New Mexico meadow jumping mouse Project Report for 2015-2017

CEAP WWWG Agreement No.: 68-7482-15-505
Reporting Period: May 2015 – December 2017
Project Title: Occurrence of New Mexico meadow jumping mouse on the Apache-Sitgreaves National Forests
PI: Carol L. Chambers, P.O. Box 15018, School of Forestry, Northern Arizona University, Flagstaff, AZ 86011, E-mail: Carol.Chambers@nau.edu, Phone: 928-523-0014

Executive Summary

1. Between 2015 and 2017, we captured 110 New Mexico meadow jumping mice (*Zapus hudsonius luteus*) in Arizona (Apache-Sitgreaves National Forest, private lands) and New Mexico (Santa Fe National Forest). From these captures, we obtained 86 fecal samples for genetic analysis of diet, 63 hair samples for stable isotope analysis of diet, 77 buccal samples for future genetic analysis, and deployed 12 transmitters to determine home range and habitat use.
2. We developed non-invasive track plate to detect New Mexico meadow jumping mice. Created training video now adopted by USFWS to survey for the species in the Southwest. Publication describing the process is in review.
3. To predict habitat use, we surveyed 75 locations on the Apache-Sitgreaves National Forest in 2016, collected habitat data, and developed an occupancy model predicting probability of presence. Identified 7 habitat elements that were positively associated with presence of jumping mice: vegetation height, stream width, percent cover of alder (*Alnus* spp.), percent forb cover, presence of wild ungulates (elk, deer), soil moisture, and percent sedge cover. Identified 1 habitat element that was negatively associated with presence of jumping mice: stream gradient. Livestock grazing was negatively associated with jumping mice but not a strong predictor in this model.
4. Identified new locations for the jumping mouse outside of designated critical habitat.
5. Conducted a diet analysis using stable isotopes and metagenomics that identified jumping mice as herbivorous, feeding largely on C3 plants.
6. After identifying diet as herbivorous from stable isotopes and metagenomics, we developed an inexpensive and rapid metabarcoding assay that genetically identifies plant diet for any herbivorous species. We successfully tested it on jumping mouse, mule deer, and pronghorn. We determined that jumping mice have a diverse diet dominated by forbs and grasses that diversifies greatly in late summer and supports gain in mass prior to hibernation.
7. Calculated home ranges using Minimum Convex Polygon and 95% Kernel Probability averaged 1.21 ha and 1.05 ha, respectively. Animals remained close to streams and side drainages. They moved an average of 6 m from stream; maximum distance from stream averaged 15 m. Day nests for jumping mice were identified as grassy bolus structures near streambanks.
8. For outreach, we have drafted a Wildlife Habitat Evaluation Guide, created a video demonstrating the non-invasive track plate method, trained others in the field to use our track plate method, gave 20 presentations on research results at meetings for resource managers and scientists, and are preparing manuscripts from our work. Peer-reviewed publications provide a sound scientific basis for management decisions. We submitted a manuscript on the track plating method to Wildlife Society Bulletin which has been reviewed favorably and is in revision. We anticipate ≥ 6 additional publications from this project.
9. We acquired additional funding from Forest Service and Arizona Game and Fish Department to survey for and examine diet of New Mexico meadow jumping mice.

10. Based on the work supported by NRCS on diet of the jumping mouse, our genetics Research Specialist, Dan Sanchez, applied for and was awarded a prestigious National Science Foundation Fellowship (https://www.nsfgrfp.org/) to work on his PhD studying diet and population genetics of the New Mexico meadow jumping mouse. He was one of 2000 selected for this award of 13,000 that applied.

Research Needs
Radio telemetry in AZ and NM ($50,000)
Radio telemetry in CO ($35,000)

Justification

The New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) is considered a riparian obligate that uses tall, dense herbaceous vegetation along perennial flowing water such as streams, ditches, and wet meadows. Although jumping mice are found in riparian areas with moist soils, they also use adjacent dry upland areas beyond the floodplain to nest, bear and raise young, and hibernate. Jumping mice need high quality food sources prior to hibernation to accumulate fat reserves; seeds are thought to provide these reserves. The diet of the jumping mouse is not clearly defined but observations from other subspecies and from a small sample in New Mexico indicated they may shift from a dominance on insects shortly after emergence from hibernation in spring to seeds just before entering hibernation in fall. Surveys identified 8 geographic areas in Arizona, New Mexico, and Colorado where jumping mice occurred but some areas remain to be surveyed. Livestock grazing is thought to affect jumping mouse habitat. To develop recommendations for grazing (timing, frequency) and allow continuation of livestock grazing while promoting habitat for the jumping mouse, this study identifies distribution, habitat requirements, diet, and population parameters of the species.

Objectives

1. Conduct field surveys for jumping mice at both historic and new locations (including on private lands wherever allowed), collect non-invasive genetic samples from jumping mice and habitat data (vegetation and grazing data) at each study site.
2. Estimate probabilities of detection and occupancy for the jumping mouse and relate this to habitat data. Use these occupancy models to predict the relative probability of occupancy across the study area and map potential habitat on private lands.
3. Determine population relatedness and diet using genetic approaches from jumping mice (live and museum specimens) captured in Arizona and New Mexico. Determine patch size and connectivity needed to support jumping mice.
4. Develop effective grazing and restoration approaches for the jumping mouse.

Overview

2015

We used 2015 as a pilot year to trap sites where New Mexico meadow jumping mice were previously captured, develop a non-invasive approach to detecting jumping mice (track plating), and collect fecal and hair samples that we analyzed for diet. Our work was focused along streams that had been previously sampled on the Apache-Sitgreaves National Forests in Arizona (Frey 2011, Hicks 2014). We used these sites to test capture methods, test track plate designs, and increase the probability of capturing jumping mice for collecting fecal samples for dietary analysis. However, we also live-trapped and track plated at new locations within proposed critical habitat (Figure 1).

In May, we visited sites to assess the habitat quality of potential habitat for the jumping mouse. Information gathered from this trip along with geospatial data was used to guide site selection for trapping during the summer field season. We hired a summer field crew (5 technicians) to capture small mammals and 2 professional botanists (Judith Springer, NAU, and Kirstin Phillips, Museum of Northern Arizona) to provide detailed lists of plant species present in areas where we captured jumping mice. Field crew personnel were trained in small mammal capture and identification techniques and vegetation sampling. During the training period, the field crew also worked on the development of a track plate design and a small mammal track reference guide that could be used in the field for identification of jumping mouse tracks. We collected field data from 15 June to 18 September 2015. We used 5 weeks for live-capture methods and 5 weeks for track plate methods to sample jumping mice. Vegetation sampling was conducted at all trap sites where jumping mice were captured. All data were entered and summarized. On 10 November we presented initial results from our field season at the Apache-Sitgreaves National Forest Supervisors Office in Springerville.

2016

In summer 2016, we compared our non-invasive track plate method to live trapping at 14 sites and found similar rates of detection for jumping mice. We surveyed 75 sites (n = 59 using track plating, n = 16 using live trapping) on the Apache-Sitgreaves National Forests in Arizona (Figure 2) and developed an occupancy model to predict presence of jumping mice. At 12 sites where we detected jumping mice there were livestock grazing allotments with varying levels of grazing. We surveyed 10 sites on the Santa Fe National Forest in New Mexico (Figure 3) to identify sites where jumping mice were present. Jumping mice were captured or detected with track plates at sites outside designated critical habitat. We collected hair samples for stable isotope analysis of diet, fecal samples for genetic analysis of diet, and buccal samples for future population genetic analysis.

We hired a crew leader, field crew (5 technicians) to capture small mammals, a field crew (4 technicians) to survey vegetation and habitat structure, and a botanist to provide detailed lists of plant species present in areas that we surveyed for the jumping mouse. Field crew personnel were trained in small mammal capture and identification techniques and vegetation sampling. We surveyed for jumping mice and collected vegetation data from June to September 2016. Vegetation sampling was conducted at all sites where we surveyed for jumping mice, regardless of whether we captured the species. All data were entered and summarized. On 18 November, we presented initial results from our field season at the Apache-Sitgreaves National Forest Supervisors Office in Springerville. On 12 December, we presented results, including our occupancy model, to the Forest Service biologists meeting in Albuquerque.

2017

Between June and September 2017, we surveyed 17 locations on the Apache-Sitgreaves National Forests (Figure 4), 11 sites on the Santa Fe National Forest (Figure 5), and 10 sites on the Lincoln National Forest (Figure 6) for presence of jumping mice. Vegetation sampling was conducted at all sites where we surveyed for jumping mice, regardless of whether we captured the species. We identified occupied sites outside designated critical habitat. We collected hair samples for stable isotope analysis of diet, fecal samples for genetic analysis of diet, and buccal samples for future population genetic analysis. We conducted a radio telemetry pilot study to identify home ranges (Minimum Convex Polygon [MCP] and Kernel Density Probability [KD; 95%]) and distances moved from riparian areas on the Apache-Sitgreaves and Santa Fe National Forests. We collected vegetation data in home ranges using the cover board approach. We identified day nests constructed of grass-like materials.

For field work conducted from June to September 2017, we hired a crew leader, 4 technicians to capture small mammals, 2 technicians to survey vegetation and habitat structure, and a botanist to document plant species present in areas that we surveyed for the jumping mouse. We trained field crew personnel in small mammal capture and identification techniques and vegetation sampling. Data for track plating, trapping, habitat, and telemetry were entered and summarized.

We submitted for publication a manuscript on the track plating procedure. This paper is in review with Wildlife Society Bulletin. We trained an independent (Arizona Game and Fish Department) crew in June on track plating methods for jumping mice that they subsequently used on the Apache-Sitgreaves National Forests. On 27 November, we presented our results to the Forest Service Wildlife, Fish, and Rare Plants Session in Albuquerque.

Methods

Site selection

In 2016, to develop our occupancy model, we used a Geographic Information System (ArcGIS, ESRI, Redlands, California) to select ~100 potential sampling sites on the Apache-Sitgreaves National Forests based on our criteria for elevation (<2740 m), stream classification (perennial vs intermittent), riparian vegetation (based on RMAP and PNVT data), and distance to roads. We set a maximum distance from roads of 2 km (1.2 miles) for feasibility of access by field crews. We then randomly selected sites that met all of the above criteria and stratified these sites based on grazing and recreational use. We used 5 vegetation categories from RMAP riparian vegetation (Arizona alder, Herbaceous riparian, willow/thin leaf alder, Upper montane conifer/Willow, Ponderosa pine/willow). We used 4 riparian vegetation categories from PNVT (Cottonwood-Willow Riparian Forest, Mixed Broadleaf deciduous riparian forest, Montane Willow riparian forest, wetland/cienega riparian areas).

For other sites and years, sites were provided by National Forest personnel. In Arizona, we surveyed land in private ownership after the landowner requested surveys.

Trapping

We live trapped small mammals using non-folding Sherman traps (LNA 7.6 x 8.9 x 22.9 cm). We trapped sites in June, July, or August each year. Traps were set for 1 to 4 days; we opened traps each evening from 3 hours prior to dusk (~17:00) and dusk (~20:00), checked them each morning within 4 hours of dawn (~0500 to 0900), and closed traps during the day. During 2015, we set 40 traps along the stream channel on the bank (adjacent to water), 40 traps in the ecotone, and 40 traps in the upland to determine whether jumping mice moved beyond riparian areas. Traps were placed 3 to 5 m apart. For 2016 and 2017, we used a trapping transect at each site that consisted of 80 traps placed 3 to 5 m apart only along the stream channel on the bank where we best detected jumping mice in 2015. In 2015, we baited traps with sweet feed. We shifted to a mixture of steel-cut oats and peanuts for subsequent years as this provided a simpler bait to detect and remove during genetic analysis of diet.

For each individual captured using Sherman traps, we recorded trap number, species captured, sex, age, and reproductive condition unless high capture rates affected our ability to check traps in a timely manner. In these cases we only collected species or genus for non-target species. When jumping mice were captured, we collected all morphological information as for other species but also measured total body length, tail length, hind foot, ear length, and mass. We also collected fecal, hair, and buccal (cheek swab) samples from individual jumping mice for diet and DNA analysis. If we expected to radio collar a jumping mouse, we limited data collection to sex and mass to avoid additional stress to animals.

Track Plating

We used track plates that we developed to survey jumping mice. We trapped sites in between June and September each year. Track plates consisted of a plastic box with 2 entry holes cut into sides, a piece of self-adhesive, clear paper cut to the dimensions of the enclosure and attached sticky side up with double sided tape, and a piece of felt fabric, saturated in solution of mineral oil and carpenter's chalk. Roofing felt provided a cover that prevented precipitation from entering the enclosure. Track plates were placed 3 to 5 m apart along riparian areas (same method as with Sherman live traps). We placed bait along the top or edge of the felt pad of the enclosure to attract rodents to the boxes. Track plates were checked for 2 to 4 days. Details of this method are presented in the track plate training video we created: https://www.youtube.com/watch?v=i2x0Ydc1XVM.

Vegetation and Habitat

Plant richness and dominance

Vegetation data were collected at sites that were track plated or trapped. Richness and dominance of plants were collected between June and October. A botanist surveyed riparian, ecotone, and upland areas along each trap site and identified plant species present in the survey area. Each survey area was ~250 x 500 m and encompassed the riparian area that included the trap transect as well as the ecotone and upland on either side of the riparian area. Dominance used the Daubenmire Cover Class categories (0 = 0%, 1 = >0 – 5% [midpoint = 2.5%], 2 = 5 – 25% [15%], 3 = 25 – 50% [37.5%], 4 = 50 – 75% [62.5%], 5 = 75 – 95% [85%], 6 = 95 – 100% [97.5%]).

Structure

We collected structure and habitat data which consisted of stream characteristics (e.g., gradient, width), elevation, aspect, vegetation height (total and laid over), Robel pole measurements, grazing sign, recreation, and beaver sign. Vegetation data were also collected at the microhabitat level using Daubenmire plots at 34% of the trap locations at each site (40 of 120 traps per site in 2015, 27 of 80 traps per site in 2016 and 2017). We collected vegetation data at all sites where we captured New Mexico meadow jumping mice.

Following development of our occupancy model in 2016, we reduced the number of variables collected but added sign of recreation. For 2016 and 2017, we used logistic regression in a preliminary analysis to compare vegetation and habitat features between sites with and without presence of jumping mice.

Diet Analysis

We used 3 techniques to analyze diet of jumping mice: isotope analysis, metagenomics, and metabarcoding. Isotope analysis was conducted on hair samples to determine long term trends in diet because carbon and nitrogen stable-isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) from assimilated foods are incorporated into tissues (e.g., hair) of the consumer. In general, $\delta^{15}N$ is enriched 3 to 5 per mil from producer to consumer and thus indicate trophic feeding level. Diet can also be described based on carbon-isotopic distinction between C_3 (dicots, cool-season grasses) or C_4 (warm-season grasses) plants.

Using metagenomics we identified species (e.g., plants, vertebrates, invertebrates, bacterial pathogens) present in the feces and the dominance of each in the fecal sample. This approach indicated the focus of metabarcoding should identify plant species present in feces. We continue to barcode plants found in the study areas and believed to be diet items that are not yet in the Barcode of Life Database (BOLD; Ratnasingham and Hebert 2007). By barcoding new species, we are better able to identify diet items to species. Presently we are confident in our identification to genus and for some plants, to species.

For analysis of fecal DNA, we collected feces from traps in which we captured a jumping mouse using the sample preservation and DNA extraction methods of Walker et al. (2016). In brief, we PCR-amplified a plant-specific ITS2 region (Chen et al. 2010) in fecal DNA of jumping mice and recorded the sequence mixtures in parallel using an Illumina MiSeq. We then classified taxonomy for each sequence using a naïve Bayes classifier (RDP) that we trained on a global, plant DNA database (Barcode of Life Database).

Telemetry

We radio collared 12 jumping mice (10 males, 2 females) in July and August on 2 national forests (Apache-Sitgreaves and Santa Fe). To limit handling stress, only sex of the animal was taken although for several animals we were also able to take mass. We used 0.47 g BD-2XC transmitters (Holohil Systems Ltd, Ontario, Canada) fitted with a 25 to 27 mm TYGON sleeve to cover the antenna wire and prevent abrasion to the neck of the animal. We used the antenna wrapped through the collar to attach to the animal. Total mass of the BD-2XC collar including sleeve and crimp was ~0.6 g. To minimize effects to the animal we limited mass of the collar to <5% of its body mass (i.e., a 0.6 g collar should be placed on an animal >12 g).

We attempted ≥1 observation per day and ≥3 observations per night per animal. We approached each animal to within 1 to 10 m, using red lights and minimizing talking to avoid disturbing the animal. At each location we placed a white pin flag, recorded observations about the habitat (vegetation, distance to stream) and location (estimated accuracy, whether we saw the animal or not). We separated locations by 1.5 hrs and varied whether we collected data during the first (dusk to 01:00) or second part (23:00 to dawn) of the night.

We used ArcGIS to map data for home range analysis. We calculated Minimum Convex Polygon (MCP) and Kernel Density Percentiles (KD; 95%) for each animal. The Percentile map was based on the number of pixels inside each contour line, such that 95% meant that 95% of pixels were inside the line. We calculated average and maximum distance animals moved from the stream. We calculated average and maximum distance between successive nocturnal locations for each jumping mouse. We also calculated maximum distance from the centroid by finding the centroid of all the locations for an animal, and calculating the distance from that centroid. These measurements might indicate how far a jumping mouse could travel.

We mapped stream locations using National Hydrology Dataset (NHD) Flowline data, the best general stream dataset available to us. We manually revised the flowlines when we knew an error existed. We calculated the distance from stream as the distance, in meters, to the closest point on the nearest flowline. We calculated maximum distance from flowline to determine furthest distance each animal moved from streams during our surveillance period as well as average distance and standard deviation of average distance moved from streams based on all locations.

We used a Cover Board Method (USDA Forest Service and USDI Bureau of Land Management 1999) to quantify the vegetation structure and composition for locations used by jumping mice within their home ranges. One person, botanist G. Billings, sampled all sites to avoid bias and classified plants to species. For locations with multiple white pin flags indicating use by a jumping mouse over multiple nights and times and ≤5 to 8 m apart, we sampled only 1 centrally-located point. We randomly selected a compass bearing for the first of 4 plots per location placed 4.57 m from the flag, thereafter shifting 90° for the other 3 plots.

Results

Trapping and Track Plating Comparison

From Jun to Sep 2015, we tested 4 enclosure designs (track plates) for accessibility, protection from weather, and efficiency of data collection. In the field, we concurrently tested the 4 enclosure types at 3 sites, setting 20 track plates at each site for one week of track plating. We selected the modified shoebox as our preferred trap plate design (Harrow et al. In review).

We collected 1 to 13 tracks each from 21 individuals representing 6 species: New Mexico meadow jumping mice (n = 5, mean number of tracks per individual ± *SE*: 3.6 ± 0.7), long-tailed vole (*Microtus longicaudus*; n = 3, 7.3 ± 2.9), Mogollon vole (*M. mogollonensis*, n = 3, 7.3 ± 0.9), montane vole (*M. montanus*, n = 5, 4.4 ± 1.4), brush mice (*Peromyscus boylii*; n = 2, 9 ± 0), and deer mice (*P. maniculatus*; n = 3, 7.3 ± 1.8). The larger tracks of chipmunks and woodrats made them clearly distinguishable from tracks of jumping mice so we did not statistically compare them. Although we did not capture shrews (*Sorex* spp.) during our project, we did capture them in subsequent tests. Their tracks, smaller than those of mice and voles, were easily distinguishable from those of jumping mice. Tracks for sympatric species (voles and deer mice) were readily distinguishable from those of jumping mice. The toes on the forefoot of jumping mice were elongated compared to voles and deer mice ($X^2 \geq 13.49$, $P \leq 0.02$) although we did not detect differences in forefoot pad width and length between jumping mice and sympatric species ($X^2 \leq 8.85$, $P \geq 0.12$).

We selected the best tracks for jumping mice and sympatric species to create a track field photo reference. Technicians and those reviewing track plates used the photo reference for identification of tracks during or after field trials of track plate enclosures and comparisons of track plate enclosures with live capture methods.

