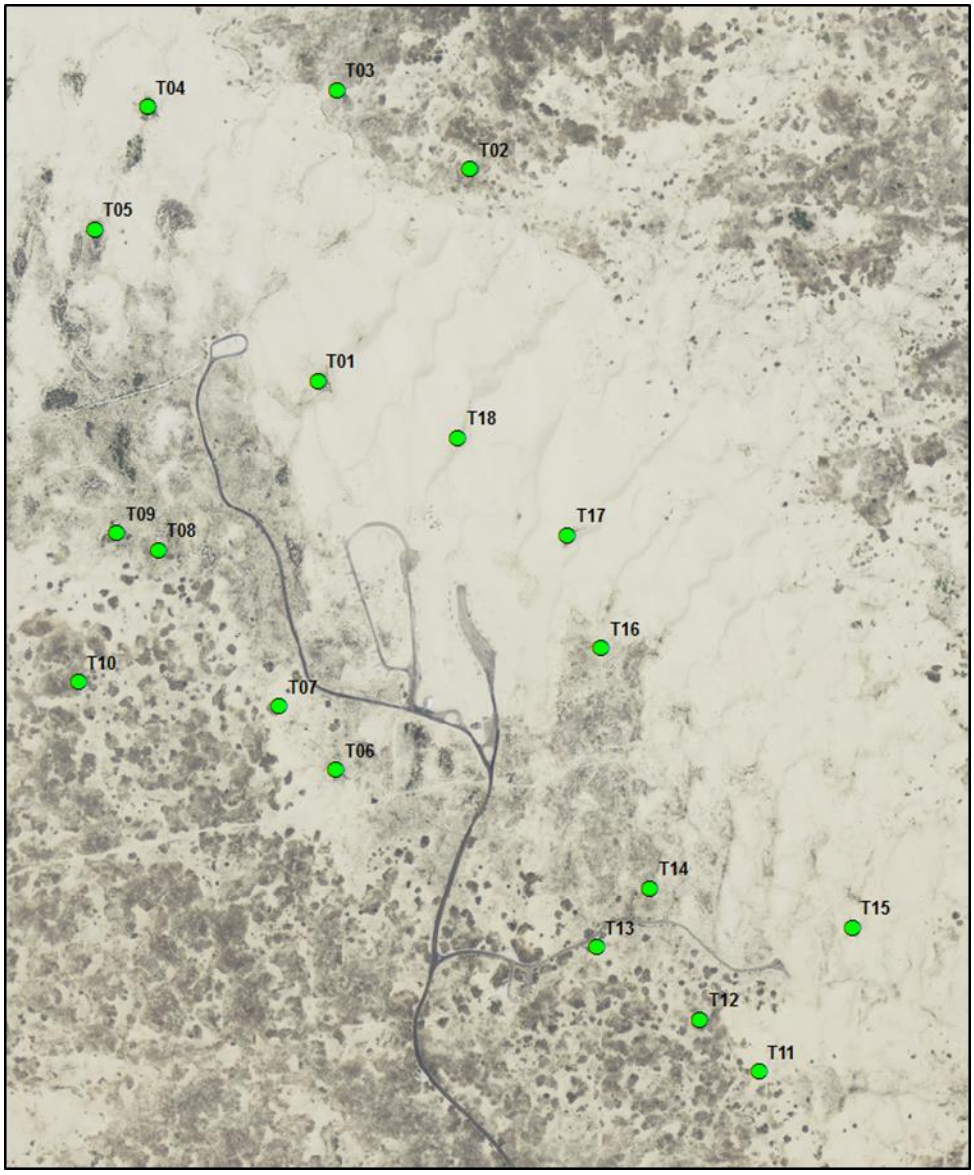


Figure 28. Monahans dune system at the Monahans Sandhills State Park. Eighteen transects were delineated among six different habitat types (n = 3 per habitat). Pitfall traps were deployed and collected at two week intervals over a three month period.

Figure 29. Pressed flowering plants collected at the Monahans Sandhills State Park. Flowering plants were collected from March through August 2014 at Monahans Sandhills State Park to quantify vegetation among our six selected habitats for the field studies (Figure 28). The flowers from the project will be displayed at Texas Tech University.

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