We captured jumping mice at 10 of 16 sites and identified tracks of jumping mice at 9 of 16 sites (Table 1). Detection differed between the track plate and trapping methods at only 1 site. At this site, we captured a jumping mouse but did not detect tracks. Thus both techniques detected jumping mice similarly, regardless of the technique we tested first (Spearman's rho = 0.83, $P < 0.0001$). In addition, capture rates of jumping mice (number of animals captured per 100 TN) positively correlated with detection by track plating (number of track plate enclosures with tracks per 100 TN; Table 1, Figure 7), suggesting track plates could indicate relative abundance of jumping mice at a site (Pearson's rho = 0.50, $P = 0.047$, Table 1).

Small mammal trapping and track plating

We captured or detected jumping mice at 50 of 134 sites in Arizona and New Mexico (Table 2). These sites represented 3 (Unit 3 Jemez Mountains Santa Fe National Forest, Unit 4 Sacramento Mountains Lincoln National Forest, Unit 5 White Mountains Apache-Sitgreaves National Forests) of 8 geographic management units in Arizona, Colorado, and New Mexico designated by the US Fish & Wildlife Service (US Fish and Wildlife Service 2016). Jumping mice were detected at 36 of 103 sites on the Apache-Sitgreaves National Forest (Unit 5), 13 of 21 sites on the Santa Fe National Forest (Unit 3), and 1 of 10 sites on the Lincoln National Forest (Unit 4).

During 12,100 trap nights (TN) from 3 years (2015, 2016, 2017) on 2 National Forests (Apache-Sitgreaves and Santa Fe), we captured 2537 small mammals (Table 3). Captures were dominated by deer mice and montane voles, but jumping mice represented 4.4% of animals. We captured 20 jumping mice in 2015 (12 females, 8 males), 55 in 2016 (28 females, 27 males), and 37 in 2017 (14 females, 23 males). Because of the small population size on the Lincoln National Forest, we did not trap small mammals to avoid injury or mortality to jumping mice.

Vegetation and Habitat - Plant richness and dominance

We sampled vegetation at 123 sites. For the Apache-Sitgreaves National Forests, we sampled 75 sites in 2016 and 17 sites in 2017 and identified 702 plant species. For the Santa Fe National Forest, we sampled 10 sites in 2016 and 11 in 2017 and identified 476 plant species. For the Lincoln National Forest, we sampled 10 sites in 2017 and identified 305 plant species. In total, we identified 786 plant species at 113 sites.

Only 2% of plant species occurred at 90% of sites (Table 4), indicating high diversity in these riparian sites. Across all sites, richness averaged 116 plant species (± 2 *SE*). The Santa Fe National Forest had highest mean richness per site (126 species ± 7), with lower richness on the Apache-Sitgreaves (114 ± 3 species) and Lincoln (110 ± 5 species) National Forests. Mean species richness of introduced (non-native) plants was highest on the Lincoln National (17 ± 1 species) and Santa Fe (16 ± 1 species) National Forests compared to the Apache-Sitgreaves National Forests (10 ± 0.4 species). However, introduced plant species accounted for only 11% (± 5 *SE*) of richness across all sites.

Dominant life forms at sites were graminoids (mean percent cover ± *SE*: 10.9 ± 0.5), trees (9.9 ± 0.6), and shrubs (8.2 ± 0.4). Forbs and ferns averaged 5.6% ± 0.3 and 4.9% ± 0.5, respectively. Dominant plants were graminoids and trees for each forest (Figure 8).

Data analysis is ongoing. We expect to describe vegetative communities in riparian areas with different overstories (e.g., willow, alder), compare vegetative characteristics of sites with and without jumping mice, and contrast availability of food sources with diet we detected genetically from feces of jumping mice.

Vegetation and Habitat - Structure

Vegetation cover measured at a microhabitat scale (Daubenmire plots) indicated differences between National Forests. The Lincoln National Forest had lowest cover of grasses of the three forests, although forb and sedge cover were comparable (Figure 9). Vegetation height (total and laid over) was substantially lower on the Lincoln National Forest compared to the other forests (Figure 10).

Soil moisture in riparian areas was high (>7) at all sites, with highest mean soil moisture on the Lincoln National Forest (Figure 11). Mean stream width was greater for the Apache-Sitgreaves and Santa Fe National Forests than the Lincoln National Forest. Mean stream gradient was highest on the Lincoln National Forest (Figure 11).

We found evidence of active beaver (*Castor canadensis*) at only 5 and 2 sites on the Apache-Sitgreaves and Santa Fe National Forests, respectively (Figure 12). However, wild ungulates were observed at >40% of sites on all National Forests. We observed signs of livestock at >70% of sites on the Santa Fe and Lincoln National Forests (Figure 12).

Occupancy Model for Apache-Sitgreaves National Forests

We detected jumping mice using track plates, traps, or both techniques at 21 sites; we did not detect mice at 54 sites (Figure 2). We used occupancy modeling to predict habitat used by jumping mice. Our global model contained 13 variables (Table 5). Seven variables were strong predictors (cumulative AIC weight >0.5) and one (percent sedge cover) was a moderately strong predictor (cumulative AIC weight 0.3 to 0.5). Based on our model, jumping mice selected sites with taller vegetation, wide, low-gradient streams with high soil moisture, higher alder, forb, and sedge cover, and presence of wild ungulates such as deer and elk (Figure 13A-H).

Logistic Regression for Apache-Sitgreaves, Santa Fe, and Lincoln National Forests

Data analysis is ongoing and we will compare vegetation (richness, dominance, structure). A preliminary analysis comparing sites with presence of jumping mice to those without jumping mice found that plant species richness, percent cover of bare ground, total vegetation height, stream width, sedge and alder cover were strong predictors (Table 6). These variables were higher or greater at sites where we captured jumping mice. Based on this model, jumping mice select sites with high plant species diversity, taller vegetation, wider streams with some exposed ground cover, and higher alder, forb, and sedge cover.

Diet Analysis

We sampled 75 C_3 plants (30 from ASNF, 16 from Lincoln National Forest, and 29 from Santa Fe National Forest) for carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) to compare plant isotope signatures with hair collected from 109 jumping mice captured from May and September between 1981 and 2017. For plants, means and standard error (*SE*) for $\delta^{13}C$ averaged -28.63 ± 0.15 (range -31.61 to -26.26). Values for $\delta^{15}N$ for plants averaged 1.21 ± 0.23 (range -4.26 to 6.72) (Figure 14). For jumping mice, means and *SE* for $\delta^{13}C$ averaged -23.17 ± 0.23. Values for $\delta^{15}N$ for jumping mice averaged 5.79 ± 0.16 (Figure 14).

Metagenomics for a subset of jumping mice (n = 9) captured in Arizona in 2015 suggested a diverse diet with mice feeding from a variety of plant families (Table 7). We found little evidence of invertebrates in the diet of jumping mice but did identify the presence of parasites (tapeworms, roundworms, pinworms). Three of 9 jumping mice tested did have high levels of *Escherichia coli*; the strain present in mice is pathogenic but we are uncertain of its origin (e.g., humans, livestock, wildlife).

We collected or obtained feces from 82 individual jumping mice captured during their active season between 2016 and 2017 in Arizona, New Mexico, and Colorado. We captured animals during summer (June, July, August) on the Apache-Sitgreaves and Santa Fe National Forests (2016-2017). We obtained samples from jumping mice captured in September on the Lincoln National Forest (n = 1, 2016), and in October on the Southern Ute Indian Reservation in Colorado (n = 10, 2017). These samples represented 5 of the 8 geographic management units designated for the species in the Southwest and were collected from 18 unique sites.

Genetically, we identified 89 genera in the diet of 82 jumping mice (Figure 15), with individuals consuming an average of 7.9 ± 0.6 (*SE*) genera per individual (range 1 – 18 genera). Forbs dominated diet although we also detected grasses and other plant life forms in the diet (Figure 15). During telemetry sessions, we observed a jumping mouse feeding on pale knotweed flowers (*Persicaria lapathifolia*) at night (Animal ID 151.342) and Kentucky bluegrass seeds (*Poa pratensis*; Animal ID 150.180) during the day.

Jumping mice dramatically increased in mass in August prior to hibernation (Figure 16). Diet richness was greatest in August to October compared to June and July (Figures 17 and 18) and forbs appeared to dominate the diet throughout most of the active period of the jumping mouse (Figure 19). Forbs appear important diet items in late summer for gain in mass prior to hibernation.

Telemetry

Of 12 jumping mice collared (8 on Santa Fe and 4 on Apache-Sitgreaves National Forests), 6 retained collars throughout the study period (>10 days, >30 locations) and 1 retained his collar for 7 days (23 locations) (Table 8). Animals that lost collars usually did so within 1 day. For 6 individuals from Arizona and New Mexico, home range for MCP and 95% Kernel Density averaged 1.21 ha and 1.05 ha, respectively. Home ranges for 3 individuals on Santa Fe National Forest averaged 2.79 ha for MCP and 1.56 for 95% KD and were larger than those for 3 individuals on Apache-Sitgreaves National Forests (1.21 ha for MCP, 1.05 for 95% KD).

For both national forests, MCP home ranges for females (2.31 ha, n = 2) were larger than for males (1.85 ha, n = 2) (Table 8). KD (95%) home ranges for females and males averaged 2.26 ha and 0.83 ha, respectively (Table 8). Jumping mice moved an average of 8 m from streams (range 5 to 12 m; Table 8) and an average maximum distance of 21 m (11 to 36 m; Table 8). The maximum distance from farthest point averaged 336 m. Jumping mice stayed close to riparian areas and used side drainages (Figure 20, Figure 21).

From cover board measurements, we identified 177 plant species in home ranges for 6 jumping mice (Figure 22). Total percent cover ranged from 30 to 59% (Figure 22). No plants dominated all home ranges although spike bentgrass (*Agrostis exarata*) occurred in all home ranges (1.3 to 11.3% cover). Gray alder (*Alnus incana*) occurred in 5 of 6 home ranges (2.8 to 26.1% cover).

We located 9 day nests for 6 jumping mice; they were constructed of grasses and leaves woven together to form an egg-shaped nest approximately 13 cm long and 9 cm diameter (Figure 23). Nests were under cover of grasses (n = 7, small trees (Gambel oak [*Quercus gambelii*], New Mexican locust [*Robinia neomexicana*]; n = 2), or forbs (n = 1). Nests were ≤10 m from streams and outside the flood plain. We genetically identified 5 to 6 plant genera per nest used by jumping mice to construct nests (Figure 24).

Discussion

Jumping mice occupied riparian habitat and were identified in areas outside designated critical habitat. The track plating method that we developed was a successful, non-invasive approach for monitoring jumping mice; USFWS is asking those monitoring the species to use our methods.

Although plant species composition did not appear dramatically different among the sites that we monitored, structure varied and may help explain presence of jumping mice. Vegetation height appeared to be very important both in our occupancy model and our preliminary logistic regression model. If composition persists, allowing plant growth may be a simple approach to improving habitat. Stream width also appeared in both models and may reflect the flood potential and soil moisture levels that maintain stable riparian systems and thus habitat for jumping mice.

Diet for jumping mice was diverse and plant-based based on stable isotope and metabarcoding genetic analyses. Jumping mice appeared to feed on a range of plant species focused on C_3 plants. Insectivory was rare. Instead, jumping mice consumed a diverse diet primarily consisting of forbs and grasses which also included sedges, rushes, shrubs, and trees. Whitaker (1963) described animals foraging on flowers and seeds rather than leaves and roots of plants. Dietary richness increased prior to hibernation and diet items were primarily forbs. We are continuing to examine diet and will conduct a multi-gene diet survey for plant (using plant bar codes ITS2 and rbcL), insect (using CO1 gene), and fungi (ITS bar code) identification. This approach will allow us to confirm plants (using 2 barcodes instead of 1) and may definitively exclude insects and fungi in the diet.

Our pilot telemetry project resulted in home ranges for 6 individuals with successful deployment of 6 out of 12 transmitters. We gained a better understanding of radio collar fit and were able to recapture animals from day nests using a butterfly net after attempts to recapture animals with Sherman traps failed. Home ranges for 6 individuals were somewhat larger than those observed by Wright (2012). Our efforts represented a range active periods for jumping mice (mid-summer versus late summer) and may reflect differences in food, activity, location, or population. Despite checking during day, most movement occurred at night.

Maximum distance from the previous nocturnal location averaged 153 m. Wright (2012) found distance traveled between successive telemetry locations on Bosque del Apache NWR was twice as large at 300 m. Wright (2012) also found that the maximum distance travelled between two successive points by meadow jumping mice on Bosque del Apache NWR was 744 m in contrast to our smaller measurement of 232 m. Jumping mice on the National Forests appeared to travel shorter distances than those on Bosque del Apache NWR.

The animals that we monitored stayed close to streams, moving only 36 m away. However, average distances were closer (12 m from streams). This species relied largely on riparian vegetation for food and cover.

One animal on the Santa Fe National Forest (ID 151.222) moved a long distance from a side stream to her nest in 25 min, approximately 500 m, using the riparian corridor and moving mostly upstream. This estimates potential movement at 20 m per min. We noted a number of occasions for most animals when jumping mice used streams for travel as indicated by change in telemetry signal (i.e., it was underwater).

Data reduction and analyses are in progress.

Literature Cited

Chambers, C. L. and R. R. Doucett. 2008. Diet of the Mogollon vole as indicated by stable isotope analysis (δ13C and δ15N). Western North American Naturalist 68:153-160.

Chen, S., Yao, H., Han, J., Liu, C., Song, J., Shi, L., & Luo, K. 2010. Validation of the ITS2 region as a novel DNA barcode for identifying medicinal plant species. PloS one, 5(1), e8613.

DeNiro, M.J. and S. Epstein. 1981. Influence of diet on the distribution of nitrogen isotopes in animals. Geochimica et Cosmochimica Acta 45:341–351.

Frey, J. K. 2011. Inventory of the meadow jumping mouse in Arizona. Arizona Game and Fish Department Heritage Grant Final Report, 114 pp. Arizona Game and Fish Department, Phoenix, Arizona.

Harrow, R. L., V. J. Horncastle, and C. L. Chambers. 2018. Track plates detect the endangered New Mexico meadow jumping mouse. Wildlife Society Bulletin. In revision.

Hicks, H. 2014. New Mexico Meadow Jumping Mouse Surveys – 2012 Summary Report, Apache Sitgreaves National Forest. Nongame and Endangered Wildlife Program Technical Report 278. Arizona Game and Fish Department, Phoenix, Arizona.

Kelly, J. F. 2000. Stable isotopes of carbon and nitrogen in the study of avian and mammalian trophic ecology. Canadian Journal of Zoology 78:1–27.

US Fish and Wildlife Service. 2016. 50 CFR Part 17 Designation of critical habitat for the New Mexico meadow jumping mouse. Final Rule.

Ratnasingham, S., and Hebert, P. D. 2007. BOLD: The Barcode of Life Data System (http://www. barcodinglife. org). Molecular Ecology Resources, 7(3), 355-364.

Walker, F. M., Williamson, C. H., Sanchez, D. E., Sobek, C. J., & Chambers, C. L. 2016. Species from feces: order-wide identification of Chiroptera from guano and other non-invasive genetic samples. PloS one, 11(9), e0162342.

Wang, Q., Garrity, G. M., Tiedje, J. M., & Cole, J. R. 2007. Naive Bayesian classifier for rapid assignment of rRNA sequences into the new bacterial taxonomy. Applied and environmental microbiology, 73(16), 5261-5267.

Whitaker, Jr., J. O. 1963. A study of the meadow jumping mouse, *Zapus hudsonius* (Zimmerman), in central New York. Ecological Monographs 33:215-254.

Wright, G. D. 2012. Multiple scale habitat selection by a small mammal habitat specialist (*Zapus hudsonius luteus*) in a managed floodplain landscape. New Mexico State University, Las Cruces. Thesis.

Outreach

Trained Arizona Game and Fish Department interns in track plating (June 2017)

Training video for track plating New Mexico meadow jumping mice: Tracking Big Feet (October 2016) https://www.youtube.com/watch?v=i2x0Ydc1XVM

NAU team finds endangered jumping mouse in Arizona and New Mexico, KNAU (August 2016) http://knau.org/post/nau-team-finds-endangered-jumping-mouse-arizona-and-new-mexico#stream/0

Presentations

_2018_

C. Chambers, Vegetation structure and composition in occupied and non-occupied New Mexico meadow jumping mouse sites (March), New Mexico Meadow Jumping Mouse Science Update Meeting, Durango, CO

C. Chambers, Home ranges, nest structures, and vegetative composition within home ranges of New Mexico meadow jumping mouse (March), New Mexico Meadow Jumping Mouse Science Update Meeting, Durango, CO

D. Sanchez, F. Walker, and C. Chambers, Diet determination using metagenomics and stable isotopes and metabarcoding (March), New Mexico Meadow Jumping Mouse Science Update Meeting, Durango, CO, Presented by Daniel Sanchez

C. Chambers, Non-invasive track plating detection method for New Mexico Meadow Jumping Mouse (March), New Mexico Meadow Jumping Mouse Science Update Meeting, Durango, CO

C. Chambers, V. Horncastle, Occupancy model for the Apache-Sitgreaves National Forest (March 2018), New Mexico Meadow Jumping Mouse Science Update Meeting, Durango, CO

D. Sanchez, A. L. Dikeman, F. M. Walker, V. Horncastle, and C. L. Chambers, The Salad Within: Herbivorous Diet of the New Mexico Meadow Jumping Mouse, Arizona/New Mexico Chapters of The Wildlife Society 51st Joint Annual Meeting (February), Presentation

A. Dikeman, D. Sanchez, V. Fofanov, F. Walker, and C. Chambers, Tracking Escherichia Coli Infections of the Endangered New Mexico Meadow Jumping Mouse (Zapus hudsonius luteus), Arizona/New Mexico Chapters of The Wildlife Society 51st Joint Annual Meeting (February), Presentation

J. Lyman, A. Dikeman, D. Sanchez, F. Walker, and C. Chambers, My nest is best: Analyzing nest composition of the endangered New Mexico meadow jumping mouse (Zapus hudsonius luteus), Arizona/New Mexico Chapters of The Wildlife Society 51st Joint Annual Meeting (February), Poster

<u>2017</u>

M. Miller, S. Tuttle, B. Southerland, and C. L. Chambers, *Geomorphic analysis of New Mexico meadow jumping mouse (Zapus hudsonius luteus) habitat*, The Wildlife Society 24th Annual Conference (September), Invited Speaker

C. Chambers, V. Horncastle, G. Billings, and J. Springer. *MOM knows best: Mouse occupancy reveals habitat of an endangered rodent*, The Wildlife Society 24th Annual Conference (September), Invited Speaker

D. Sanchez, A. Dikeman, F. Walker, V. Horncastle, and C. Chambers, *Salad within: Genetically identifying diet of an endangered species*, The Wildlife Society 24th Annual Conference (September), Invited Speaker

A. Dikeman, D. Sanchez, V. Fofanov, F. Walker, and C. Chambers, *Tracking Escherichia coli infections of the endangered New Mexico meadow jumping mouse*, The Wildlife Society 24th Annual Conference (September), Invited Speaker

D.E. Sanchez, A.L. Dikeman, F.M. Walker, V. Horncastle, and C.L. Chambers, *Salad within: Genetically identifying diet of an endangered species*, 14th Biennial Conference of Science and Management on the Colorado Plateau & Southwest Region (September), Presentation

A. Dikeman, D.Sanchez, V. Fofanov, F. Walker, and C. Chambers, *Tracking Escherichia coli infections of the endangered New Mexico meadow jumping mouse (Zapus hudsonius luteus)*, 14th Biennial Conference of Science and Management on the Colorado Plateau & Southwest Region (September), Presentation

C.L. Chambers, V. Horncastle, G. Billings, and J. Springer, *MOM knows best: Mouse Occupancy Modeling reveals habitat of an endangered rodent*, Arizona/New Mexico Chapters of The Wildlife Society 50th Joint Annual Meeting (February), Presentation

D.E. Sanchez, A.L. Dikeman, F.M. Walker, V. Horncastle, and C.L. Chambers, *Varied herbaceous diet of the New Mexico meadow jumping mouse revealed by DNA metabarcoding*, Arizona/New Mexico Chapters of The Wildlife Society 50th Joint Annual Meeting (February), Presentation

C. Chambers, J.G. Martinez-Fonseca, R. Harrow, and V. Horncastle, *Tracking big feet: detecting New Mexico meadow jumping mice with track plates*, Arizona/New Mexico Chapters of The Wildlife Society 50th Joint Annual Meeting (February), Poster and Video

A. Dikeman, D. Sanchez, F. Walker, and C. Chambers, *ITS2 good to be true: an optimal metabarcoding approach to determine diet of herbivores* Arizona/New Mexico Chapters of The Wildlife Society 50th Joint Annual Meeting (February), Presentation **(2nd place in Best Arizona Student Paper Competition)**

<u>2016</u>

C. L. Chambers, V. Y. Fofanov, V. Horncastle, J. Springer, S. Tuttle, and F. M. Walker, Reducing risks while maintaining a working landscape: Livestock grazing in endangered mouse habitat, The Wildlife Society 23rd Annual Conference (October), Invited Speaker

C.L. Chambers, J. Springer, K. O. Phillips, V. Horncastle, F.M. Walker, J. Frey, and V. Y. Fofanov, The diverse world of New Mexico meadow jumping mouse, Arizona/New Mexico Chapters of The Wildlife Society 49th Joint Annual Meeting (February), Presentation

Publications

In revision

Harrow, R. L., V. J. Horncastle, and C. L. Chambers. Track plates detect the endangered New Mexico meadow jumping mouse. Wildlife Society Bulletin. In review.

Publications in preparation

Chambers, C. L., J. Frey, and V. Fofanov. Diet of the New Mexico meadow jumping mouse as indicated by stable isotope analysis (δ13C and δ15N).

Chambers, C. L., D. Sanchez, K. Yasuda. Home ranges and summer day nests of New Mexico meadow jumping mice.

Horncastle, V. and C. L. Chambers. New Mexico meadow jumping mouse occupancy reveals habitat of an endangered rodent.

Sanchez, D., A. Dikeman, F. Walker, V. Horncastle, and C. Chambers. Varied herbaceous diet of the New Mexico meadow jumping mouse revealed by DNA metabarcoding.

Chambers, C. L., G. Billings, J. Springer, D. Sanchez. A comparison of plant communities at sites with and without New Mexico meadow jumping mice.

Sanchez, D. G. Billings, J. Springer, C. Chambers. Use versus availability of plants as diet items by the New Mexico meadow jumping mouse.

Grants

2018

Habitat use and diet of the New Mexico meadow jumping mouse in the Southwest, USDA Forest Service, $187,000 (Funded)

2017

Identifying and predicting habitat for the New Mexico meadow jumping mouse (Zapus hudsonius luteus), Conservation Effects Assessment Project (CEAP), $50,000 (Funded)

Occurrence and diet of the New Mexico meadow jumping mouse on Apache-Sitgreaves National Forests, USDA Forest Service, $50,000 (Funded)

Occurrence and diet of the New Mexico meadow jumping mouse on Santa Fe National Forest, USDA Forest Service, $50,000 (Funded)

Occurrence and diet of the New Mexico meadow jumping mouse on Lincoln National Forest, USDA Forest Service, $50,000 (Funded)

2016

Identifying and predicting habitat for the New Mexico meadow jumping mouse (Zapus hudsonius luteus), Conservation Effects Assessment Project (CEAP), $50,000 (Funded)

2015

Identifying and predicting habitat for the New Mexico meadow jumping mouse (Zapus hudsonius luteus), Conservation Effects Assessment Project (CEAP), $149,283 (Funded)Occurrence and diet of the New Mexico meadow jumping mouse on the Apache-Sitgreaves National Forests, USDA Forest Service, Apache-Sitgreaves National Forests, $135,000 (Funded)

2014

New Mexico meadow jumping mouse surveys and habitat modeling in Arizona, Arizona Game & Fish Department Heritage IIAPM Program, $49,079 (Funded)

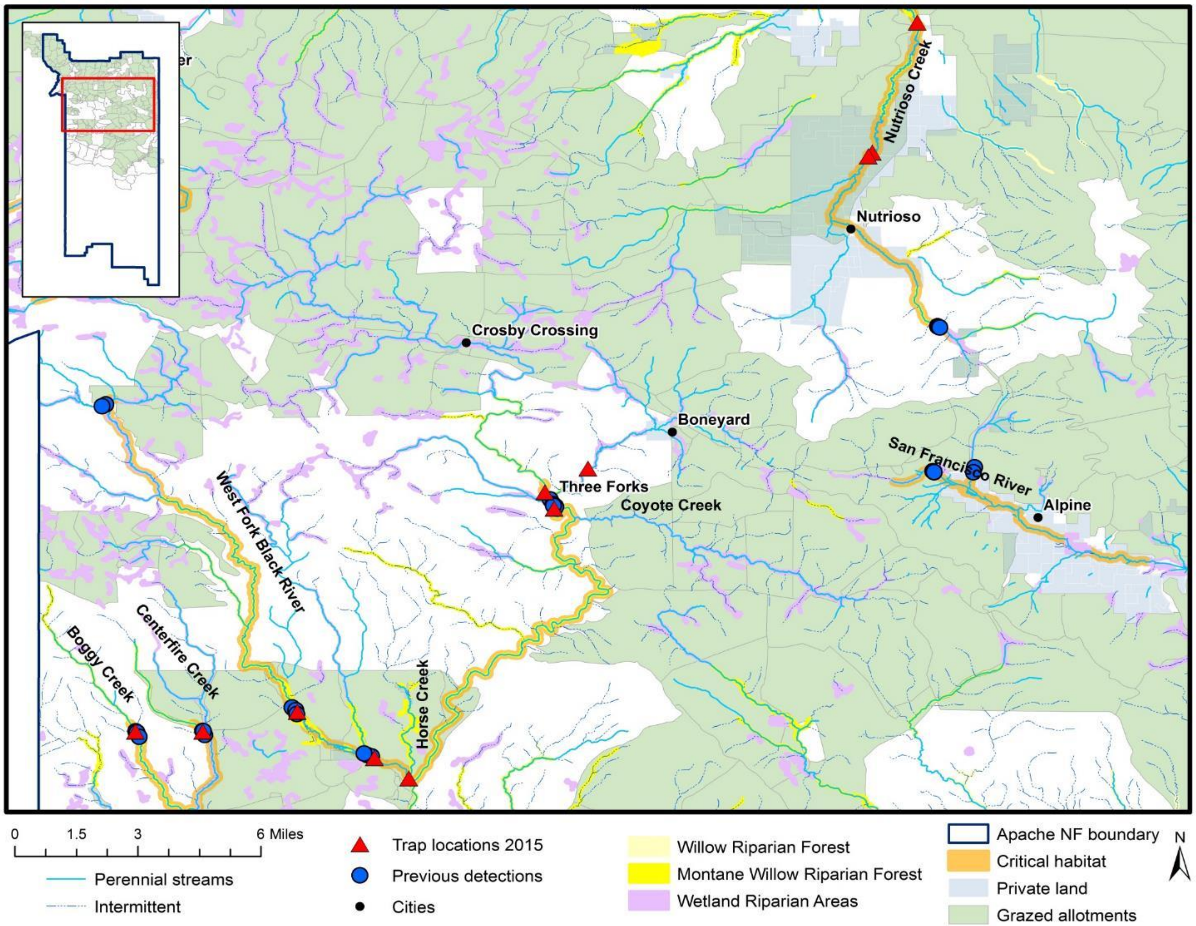


Figure 1. Trap site locations for the 2015 pilot field season and previously known New Mexico meadow jumping mouse detections (Frey 2011, Hicks 2014) for the Apache-Sitgreaves National Forests, Arizona.

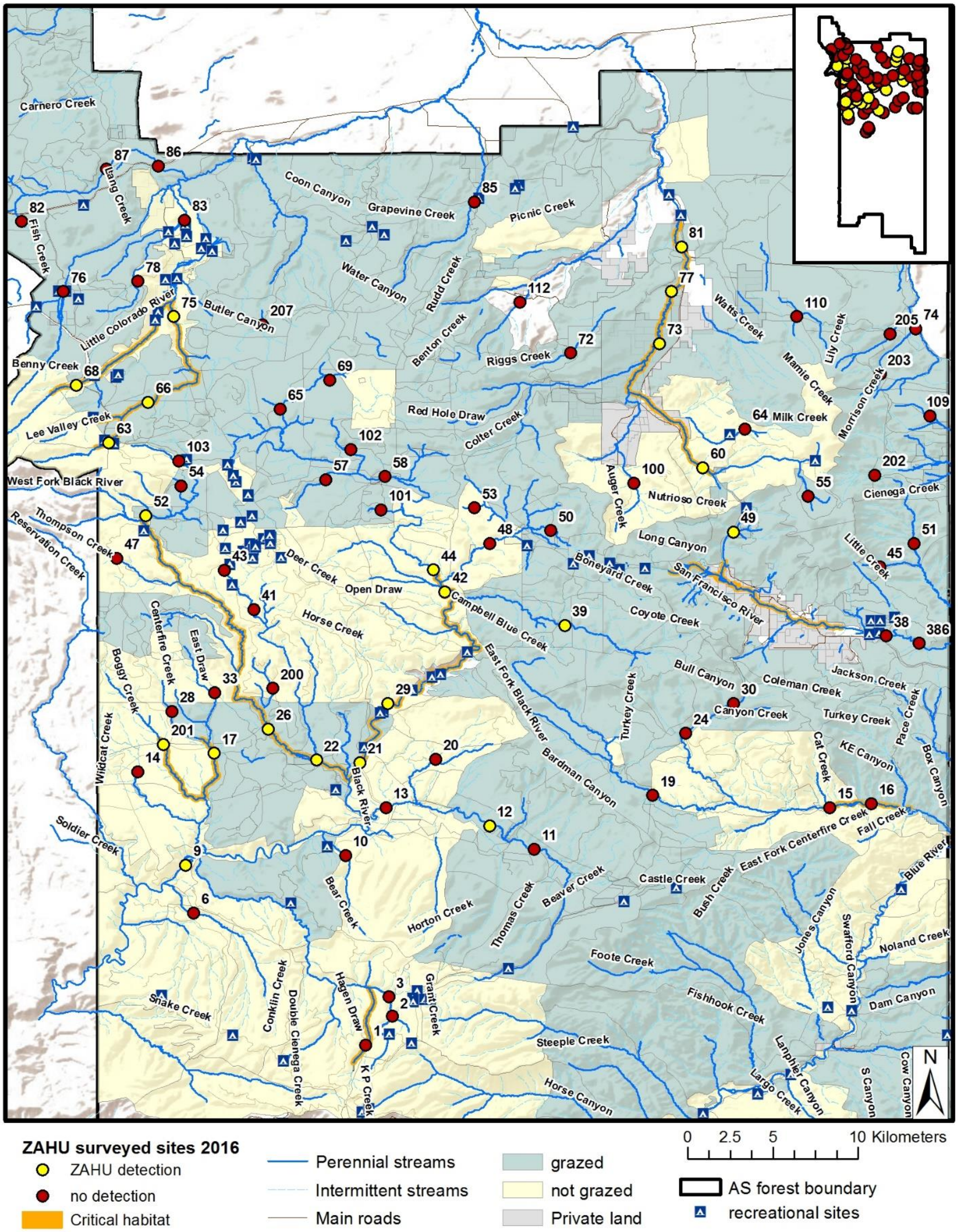


Figure 2. Sites monitored using track plates or live trapping for New Mexico meadow jumping mouse, June – September 2016, Apache-Sitgreaves National Forests, Arizona.

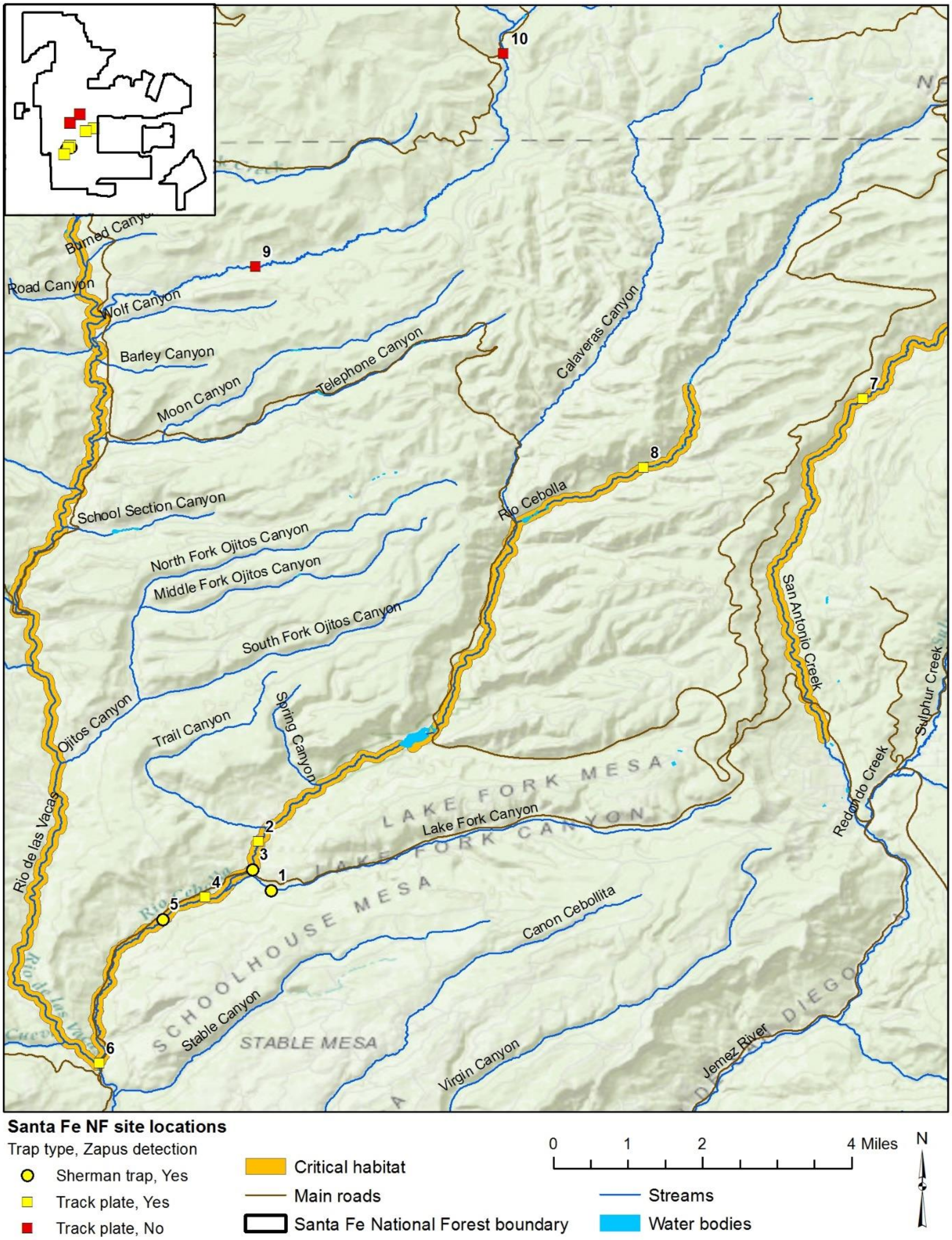


Figure 3. Sites monitored using track plates or live trapping for New Mexico meadow jumping mouse, July 2016, Santa Fe National Forest, New Mexico.

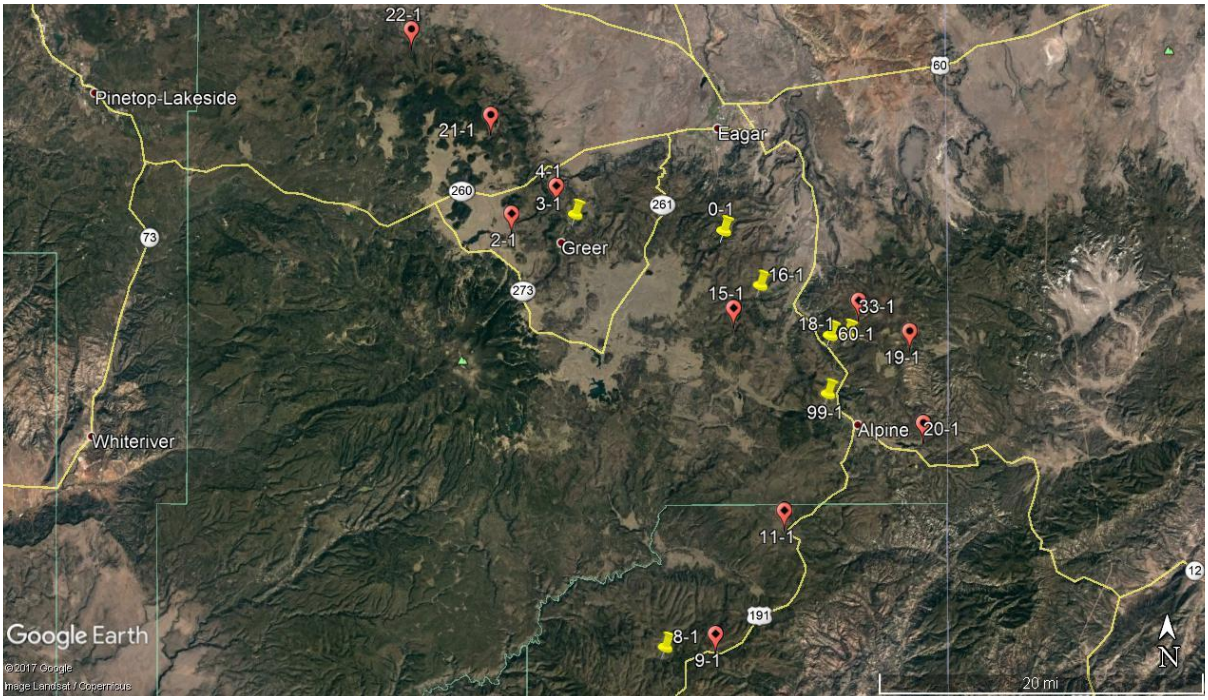


Figure 4. Sites monitored using track plates or live trapping for New Mexico meadow jumping mouse, June – September 2017, Apache-Sitgreaves National Forests, Arizona. Yellow pins are sites where jumping mice were detected using trapping or track plating; jumping mice were not detected at sites with red pins.

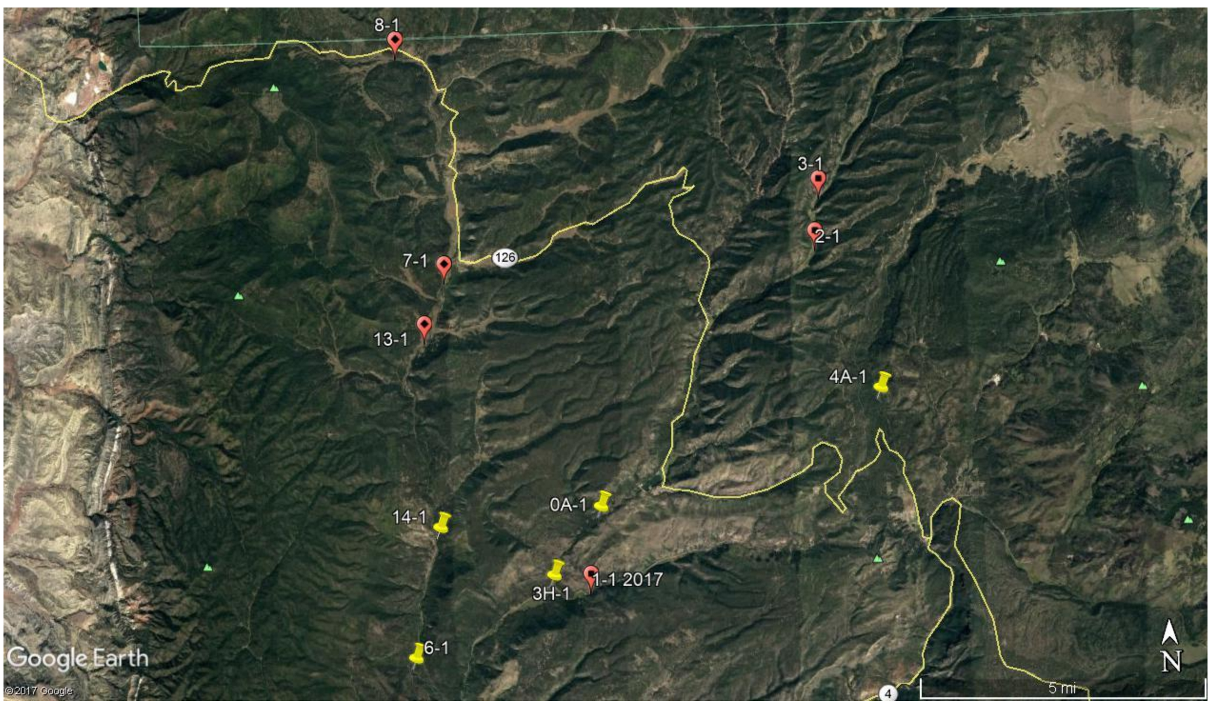


Figure 5. Sites monitored using track plates or live trapping for New Mexico meadow jumping mouse, June – September 2017, Santa Fe National Forest, New Mexico. Yellow pins are sites where jumping mice were detected using trapping or track plating; jumping mice were not detected at sites with red pins.

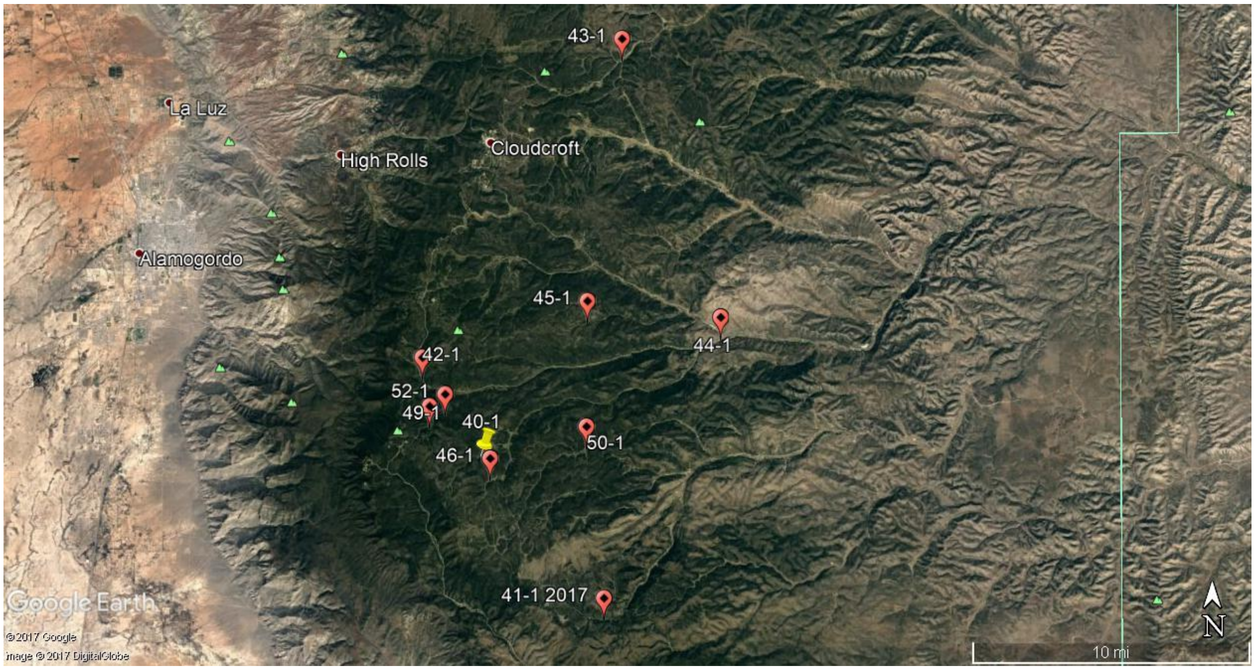


Figure 6. Sites monitored using track plates or live trapping for New Mexico meadow jumping mouse, June – September 2017, Lincoln National Forest, New Mexico. Yellow pins are sites where jumping mice were detected using trapping or track plating; jumping mice were not detected at sites with red pins.

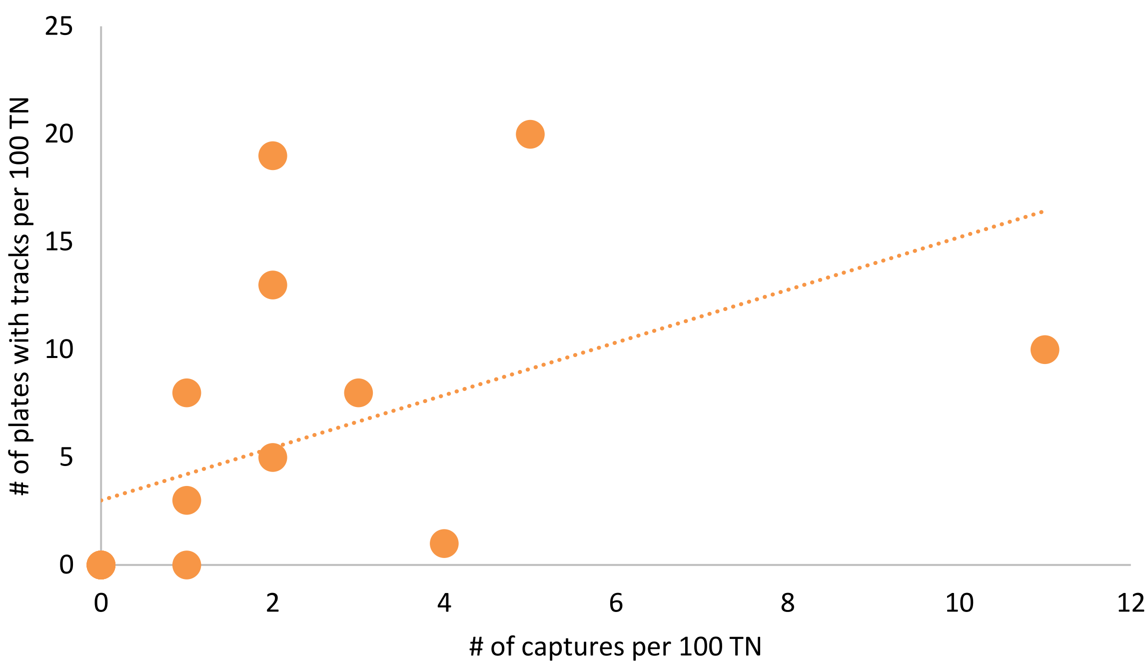


Figure 7. Comparison of track plate (number of plates with tracks per 100 Trap Nights [TN]) and live trap (number of captures per 100 TN) methods for detecting New Mexico meadow jumping mice, Arizona and New Mexico, 2016-2017.

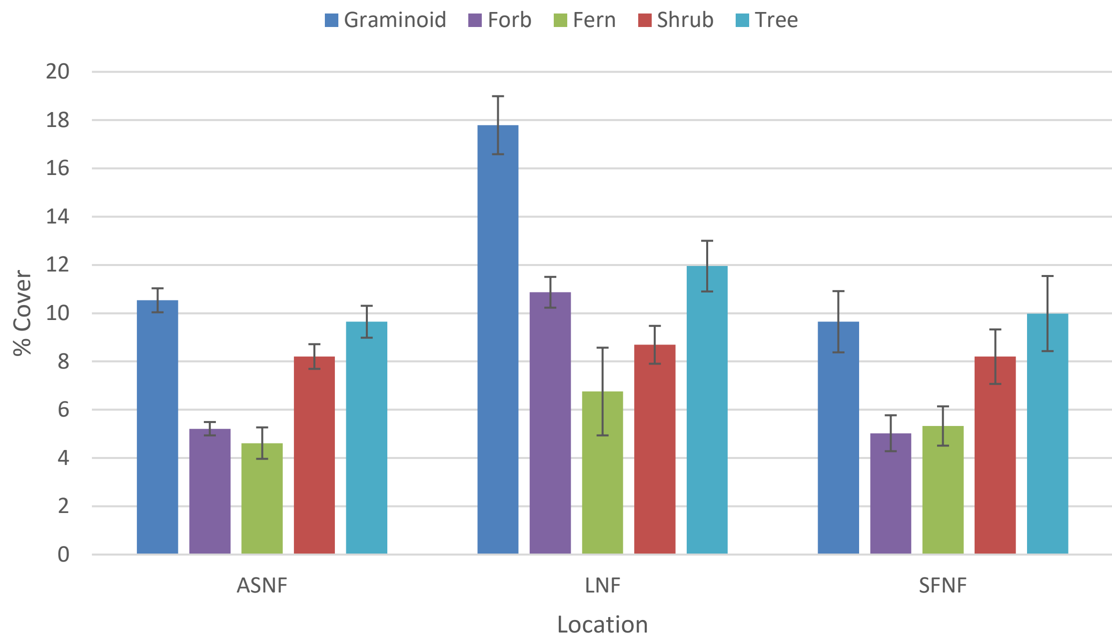


Figure 8. Comparison of plant dominance by life form for Apache-Sitgreaves (ASNF), Lincoln (LNF), and Santa Fe (SFNF) National Forests. Plant composition and dominance was sampled during summer 2016 and 2017 in riparian areas where sampling was conducted for New Mexico meadow jumping mouse. Dominance was estimated for a site.

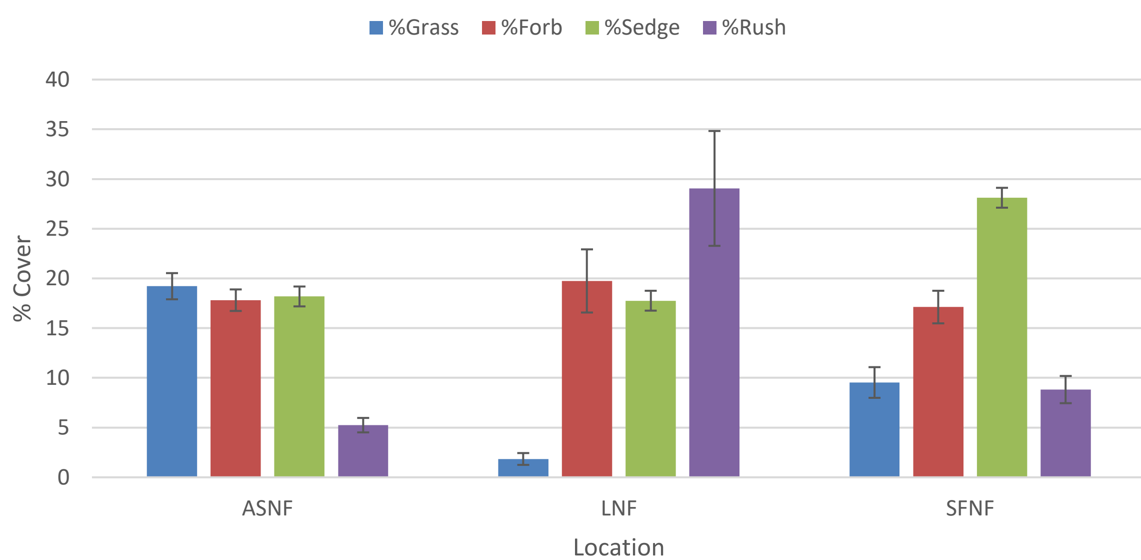


Figure 9. Mean percent cover (± SE) for plants by life form estimated from Daubenmire plots (n = 27 per site) for 113 sites sampled for New Mexico meadow jumping mice on the Apache-Sitgreaves (ASNF), Lincoln (LNF), and Santa Fe (SFNF) National Forests, summer 2016, 2017.

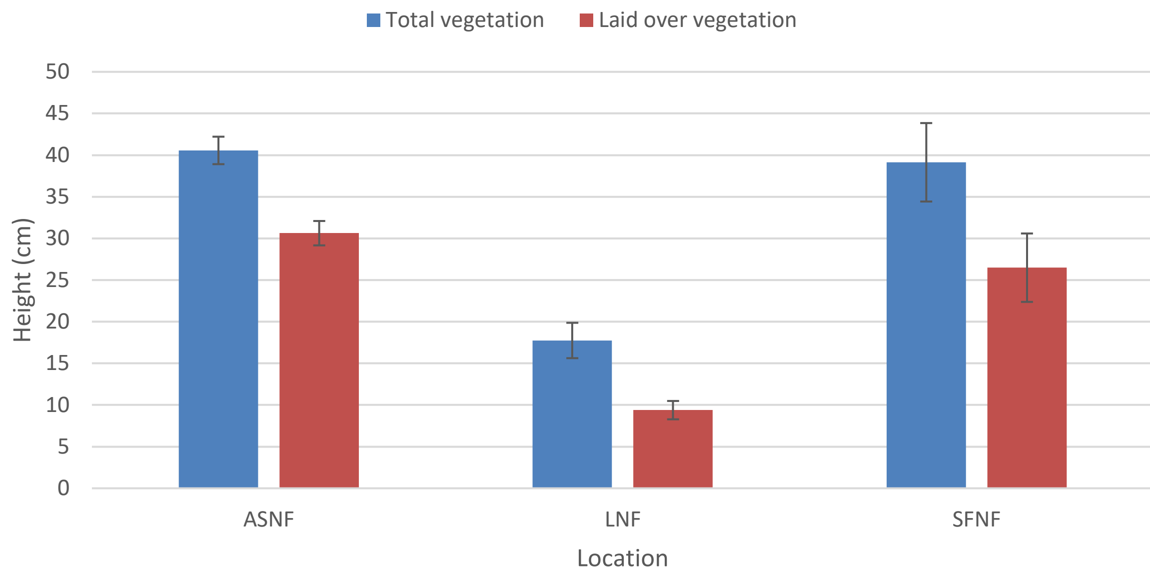


Figure 10. Mean height (cm) (± SE) for plants by life form estimated from Daubenmire plots (n = 27 per site) for 113 sites sampled for New Mexico meadow jumping mice on the Apache-Sitgreaves (ASNF), Lincoln (LNF), and Santa Fe (SFNF) National Forests, summer 2016, 2017.

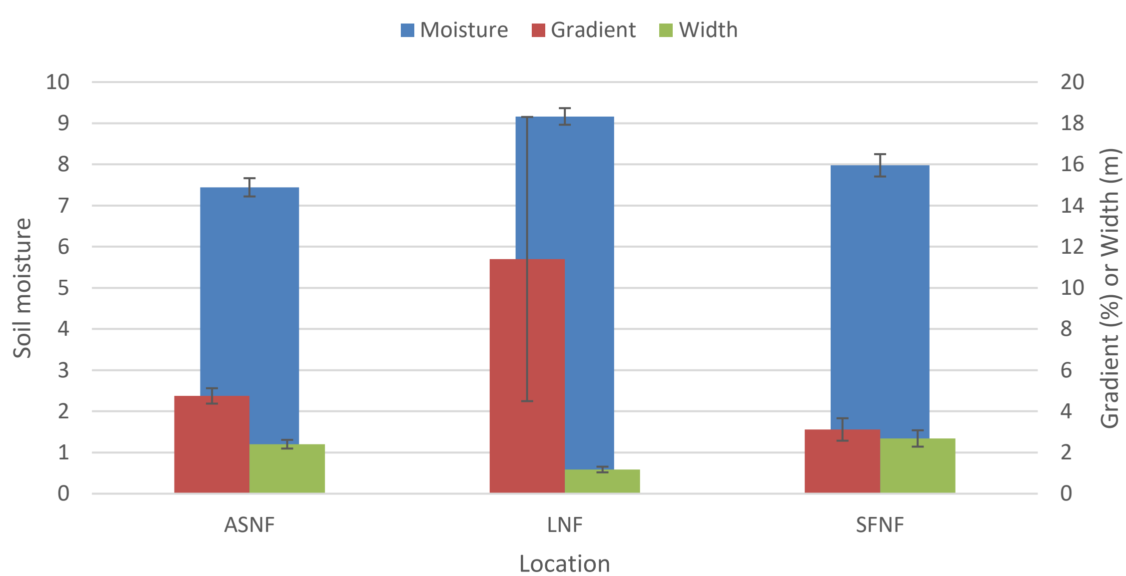


Figure 11. Mean soil moisture (scaled 1 to 10 with 1 dry and 10 saturated), stream gradient (%), and stream width (m) (± SE) for 113 sites sampled for New Mexico meadow jumping mice on the Apache-Sitgreaves (ASNF), Lincoln (LNF), and Santa Fe (SFNF) National Forests, summer 2016, 2017.

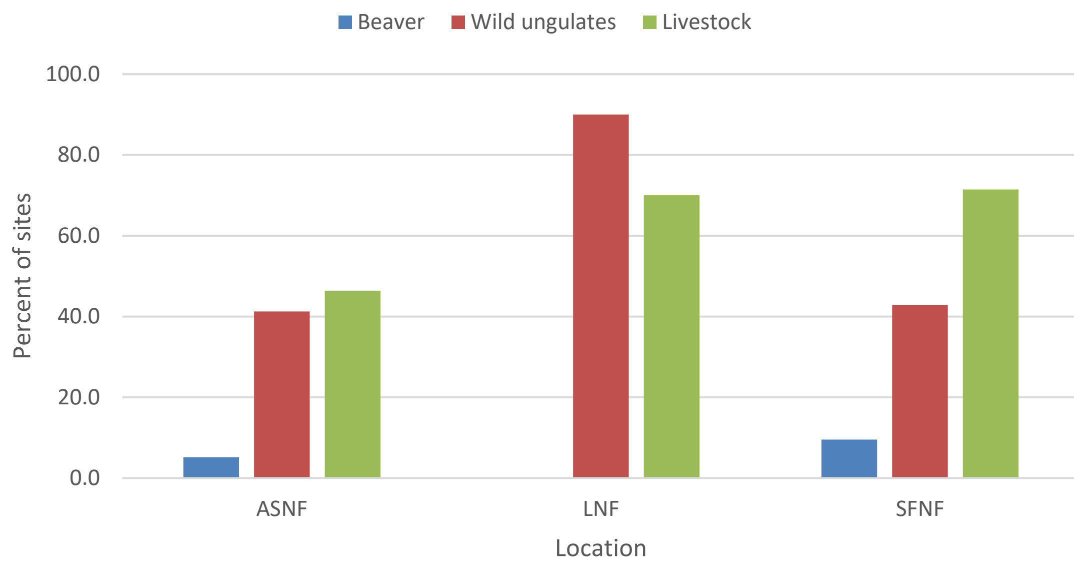
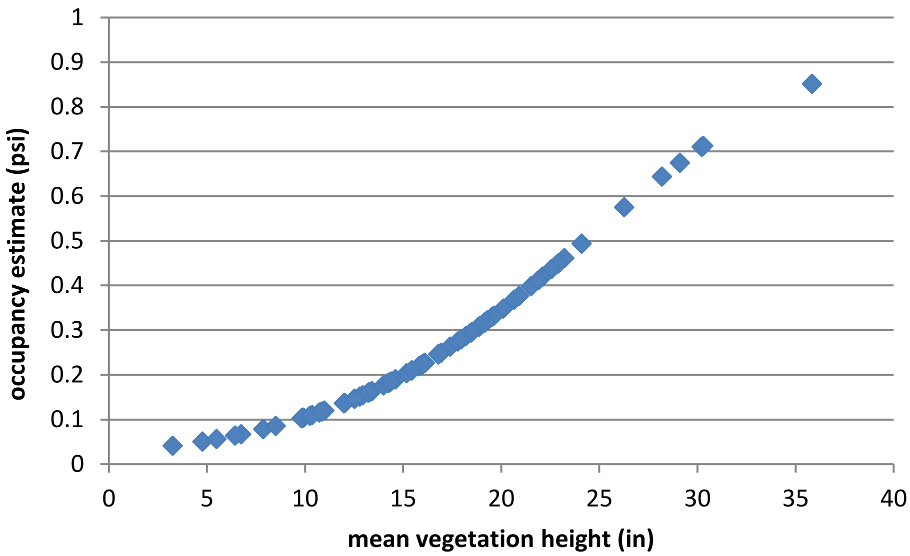


Figure 12. Percentage of sites with evidence (sign or presence of animals) of beaver, wild ungulates, or livestock for 128 sites sampled for New Mexico meadow jumping mice on the Apache-Sitgreaves (ASNF), Lincoln (LNF), and Santa Fe (SFNF) National Forests, summer 2016, 2017.

Figure 13.

A.


occupancy estimate (psi)
mean vegetation height (in)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
5
10
15
20
25
30
35
40

B.

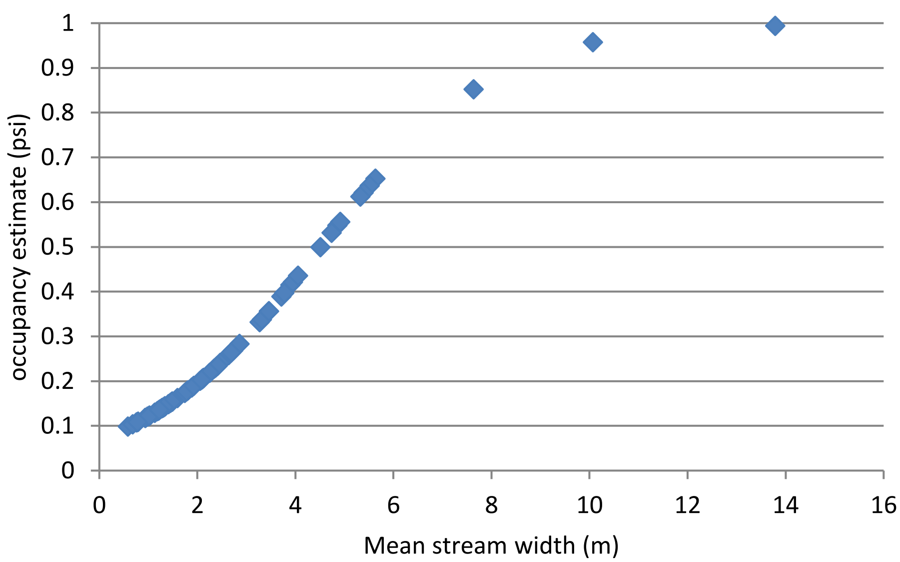
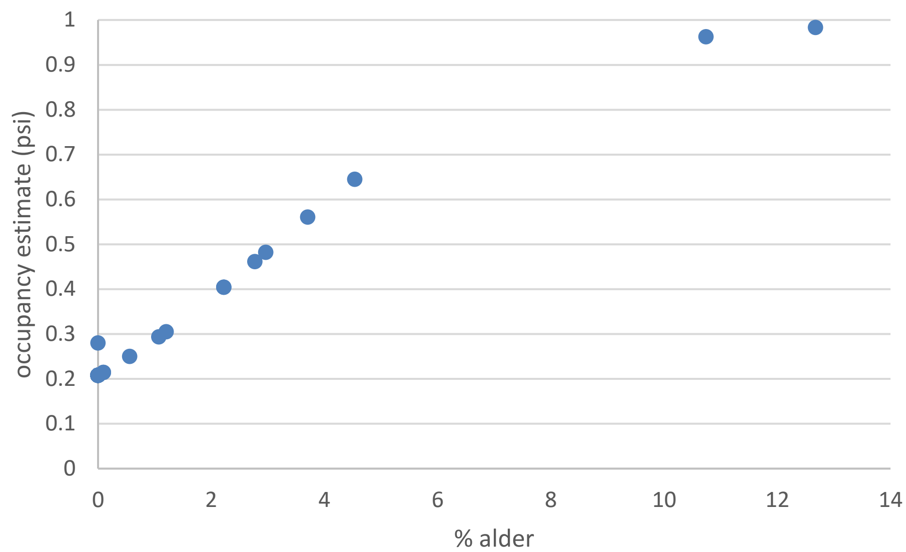

occupancy estimate (psi)
Mean stream width (m)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
2
4
6
8
10
12
14
16

Figure 13.
C.


occupancy estimate (psi)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
14
% alder

D.

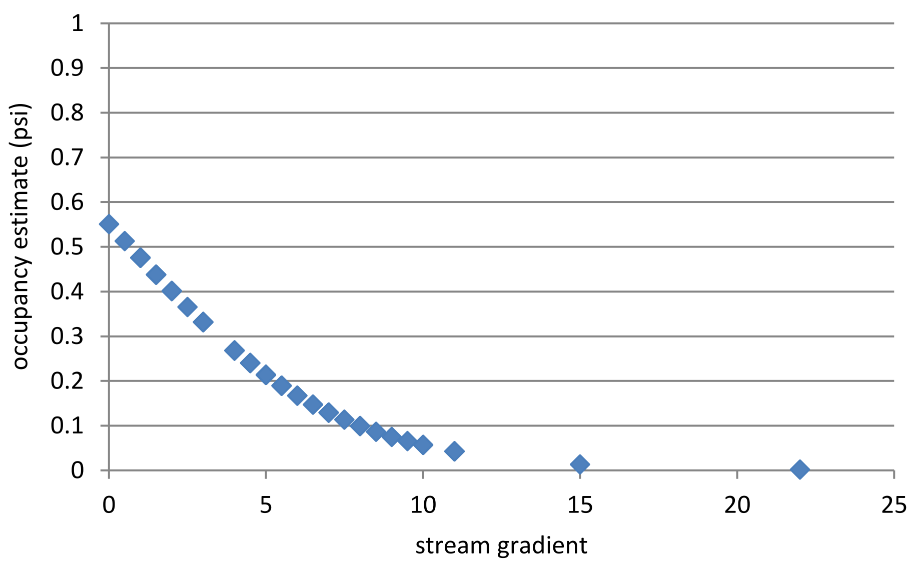
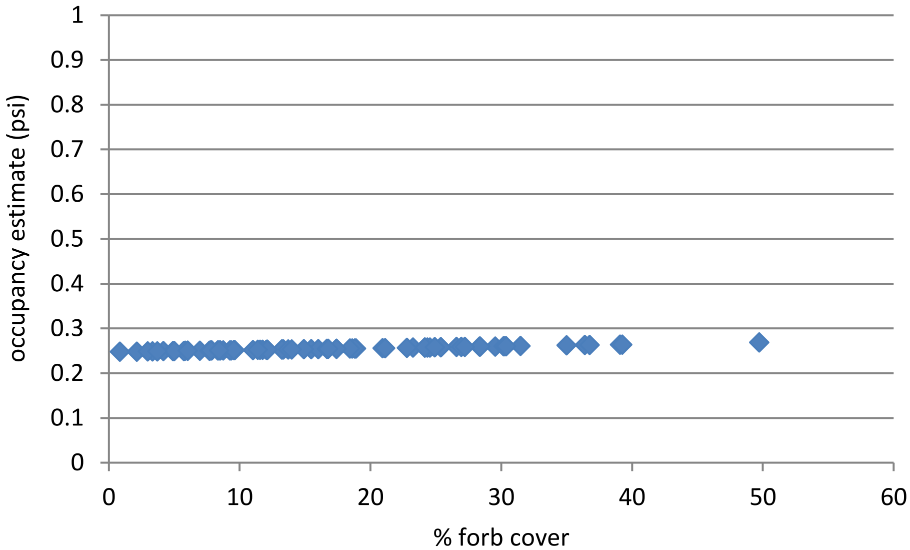
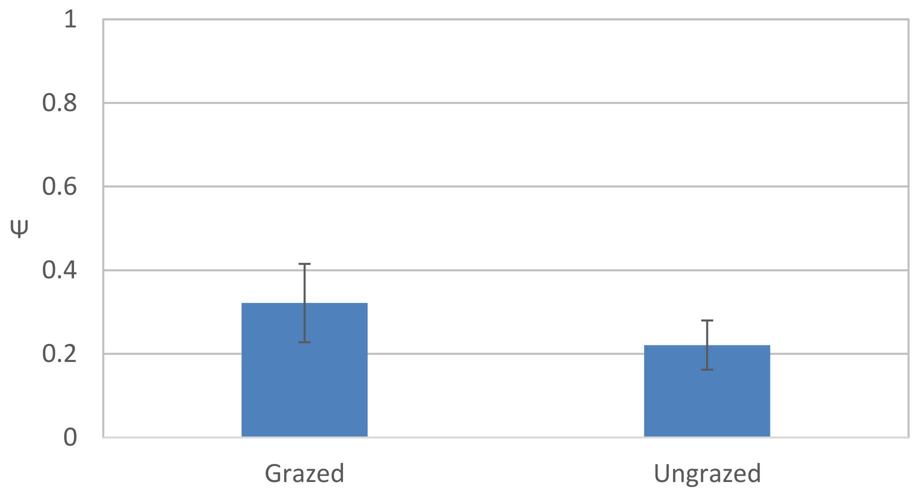

occupancy estimate (psi)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
5
10
15
20
25
stream gradient

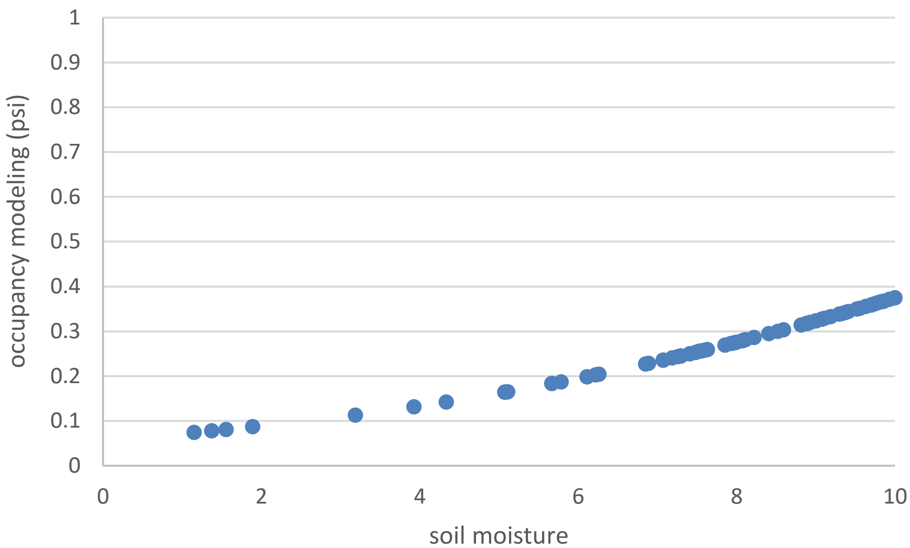
Figure 13.
E.


occupancy estimate (psi)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
% forb cover

F.


Ψ
1
0.8
0.6
0.4
0.2
0
Grazed
Ungrazed

G.



H.

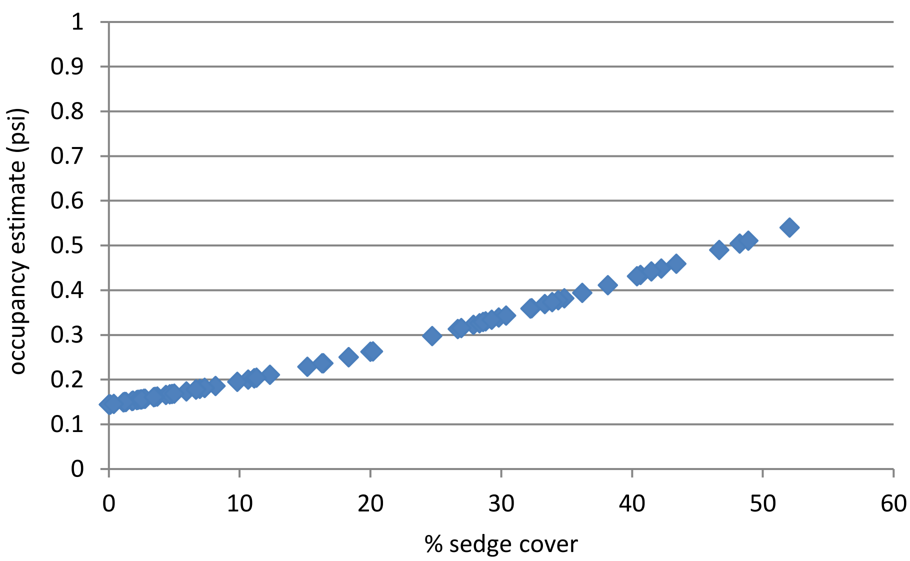


Figure 13. Relationship between habitat variables and probability of presence of New Mexico meadow jumping mouse, Apache-Sitgreaves National Forests, 2016. A. mean vegetation height, B. mean stream width, C. Percent alder cover, D. Stream gradient, E. Percent forb cover, F. Wild ungulate grazing, G. Mean soil moisture, H. Percent sedge cover.

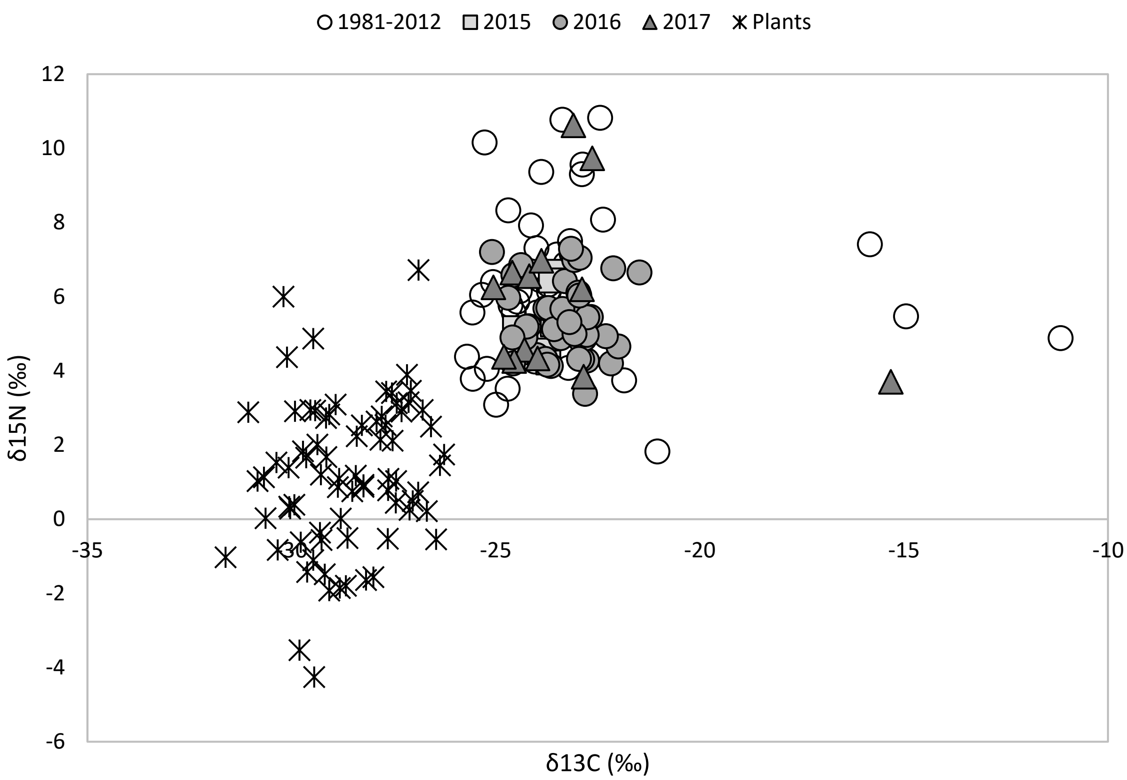


Figure 14. Values of $\delta^{15}N$ versus $\delta^{13}C$ from plants sampled in 2017 and hair samples taken from New Mexico meadow jumping mice captured in Arizona and New Mexico between 1981 and 2017.

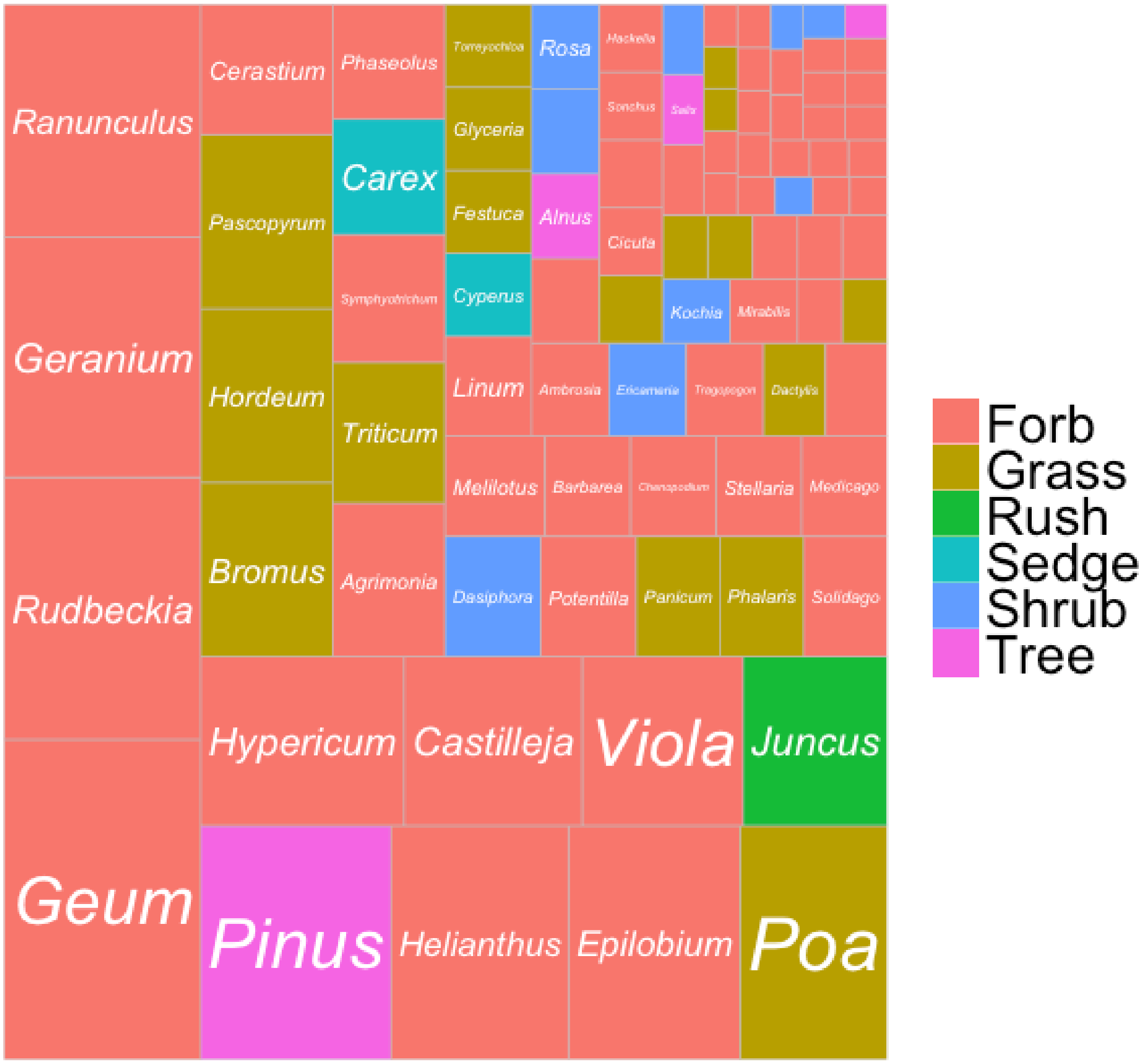


Figure 15. Plant genera identified in the diet of 82 New Mexico meadow jumping mice sampled from Arizona, New Mexico, and Colorado (2016-2017). Box size reflects frequency the genus appeared in diet of jumping mice (e.g., larger box size indicates more jumping mice consumed this genus).

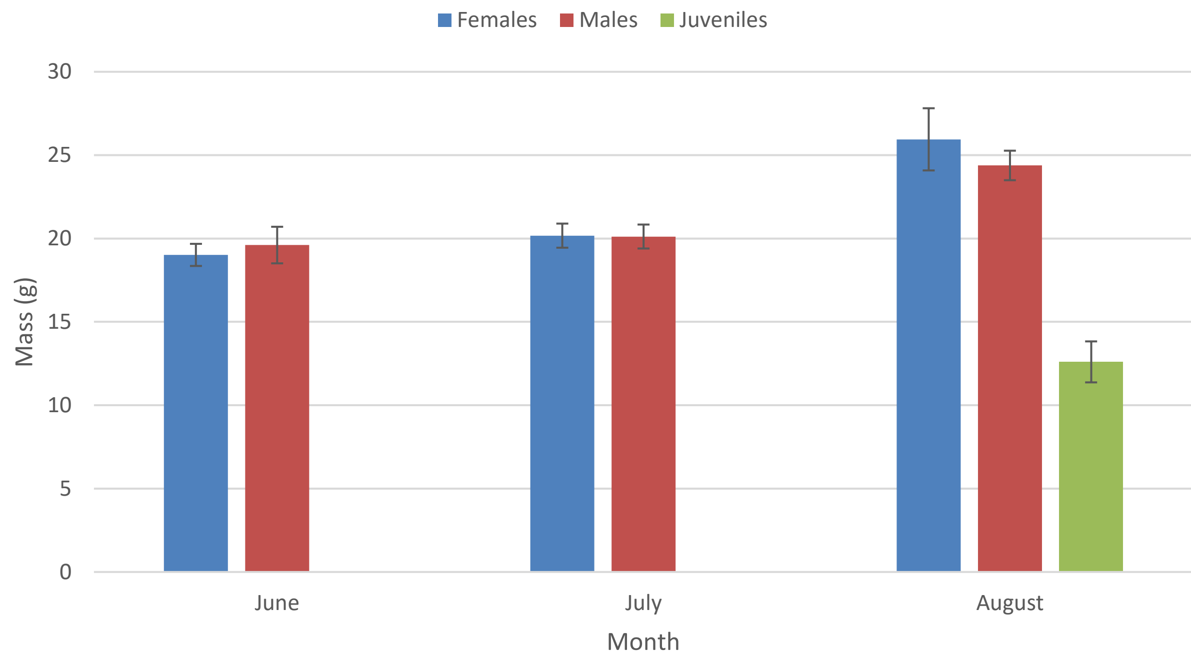


Figure 16. Mass (± *SE*) of female, male, and juvenile New Mexico meadow jumping mice captured summer (June – August) 2015-2017 on the Apache-Sitgreaves and Santa Fe National Forests.

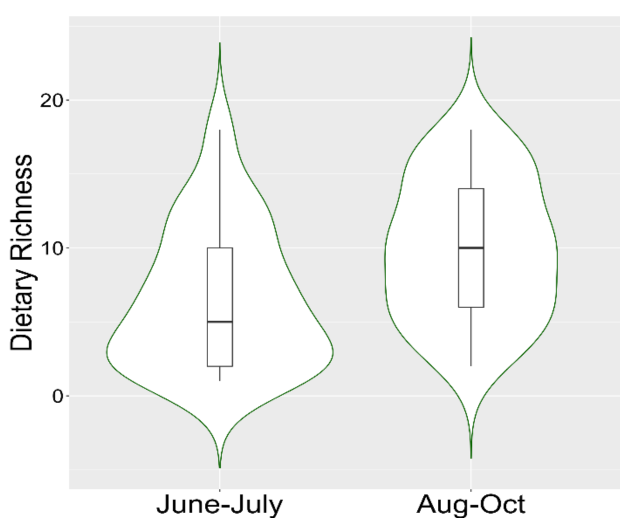


Figure 17. Number of genera (dietary richness) consumed by New Mexico meadow jumping mice in early summer (June-July; n = 48) compared to late summer-early fall (August-October; n = 34).

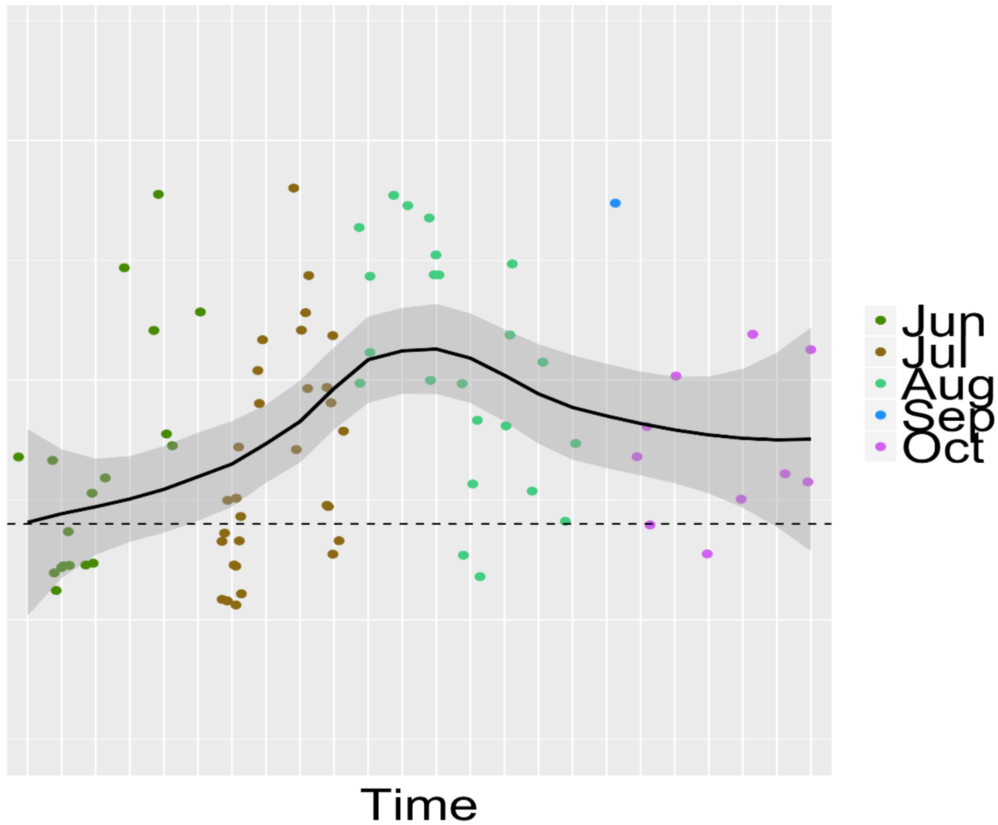
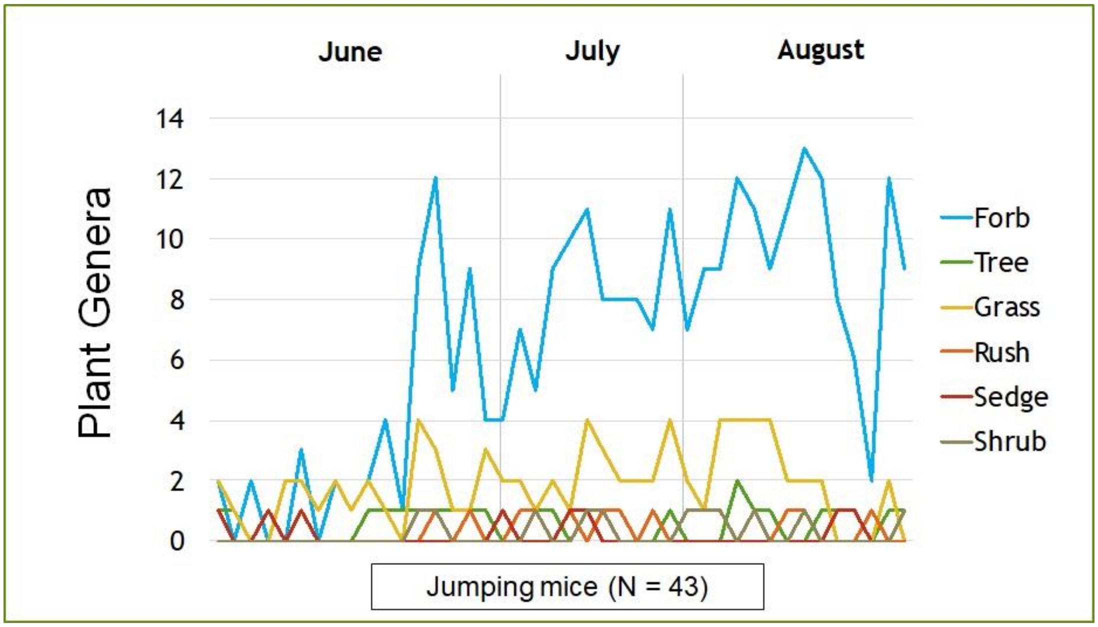


Figure 18. Black line represents the number of dietary genera consumed by individual New Mexico meadow jumping mice (n = 82) throughout their active period (Jun – Oct 2016-2017). Confidence intervals (95%) are indicated by shaded areas above and below black line; individual jumping mice by month are represented by filled circles. Jumping mice were sampled in Arizona, New Mexico (Jun-Sep 2016-2017), and Colorado (Oct 2017).

A.



B.

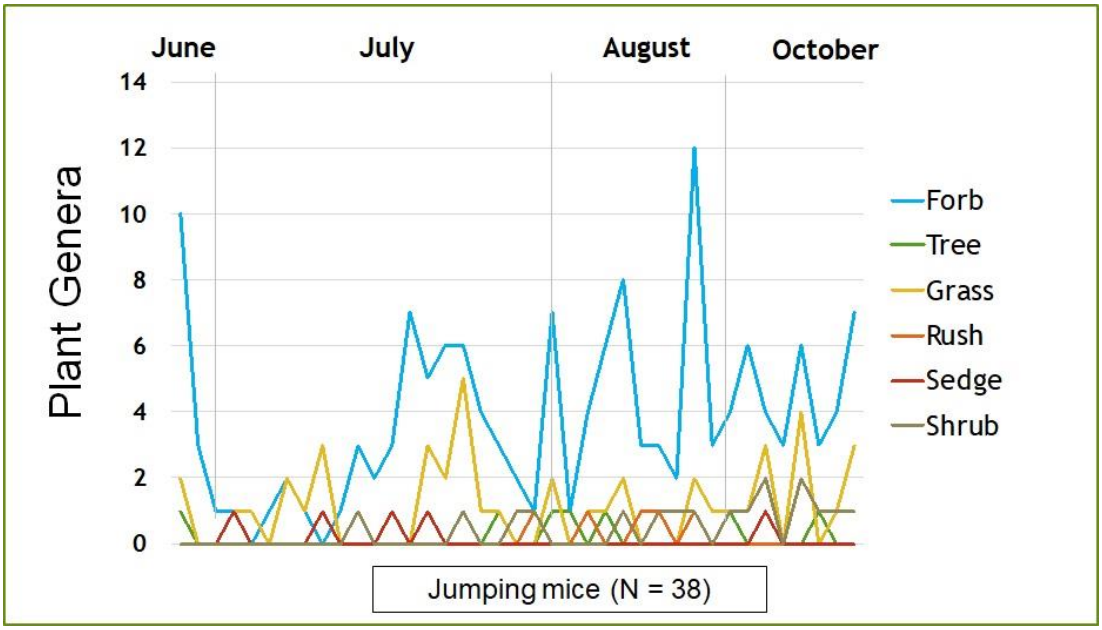
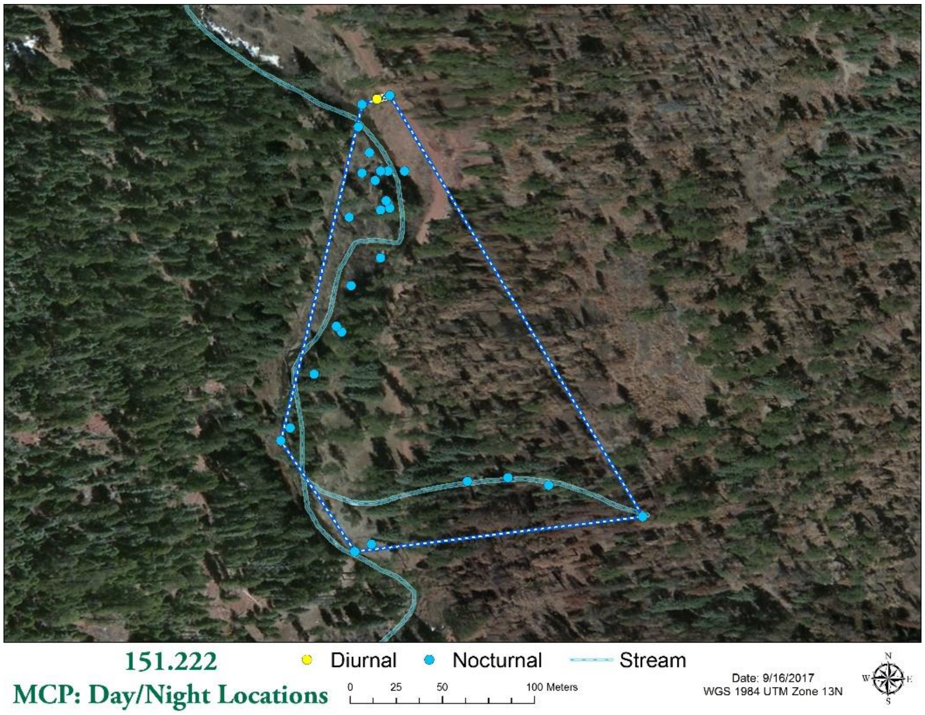


Figure 19. Diet richness by month and plant form identified through metabarcoding for New Mexico meadow jumping mice captured in Arizona and New Mexico during summer A. 2016 and B. 2017.



B.

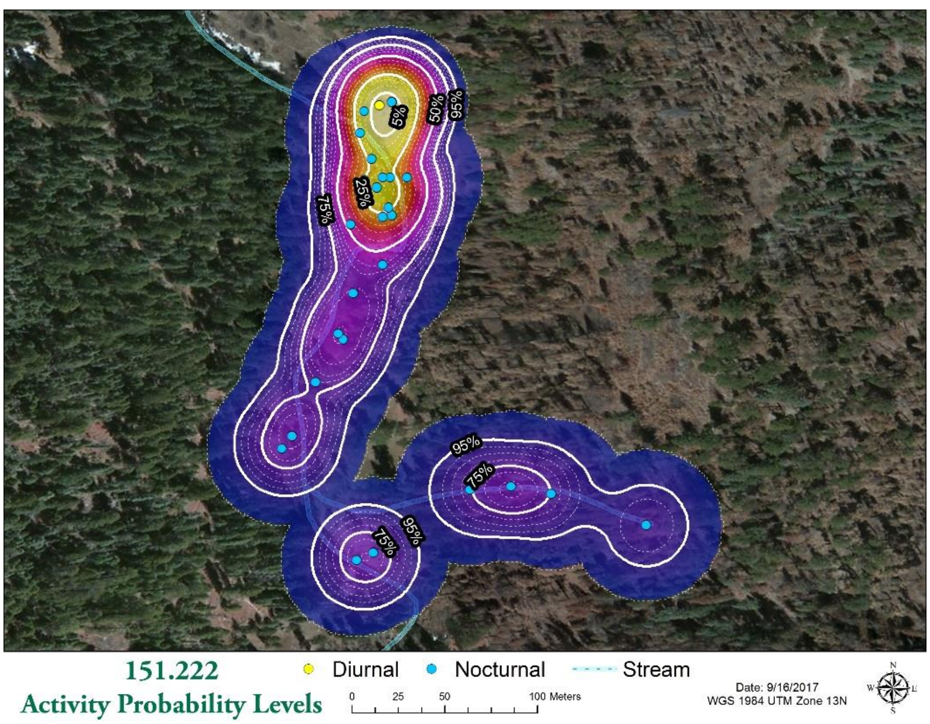


Figure 20. Home range using A. Minimum Convex Polygon (MCP) and B. Kernel Density Probability for female New Mexico meadow jumping mouse ID 151.222, San Antonio Creek, Santa Fe National Forest, Jul – Aug 2017.

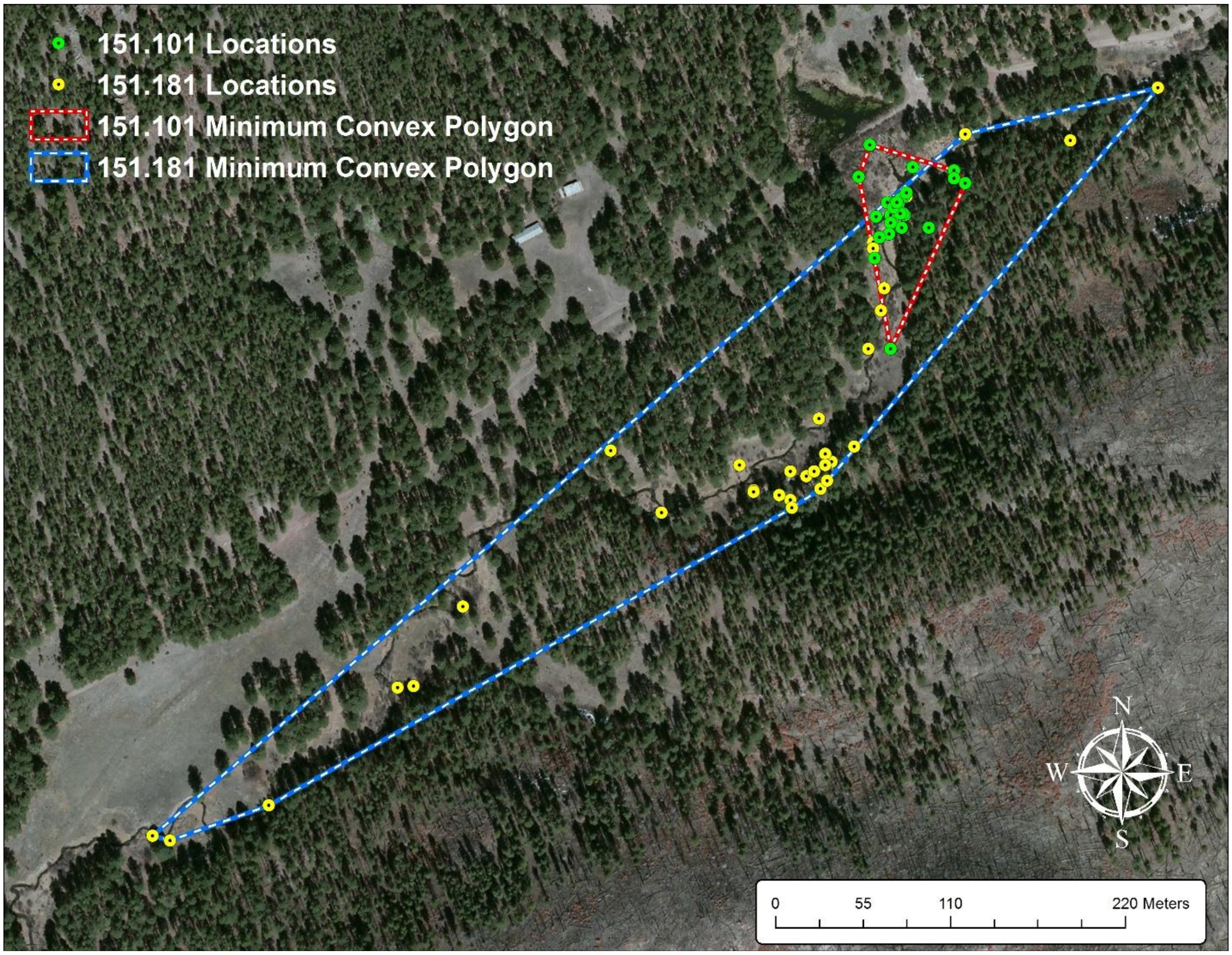


Figure 21. Overlap of Minimum Convex Polygon (MCP) home ranges for male jumping mice ID 151.101 and ID 151.181, Rio Cebolla, Fenton Lake, Santa Fe National Forest, Jul – Aug 2017.

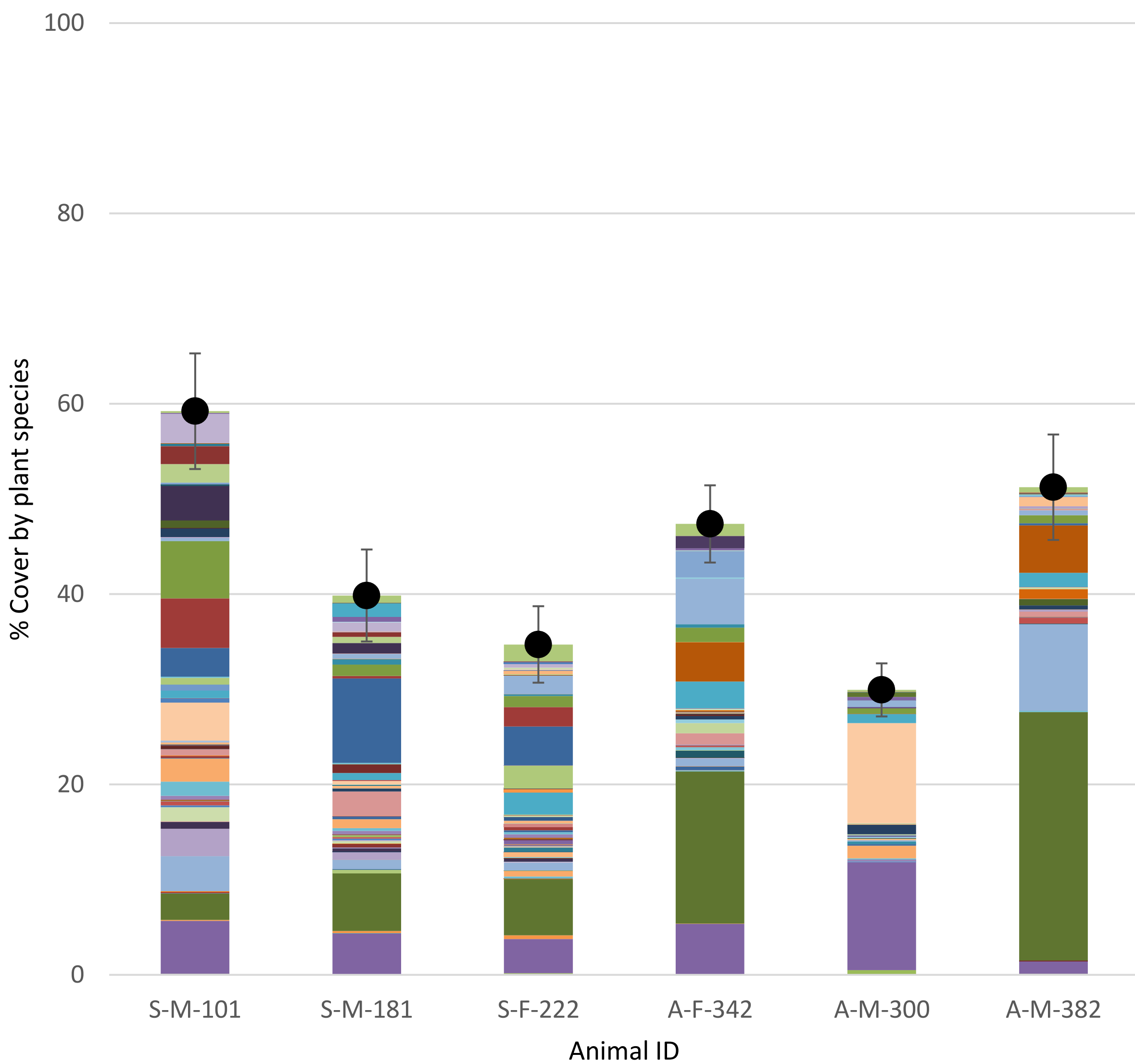


Figure 22. Plant composition of home range locations for New Mexico meadow jumping mice from SFNF (S-M-101, S-M-181, S-F-222) and ASNF (A-F-342, A-M-300, A-M-382) from cover board measurements. Each plant species (n = 177) is indicated by a different color; same color is used across all animals for a species. Mean percent cover (and SE) for home range is indicated by black-filled circle.

A.

B.

Figure 23. Day nests for male New Mexico meadow jumping mice A. ID 151.101, Santa Fe National Forest, Aug 2017 and B. ID 151.382, located on the Apache-Sitgreaves National Forests, Sep 2017.

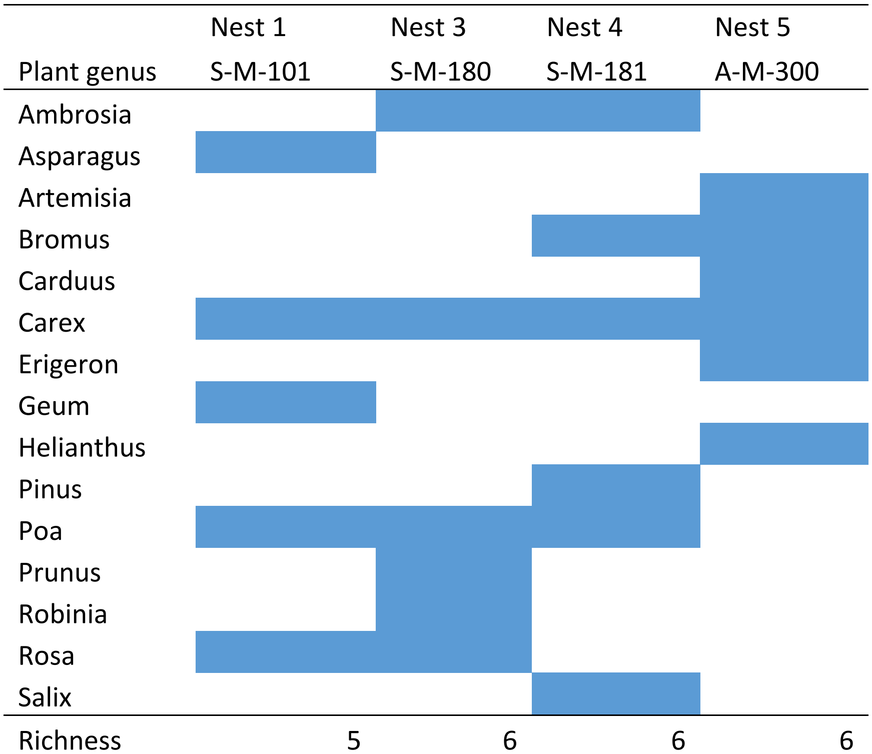


Figure 24. Plant composition of nests for New Mexico meadow jumping mice from SFNF (Nest 1, male transmitter 151.101; Nest 3, male, transmitter 150.180; Nest 4, male, transmitter 151.181) and ASNF (Nest 5, male, transmitter 151.300) determined genetically using metabarcoding. Presence of a plant genus is indicated by blue in nest column.

Table 1. Location of sites on Apache-Sitgreaves (ASNF) and Santa Fe (SFNF) National Forests that were both live trapped and track plated to detect jumping mice. No indicates that jumping mice were not detected, Yes indicates detection. First identifies the technique used first (i.e., if 'trap' then the site was trapped first, then track plated second; techniques were not run simultaneously).

Site Number	Forest	Site Name	Trap	Track plate	First
13	ASNF	Beaver Creek canyon	No	No	Trap
15	ASNF	Luce Ranch 1	No	No	Trap
16	ASNF	Luce Ranch 2	No	No	Trap
38	ASNF	Luna Lake by dam	No	No	Trap
39	ASNF	Coyote	Yes	Yes	Track plate
42	ASNF	Three Forks	Yes	Yes	Track plate
48	ASNF	Boneyard	No	No	Trap
52	ASNF	WFBR (Burro Mountain)	Yes	Yes	Track plate
60	ASNF	Alpine mile 419.9	Yes	Yes	Trap
73	ASNF	Crosswhite N2	Yes	Yes	Trap
77	ASNF	Nutrioso Creek	No	No	Trap
26	ASNF	West Fork Black River Middle	Yes	Yes	Trap
63	ASNF	East Fork Little Colorado river (West)	Yes	Yes	Track plate
66	ASNF	East Fork Little Colorado river (East)	Yes	No	Track plate
0	SFNF	Fenton Lake	Yes	Yes	Track plate
4	SFNF	San Antonio Creek	Yes	Yes	Track plate

Table 2. Sites surveyed for New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) on the Apache-Sitgreaves National Forest (ASNF, Arizona; 2015-2017), Lincoln National Forest (LNF, New Mexico; 2017), and Santa Fe National Forest (SFNF, New Mexico; 2016-2017). Jumping mice were detected at 50 of 134 sites (ZAHU Presence = Yes) using live trapping, track plating, or visual sighting.

Year	Forest	Site Number	Site Name	ZAHU Presence	Datum	Latitude	Longitude
2015	ASNF	8058-15	Rd 8058N	No	WGS84	34.02817	-109.18513
2015	ASNF	201-15	Boggy Creek	Yes	WGS84	33.77018	-109.46101
2015	ASNF	48-15	Boneyard	Yes	WGS84	33.86587	-109.30141
2015	ASNF	17-15	Centerfire Creek	Yes	WGS84	33.77096	-109.43785
2015	ASNF	73N-15	Crosswhite North	Yes	WGS84	33.98089	-109.20107
2015	ASNF	73S-15	Crosswhite South	Yes	WGS84	33.97946	-109.20248
2015	ASNF	2-15	Horse Creek Junction	Yes	WGS84	33.75315	-109.36473
2015	ASNF	42-15	Three Forks	Yes	WGS84	33.85132	-109.31341
2015	ASNF	1-15	Three Forks North	No	WGS84	33.85727	-109.31664
2015	ASNF	22-15	West Fork Black River Lower	Yes	WGS84	33.76142	-109.37814
2015	ASNF	26-15	West Fork Black River Middle	Yes	WGS84	33.77841	-109.40561
2016	ASNF	1	Corduroy Creek	No	WGS84	33.61155	-109.35424
2016	ASNF	2	Fish Creek1	No	WGS84	33.62685	-109.34026
2016	ASNF	3	Fish Creek2	No	WGS84	33.63703	-109.34216
2016	ASNF	6	Conklin Creek	No	WGS84	33.68143	-109.44498
2016	ASNF	9	Black River	Yes	WGS84	33.70652	-109.44943
2016	ASNF	10	Bear Creek	No	WGS84	33.71159	-109.36504
2016	ASNF	11	Beaver Creek1	No	WGS84	33.71499	-109.26542
2016	ASNF	12	Beaver Creek2	Yes	WGS84	33.72742	-109.28902
2016	ASNF	13	Beaver Creek canyon	No	WGS84	33.73696	-109.34370
2016	ASNF	14	Wildcat Creek	No	WGS84	33.75585	-109.47472
2016	ASNF	15	Campbell Blue Creek Luce Ranch1	No	WGS84	33.73701	-109.10955
2016	ASNF	16	Campbell Blue Creek Luce Ranch2	No	WGS84	33.73903	-109.08740
2016	ASNF	17	Centerfire Creek 1	Yes	WGS84	33.76562	-109.43435
2016	ASNF	19	Campbell Blue Creek 3	No	WGS84	33.74339	-109.20280
2016	ASNF	20	Johns Canyon	No	WGS84	33.76237	-109.31730
2016	ASNF	21	East Fork Black River	Yes	WGS84	33.76072	-109.35728
2016	ASNF	22	West Fork Black River Lower	Yes	WGS84	33.76202	-109.38037
2016	ASNF	24	Coleman Creek 1	No	WGS84	33.77612	-109.18546
2016	ASNF	26	West Fork Black River Middle	Yes	WGS84	33.77840	-109.40562
2016	ASNF	28	Centerfire Creek 2	No	WGS84	33.78779	-109.45640
2016	ASNF	29	East Fork Black River (Cattle exclosure West Fork)	Yes	WGS84	33.79182	-109.34270
2016	ASNF	30	Coleman Creek 2	No	WGS84	33.79187	-109.16017
2016	ASNF	33	East Draw	No	WGS84	33.79760	-109.43405
2016	ASNF	38	San Francisco River 1 (Luna Lake by dam)	No	WGS84	33.82754	-109.07973
2016	ASNF	39	Coyote Creek 1	Yes	WGS84	33.83309	-109.24934
2016	ASNF	41	Home Creek 1	No	WGS84	33.84151	-109.41332

2016	ASNF	42	Three Forks	Yes	WGS84	33.85083	-109.31249
2016	ASNF	43	Home Creek 2	No	WGS84	33.86219	-109.42884
2016	ASNF	44	North Fork East Fork Black River (N of Three Forks)	Yes	WGS84	33.86236	-109.31857
2016	ASNF	45	Bob Thomas Creek	No	WGS84	33.86388	-109.08317
2016	ASNF	47	unknown perennial stream near road 116T	No	WGS84	33.86859	-109.48558
2016	ASNF	48	Boneyard	No	WGS84	33.87627	-109.28880
2016	ASNF	49	Turkey Creek	Yes	WGS84	33.88235	-109.16037
2016	ASNF	50	Boneyard 2	No	WGS84	33.88316	-109.25665
2016	ASNF	51	Stone Creek	No	WGS84	33.87637	-109.06509
2016	ASNF	52	WFBR (Burro Mountain)	Yes	WGS84	33.89107	-109.47036
2016	ASNF	53	unknown perennial stream near boneyard	No	WGS84	33.89510	-109.29688
2016	ASNF	54	unknown perennial stream near road 8037B	No	WGS84	33.90675	-109.45181
2016	ASNF	55	Paddy Creek	No	WGS84	33.90137	-109.12075
2016	ASNF	57	unknown perennial stream near 8007 road	No	WGS84	33.91008	-109.37543
2016	ASNF	58	North Fork East Fork Black River	No	WGS84	33.91166	-109.34409
2016	ASNF	60	Nutrioso Creek 1	Yes	WGS84	33.91631	-109.17645
2016	ASNF	63	East Fork Little Colorado river (West)	Yes	WGS84	33.92946	-109.48993
2016	ASNF	64	Hulsey Creek	No	WGS84	33.93681	-109.15424
2016	ASNF	65	Seven Springs Draw 1	No	WGS84	33.94728	-109.39951
2016	ASNF	66	East Fork Little Colorado river (East)	Yes	WGS84	33.95091	-109.46904
2016	ASNF	68	West Fork Little Colorado River	Yes	WGS84	33.95990	-109.50703
2016	ASNF	69	Seven Springs Draw 2	No	WGS84	33.96263	-109.37335
2016	ASNF	72	Riggs Creek	No	WGS84	33.97686	-109.24611
2016	ASNF	73	Nutrioso Creek (Crosswhite N2 property)	Yes	WGS84	33.98188	-109.19937
2016	ASNF	74	Coyote creek 2	No	WGS84	33.98961	-109.06409
2016	ASNF	75	East Fork Little Colorado River	Yes	WGS84	33.99611	-109.45561
2016	ASNF	76	Hall Creek	No	WGS84	34.00929	-109.51402
2016	ASNF	77	Nutrioso Creek 2	No	WGS84	34.00936	-109.19290
2016	ASNF	78	Benny Creek 1	No	WGS84	34.01477	-109.47462
2016	ASNF	81	Nutrioso Creek Nelson reservoir	Yes	WGS84	34.03281	-109.18771
2016	ASNF	82	Fish Creek 3	No	WGS84	34.04625	-109.53584
2016	ASNF	83	Benny Creek 2	No	WGS84	34.04704	-109.44998
2016	ASNF	85	Water Canyon	No	WGS84	34.05676	-109.29705
2016	ASNF	86	Fish Creek 4	No	WGS84	34.07568	-109.46363
2016	ASNF	87	Fish Creek 5	No	WGS84	34.07397	-109.49112
2016	ASNF	100	Auger Creek	No	WGS84	33.90823	-109.21277
2016	ASNF	101	unknown perennial stream near road 8004	No	WGS84	33.89403	-109.34625

2016	ASNF	102	Chambers Draw	No	WGS84	33.92585	-109.36205
2016	ASNF	103	Burro Creek 2	No	WGS84	33.91988	-109.45294
2016	ASNF	109	unknown perennial stream near road 8372	No	WGS84	33.94365	-109.05646
2016	ASNF	110	Davis Creek	No	WGS84	33.99612	-109.12687
2016	ASNF	112	Benton Creek	No	WGS84	34.00385	-109.27290
2016	ASNF	200	unknown perennial stream near Conklin Ridge	No	WGS84	33.79991	-109.40338
2016	ASNF	201	Boggy Creek	Yes	WGS84	33.77018	-109.46102
2016	ASNF	202	ELC Creek (intermittent)	No	WGS84	33.91246	-109.08560
2016	ASNF	203	Mamie Creek	No	WGS84	33.96579	-109.08286
2016	ASNF	205	Lily Creek	No	WGS84	33.98684	-109.07751
2016	ASNF	207	South Fork Little Colorado River	No	WGS84	33.99173	-109.40866
2016	ASNF	38b	Luna Lake	No	WGS84	33.82361	-109.06236
2016	SFNF	1	Lake Fork Corral	Yes	WGS84	35.85369	-106.75446
2016	SFNF	2	Rio Cebolla	Yes	WGS84	35.86322	-106.75688
2016	SFNF	3	Upper Cebolla Culvert	Yes	WGS84	35.85773	-106.75802
2016	SFNF	4	Upper Cebolla Exclosure	Yes	WGS84	35.85239	-106.76722
2016	SFNF	5	Rio Cebolla 4th Exclosure	Yes	WGS84	35.84807	-106.77542
2016	SFNF	6	Confluence of Rio Cebolla and Rio de las Vacas	Yes	WGS84	35.82016	-106.78776
2016	SFNF	7	San Antonio Hot Springs	Yes	WGS84	35.94926	-106.63945
2016	SFNF	8	Seven Springs	Yes	WGS84	35.93592	-106.68205
2016	SFNF	9	Peñas Negras Exclosures	No	WGS84	35.97492	-106.75745
2016	SFNF	10	Peñas Negras Shroyer Exclosure	No	WGS84	36.01628	-106.70928
2017	ASNF	3	Site 3 LCR	Yes	NAD83	34.02351	-109.44779
2017	ASNF	2	Site 2 Hall Creek	No	NAD83	34.01670	-109.51158
2017	ASNF	4	Site 4 Rosey Creek	No	NAD83	34.04163	-109.46414
2017	ASNF	19	Site 19 Romero Creek	No	WGS84	33.91269	-109.08849
2017	ASNF	20	Site 20 Luna Lake	No	WGS84	33.83147	-109.07329
2017	ASNF	21	Site 21 Carnero Spring	No	WGS84	34.10380	-109.53379
2017	ASNF	22	Site 22 Mineral Springs	No	WGS84	34.18022	-109.61908
2017	ASNF	60	Site 60 near Alpine mile 419.9	Yes	WGS84	33.91629	-109.17645
2017	ASNF	18	Site 18 Paddy Creek	Yes	NAD83	33.91721	-109.15819
2017	ASNF	99	Site 99 San Francisco River	Yes	WGS84	33.86503	-109.18012
2017	ASNF	0	Site 0 Rudd Creek	Yes	WGS84	34.00885	-109.28961
2017	ASNF	8	Site 8 Fish & Corduroy Creeks	Yes	NAD83	33.64150	-109.35260
2017	ASNF	9	Site 9 Hannagan Creek	No	WGS84	33.64606	-109.29541
2017	ASNF	11	Site 11 Cienega Creek	No	WGS84	33.75442	-109.22169
2017	ASNF	15	Site 15 Colter Creek Upstream	No	WGS84	33.93343	-109.27558
2017	ASNF	16	Site 16 Colter Creek Downstream	Yes	WGS84	33.96073	-109.25073
2017	ASNF	33	Site 33 Milk Creek	No	WGS84	33.93976	-109.14266
2017	LNF	40	Site 40 Mauldin Spring	Yes	WGS84	32.79391	-105.74880
2017	LNF	41	Site 41 Agua Chiquita	No	WGS84	32.70938	-105.67251
2017	LNF	42	Site 42 Upper Rio Penasco	No	WGS84	32.83433	-105.78476

2017	LNF	43	Site 43 Silver Springs	No	WGS84	32.99997	-105.66127
2017	LNF	44	Site 44 Lower Rio Penasco	No	WGS84	32.85523	-105.60030
2017	LNF	45	Site 45 Wilmeth Canyon	No	WGS84	32.86373	-105.68271
2017	LNF	46	Site 46 Hubbell	No	WGS84	32.78196	-105.74283
2017	LNF	49	Site 49 Water Canyon	No	WGS84	32.80901	-105.78029
2017	LNF	50	Site 50 Masterson	No	WGS84	32.79854	-105.68331
2017	LNF	52	Site 52 Telephone Canyon	No	WGS84	32.81528	-105.77068
2017	SFNF	0	Site 0 Fenton Lake	Yes	WGS84	35.87460	-106.74391
2017	SFNF	1	Site 1 Lake Fork	No	WGS84	35.85521	-106.74656
2017	SFNF	2	Site 2 Seven Springs Rio Cebolla	No	WGS84	35.94202	-106.67288
2017	SFNF	3	Site 3 McKinney Pond	No	WGS84	35.95523	-106.67156
2017	SFNF	4	Site 4 Lower San Antonio	Yes	WGS84	35.90345	-106.65413
2017	SFNF	6	Site 6 Rio de las Vacas	Yes	WGS84	35.83640	-106.80410
2017	SFNF	7	Site 7 Turkey Creek	No	WGS84	35.93588	-106.79079
2017	SFNF	8	Site 8 Clear Creek	No	WGS84	35.99366	-106.80429
2017	SFNF	13	Site 13 Trail Creek	No	WGS84	35.92058	-106.79750
2017	SFNF	14	Site 14 O'Neil Landing	Yes	WGS84	35.87012	-106.79520
2017	SFNF	3-16	Site 3H 2016	Yes	WGS84	35.85773	-106.75802

Table 3. Small mammals captured from live trapping on Apache-Sitgreaves National Forests (ASNF) and Santa Fe National Forest during summer (Jun – Sep 2015, 2016, 2017). One trap night is one Sherman trap open for 1 night.

Scientific name	Common name	2015 ASNF	2016 ASNF	2017 ASNF	2016 SFNF	2017 SFNF	Total
Peromyscus maniculatus	deer mouse	545	262	30	46	30	913
Microtus montanus arizonensis	montane vole	490	383	12	0	9	894
Microtus mogollonensis navajo	Mogollon vole	101	54	9	0	1	165
Microtus longicaudus	long-tailed vole	77	22	0	2	17	118
Zapus hudsonius luteus	**New Mexico meadow jumping mouse**	**20**	**42**	**9**	**13**	**28**	**112**
Neotoma mexicana	Mexican woodrat	76	6	4	0	0	86
Sorex spp.	shrew species	1	52	7	3	23	86
Microtus spp.	Unidentified vole	0	44	1	0	17	62
Peromyscus boylii	brush mouse	33	0	0	3	0	36
Peromyscus spp.	Unidentified deer mouse	0	0	3	0	23	26
Reithrodontomys megalotis	western harvest mouse	8	7	0	2	0	17
Neotamias cinereicollis	gray-collard chipmunk	6	0	0	0	1	7
Tamias minimus	least chipmunk	4	0	0	0	0	4
Sorex palustris	American water shrew	0	0	0	0	4	4
Myodes gapperi	southern red-backed vole	3	0	0	0	0	3
Mustela frenata	long-tailed weasel	1	0	0	1	0	2
Spermophilus lateralis	golden-mantled ground squirrel	1	0	0	0	0	1
Tamias dorsalis	cliff chipmunk	1	0	0	0	0	1
Total captures		1367	872	75	70	153	2537
Total trap nights		6472	3654	1120	454	400	12100

Table 4. Plant species identified at 78 sites from Apache-Sitgreaves (Arizona), Santa Fe (New Mexico), and Lincoln (New Mexico) National Forests occurring in riparian and adjacent ecotone and upland.

Scientific name	Number of sites	Percent of sites
Achillea millefolium	76	97.4
Taraxacum officinale	73	93.6
Iris missouriensis	72	92.3
Poa pratensis	72	92.3
Verbascum thapsus	70	89.7
Epilobium ciliatum	69	88.5
Bromus ciliatus	68	87.2
Sidalcea neomexicana	67	85.9
Mentha arvensis	66	84.6
Potentilla hippiana	65	83.3
Elymus elymoides	63	80.8
Juncus balticus	63	80.8
Erigeron divergens	62	79.5
Artemisia carruthii	61	78.2
Geranium caespitosum	61	78.2
Hymenoxys hoopesii	61	78.2
Erigeron flagellaris	59	75.6
Pinus ponderosa	59	75.6
Rosa woodsii	59	75.6
Antennaria parvifolia	58	74.4
Laennecia schiedeana	58	74.4
Ranunculus hydrocharoides	58	74.4
Prunella vulgaris	57	73.1
Unknown Forb	57	73.1
Agrostis stolonifera	56	71.8
Thalictrum fendleri	56	71.8
Rumex crispus	55	70.5
Tragopogon dubius	55	70.5
Koeleria macrantha	53	67.9
Elymus trachycaulus	52	66.7
Hypericum formosum	52	66.7
Heterotheca villosa	51	65.4
Muhlenbergia tricholepis	51	65.4
Pascopyrum smithii	51	65.4
Medicago lupulina	50	64.1
Rudbeckia laciniata	50	64.1
Vicia americana	50	64.1
Pseudocymopterus montanus	49	62.8
Allium sp.	48	61.5
Amauriopsis dissecta	48	61.5
Carex sp.	48	61.5

Rumex acetosella	48	61.5
Campanula parryi	47	60.3
Carex utriculata	47	60.3
Muhlenbergia wrightii	47	60.3
Veronica americana	47	60.3
Androsace septentrionalis	46	59.0
Bromus inermis	46	59.0
Phleum pratense	46	59.0
Geranium richardsonii	45	57.7
Muhlenbergia montana	45	57.7
Mertensia franciscana	44	56.4
Deschampsia cespitosa	43	55.1
Ipomopsis aggregata	43	55.1
Ranunculus macounii	43	55.1
Rubus idaeus	43	55.1
Chenopodium album	42	53.8
Equisetum arvense	42	53.8
Urtica dioica	42	53.8
Agastache pallidiflora	41	52.6
Cirsium sp.	41	52.6
Erigeron speciosus	41	52.6
Geum macrophyllum	41	52.6
Potentilla anserina	41	52.6
Plantago major	40	51.3
Lithospermum multiflorum	39	50.0
Synthyris plantaginea	38	48.7
Dasiphora fruticosa	37	47.4
Heliomeris multiflora	37	47.4
Mirabilis linearis	37	47.4
Senecio wootonii	37	47.4
Trifolium wormskioldii	37	47.4
Juncus sp.	36	46.2
Packera hartiana	36	46.2
Unknown Asteraceae	36	46.2
Viola canadensis	36	46.2
Alnus incana	35	44.9
Oxalis decaphylla	35	44.9
Bouteloua gracilis	34	43.6
Conioselinum scopulorum	34	43.6
Festuca sp.	34	43.6
Unknown Fabaceae	34	43.6
Eleocharis sp.	33	42.3
Populus tremuloides	33	42.3
Potentilla X diversifolia	33	42.3
Trifolium hybridum	33	42.3

Cirsium wheeleri	32	41.0
Hackelia floribunda	32	41.0
Poa fendleriana	32	41.0
Ribes cereum	32	41.0
Unknown Poaceae	32	41.0
Agrimonia striata	31	39.7
Bistorta bistortoides	31	39.7
Cicuta maculata	31	39.7
Carex praegracilis	30	38.5
Dactylis glomerata	30	38.5
Erodium cicutarium	30	38.5
Geum triflorum	30	38.5
Glyceria striata	30	38.5
Mimulus guttatus	30	38.5
Oenothera flava	30	38.5
Sisyrinchium demissum	30	38.5
Cyperus fendlerianus	29	37.2
Equisetum hyemale	29	37.2
Fragaria virginiana	29	37.2
Muhlenbergia minutissima	29	37.2
Pseudognaphalium macounii	29	37.2
Quercus gambelii	29	37.2
Rorippa sp.	29	37.2
Toxicodendron rydbergii	29	37.2
Artemisia dracunculus	28	35.9
Hordeum brachyantherum	28	35.9
Poa compressa	28	35.9
Rumex densiflorus	28	35.9
Euphorbia schizoloba	27	34.6
Humulus lupulus	27	34.6
Phacelia heterophylla	27	34.6
Trifolium sp.	27	34.6
Houstonia wrightii	26	33.3
Phalaris arundinacea	26	33.3
Stachys palustris	26	33.3
Veronica peregrina	26	33.3
Monarda fistulosa	25	32.1
Penstemon sp.	25	32.1
Potentilla thurberi	25	32.1
Carex subfusca	24	30.8
Cirsium undulatum	24	30.8
Commelina dianthifolia	24	30.8
Erigeron sp.	24	30.8
Oenothera elata	24	30.8
Oenothera pubescens	24	30.8

Solidago sp.	24	30.8
Cirsium vulgare	23	29.5
Festuca arizonica	23	29.5
Hymenopappus mexicanus	23	29.5
Polemonium foliosissimum	23	29.5
Potentilla crinita	23	29.5
Salix sp.	23	29.5
Valeriana acutiloba	23	29.5
Veratrum californicum	23	29.5
Bromus tectorum	22	28.2
Galium boreale	22	28.2
Lepidium sp.	22	28.2
Orthocarpus luteus	22	28.2
Vicia sp.	22	28.2
Vicia pulchella	22	28.2
Castilleja miniata	21	26.9
Descurainia incana	21	26.9
Dracocephalum parviflorum	21	26.9
Gentiana affinis	21	26.9
Juncus ensifolius	21	26.9
Ranunculus aquatilis	21	26.9
Cirsium grahamii	20	25.6
Fragaria vesca	20	25.6
Geranium lentum	20	25.6
Juncus interior	20	25.6
Trifolium mucronatum	20	25.6
Ambrosia psilostachya	19	24.4
Artemisia ludoviciana	19	24.4
Leibnitzia lyrata	19	24.4
Lepidium virginicum	19	24.4
Penstemon barbatus	19	24.4
Potentilla concinna	19	24.4
Ranunculus inamoenus	19	24.4
Heterosperma pinnatum	18	23.1
Lobelia anatina	18	23.1
Perideridia parishii	18	23.1
Pteridium aquilinum	18	23.1
Ribes aureum	18	23.1
Senecio actinella	18	23.1
Unknown Brassicaceae	18	23.1
Antennaria marginata	17	21.8
Descurainia sp.	17	21.8
Galium sp.	17	21.8
Gnaphalium exilifolium	17	21.8
Hordeum jubatum	17	21.8

Lupinus argenteus	17	21.8
Polygonum aviculare	17	21.8
Ratibida columnifera	17	21.8
Ribes inerme	17	21.8
Rumex orthoneurus	17	21.8
Salix exigua	17	21.8
Ambrosia acanthicarpa	16	20.5
Apocynum cannabinum	16	20.5
Carex pellita	16	20.5
Corydalis aurea	16	20.5
Halenia rothrockii	16	20.5
Heuchera rubescens	16	20.5
Hymenoxys richardsonii	16	20.5
Linum lewisii	16	20.5
Salix bebbiana	16	20.5
Silene scouleri	16	20.5
Actaea rubra	15	19.2
Arenaria lanuginosa	15	19.2
Cerastium sp.	15	19.2
Juniperus scopulorum	15	19.2
Muhlenbergia rigens	15	19.2
Oenothera suffrutescens	15	19.2
Onopordum acanthium	15	19.2
Picea engelmannii	15	19.2
Picea pungens	15	19.2
Scirpus microcarpus	15	19.2
Senecio sp.	15	19.2
Solanum stoloniferum	15	19.2
Verbena macdougalii	15	19.2
Astragalus sp.	14	17.9
Carduus nutans	14	17.9
Convolvulus arvensis	14	17.9
Maianthemum stellatum	14	17.9
Potentilla ovina	14	17.9
Aconitum columbianum	13	16.7
Apocynum sp.	13	16.7
Chenopodium fremontii	13	16.7
Equisetum laevigatum	13	16.7
Euphorbia sp.	13	16.7
Frasera speciosa	13	16.7
Lactuca serriola	13	16.7
Melilotus officinalis	13	16.7
Oxytropis lambertii	13	16.7
Sedum cockerellii	13	16.7
Senecio bigelovii	13	16.7

Agoseris aurantiaca	12	15.4
Amaranthus powellii	12	15.4
Aristida arizonica	12	15.4
Carex athrostachya	12	15.4
Cerastium nutans	12	15.4
Hesperidanthus linearifolius	12	15.4
Leucanthemum vulgare	12	15.4
Lonicera involucrata	12	15.4
Persicaria lapathifolia	12	15.4
Ranunculus sp.	12	15.4
Rumex sp.	12	15.4
Salix irrorata	12	15.4
Scutellaria galericulata	12	15.4
Silene sp.	12	15.4
Silene laciniata	12	15.4
Artemisia franserioides	11	14.1
Brickellia grandiflora	11	14.1
Cerastium arvense	11	14.1
Clematis ligusticifolia	11	14.1
Conyza canadensis	11	14.1
Elymus lanceolatus	11	14.1
Festuca sororia	11	14.1
Maianthemum racemosum	11	14.1
Marrubium vulgare	11	14.1
Muhlenbergia virescens	11	14.1
Persicaria pensylvanica	11	14.1
Rhaponticum repens	11	14.1
Ribes viscosissimum	11	14.1
Rorippa microtitis	11	14.1
Unknown Apiaceae	11	14.1
Unknown Fern	11	14.1
Viola sp.	11	14.1
Acmispon wrightii	10	12.8
Agrostis sp.	10	12.8
Artemisia campestris	10	12.8
Barbarea orthoceras	10	12.8
Castilleja sp.	10	12.8
Chamerion angustifolium	10	12.8
Chenopodium atrovirens	10	12.8
Chenopodium capitatum	10	12.8
Delphinium geraniifolium	10	12.8
Delphinium sp.	10	12.8
Erigeron neomexicanus	10	12.8
Erigeron tracyi	10	12.8
Festuca ovina	10	12.8

Galium aparine	10	12.8
Grindelia squarrosa	10	12.8
Nasturtium officinale	10	12.8
Pseudotsuga menziesii	10	12.8
Ranunculus cardiophyllus	10	12.8
Rubus parviflorus	10	12.8
Solidago missouriensis	10	12.8
Thermopsis montana	10	12.8
Unknown Boraginaceae	10	12.8
Antennaria sp.	9	11.5
Bidens tenuisecta	9	11.5
Bouteloua hirsuta	9	11.5
Ceanothus fendleri	9	11.5
Cornus sericea	9	11.5
Galium triflorum	9	11.5
Glyceria grandis	9	11.5
Hymenoxys sp.	9	11.5
Lupinus sp.	9	11.5
Oxalis stricta	9	11.5
Pericome caudata	9	11.5
Potentilla sp.	9	11.5
Rhus aromatica	9	11.5
Schedonorus arundinaceus	9	11.5
Schedonorus sp.	9	11.5
Scirpus sp.	9	11.5
Senecio flaccidus	9	11.5
Sphaeralcea sp.	9	11.5
Symphyotrichum foliaceum	9	11.5
Symphotrichum sp.	9	11.5
Tagetes micrantha	9	11.5
Thermopsis rhombifolia	9	11.5
Trifolium repens	9	11.5
Valeriana sp.	9	11.5
Alopecurus aequalis	8	10.3
Alopecurus geniculatus	8	10.3
Arabis sp.	8	10.3
Bromus sp.	8	10.3
Cerastium brachypodum	8	10.3
Cirsium arizonicum	8	10.3
Eriogonum alatum	8	10.3
Eriogonum sp.	8	10.3
Helianthus nuttallii	8	10.3
Lathyrus lanszwertii	8	10.3
Linum sp.	8	10.3
Oenothera sp.	8	10.3

Oxalis sp.	8	10.3
Phleum alpinum	8	10.3
Plantago patagonica	8	10.3
Unknown Lamiaceae	8	10.3
Veronica anagallis-aquatica	8	10.3
Agoseris glauca	7	9.0
Amaranthus sp.	7	9.0
Artemisia frigida	7	9.0
Chenopodium sp.	7	9.0
Cymopterus sp.	7	9.0
Eleocharis palustris	7	9.0
Erigeron concinnus	7	9.0
Ericameria nauseosa	7	9.0
Euphorbia serpyllifolia	7	9.0
Fallopia convolvulus	7	9.0
Gentianella amarella	7	9.0
Gutierrezia sarothrae	7	9.0
Juniperus sp.	7	9.0
Medicago sativa	7	9.0
Mimulus sp.	7	9.0
Pedicularis parryi	7	9.0
Persicaria amphibia	7	9.0
Polygonum sawatchense	7	9.0
Portulaca oleracea	7	9.0
Potentilla plattensis	7	9.0
Sambucus racemosa	7	9.0
Sisyrinchium arizonicum	7	9.0
Unknown Solanaceae	7	9.0
Vitis arizonica	7	9.0
Antennaria rosea	6	7.7
Carex oreocharis	6	7.7
Cirsium arvense	6	7.7
Cryptantha sp.	6	7.7
Delphinium nuttallianum	6	7.7
Delphinium scopulorum	6	7.7
Erigeron formosissimus	6	7.7
Glyceria borealis	6	7.7
Helianthus annuus	6	7.7
Hesperostipa comata	6	7.7
Lithospermum viridiflora	6	7.7
Lolium perenne	6	7.7
Malva neglecta	6	7.7
Melica porteri	6	7.7
Monarda sp.	6	7.7
Orobanche fasciculata	6	7.7

Oxalis alpina	6	7.7
Persicaria maculosa	6	7.7
Salix lasiolepis	6	7.7
Selaginella sp.	6	7.7
Sonchus arvensis	6	7.7
Typha latifolia	6	7.7
Verbena sp.	6	7.7
Zuloagaea bulbosa	6	7.7
Achnatherum robustum	5	6.4
Asclepias sp.	5	6.4
Berberis repens	5	6.4
Brickellia sp.	5	6.4
Bromus carinatus	5	6.4
Calamagrostis stricta	5	6.4
Carex senta	5	6.4
Cerastium fastigiatum	5	6.4
Chenopodium leptophyllum	5	6.4
Cystopteris sp.	5	6.4
Descurainia sophia	5	6.4
Elymus sp.	5	6.4
Erigeron oreophilus	5	6.4
Euphorbia brachycera	5	6.4
Festuca saximontana	5	6.4
Helianthella quinquenervis	5	6.4
Lomatium sp.	5	6.4
Lupinus kingii	5	6.4
Malaxis macrostachya	5	6.4
Oenothera hexandra	5	6.4
Paxistima myrsinites	5	6.4
Plantago lanceolata	5	6.4
Robinia neomexicana	5	6.4
Rorippa sphaerocarpa	5	6.4
Schoenoplectus acutus	5	6.4
Schizachyrium scoparium	5	6.4
Sidalcea candida	5	6.4
Sisyrinchium longipes	5	6.4
Thinopyrum intermedium	5	6.4
Tragia nepetifolia	5	6.4
Verbena bracteata	5	6.4
Viola sororia	5	6.4
Xanthium strumarium	5	6.4
Acer negundo	4	5.1
Agoseris sp.	4	5.1
Allium cernuum	4	5.1
Aquilegia chrysantha	4	5.1

Aquilegia sp.	4	5.1
Boehmeria cylindrica	4	5.1
Calamagrostis canadensis	4	5.1
Carex scoparia	4	5.1
Dalea polygonoides	4	5.1
Elymus canadensis	4	5.1
Eremogone congesta	4	5.1
Eremogone eastwoodiae	4	5.1
Erysimum capitatum	4	5.1
Gaura sp.	4	5.1
Helianthus sp.	4	5.1
Hieracium fendleri	4	5.1
Juniperus communis	4	5.1
Juniperus deppeana	4	5.1
Leptosiphon nuttallii	4	5.1
Linum perenne	4	5.1
Monardella sp.	4	5.1
Pinus strobiformis	4	5.1
Poa sp	4	5.1
Polygonum sp.	4	5.1
Potentilla macounii	4	5.1
Ranunculus pedatifidus	4	5.1
Rumex salicifolious	4	5.1
Salix laevigata	4	5.1
Solidago simplex	4	5.1
Sorbus scopulina	4	5.1
Tradescantia pinetorum	4	5.1
Unknown Caryophyllaceae	4	5.1
Abies sp.	3	3.8
Anticlea elegans	3	3.8
Beckmannia syzigachne	3	3.8
Carex vesicaria	3	3.8
Carex wootonii	3	3.8
Castilleja sulphurea	3	3.8
Cerastium fontanum	3	3.8
Collomia linearis	3	3.8
Conium maculatum	3	3.8
Delphinium barbeyi	3	3.8
Draba sp.	3	3.8
Elymus glaucus	3	3.8
Eragrostis curvula	3	3.8
Eremogone aberrans	3	3.8
Erigeron ursinus	3	3.8
Festuca rubra	3	3.8
Galium fendleri	3	3.8

Juncus longistylis	3	3.8
Lappula occidentalis	3	3.8
Linum neomexicanum	3	3.8
Melilotus albus	3	3.8
Mimulus dentilobus	3	3.8
Monarda citriodora	3	3.8
Monardella odoratissima	3	3.8
Oenothera coronopifolia	3	3.8
Packera neomexicana	3	3.8
Parthenocissus vitacea	3	3.8
Pedicularis grayi	3	3.8
Picea sp.	3	3.8
Populus angustifolia	3	3.8
Potentilla pensylvanica	3	3.8
Primula pauciflora	3	3.8
Prunus virginiana	3	3.8
Rhamnus betulifolia	3	3.8
Rubus sp.	3	3.8
Scutellaria sp.	3	3.8
Sphaeralcea coccinea	3	3.8
Sphaeralcea fendleri	3	3.8
Symphoricarpos oreophilus	3	3.8
Trifolium pratense	3	3.8
Unknown Polygonaceae	3	3.8
Abies concolor	2	2.6
Abies lasiocarpa	2	2.6
Agastache sp.	2	2.6
Ageratina herbacea	2	2.6
Agrostis exarata	2	2.6
Agrostis scabra	2	2.6
Allium geyeri	2	2.6
Ambrosia artemisiifolia	2	2.6
Ambrosia sp.	2	2.6
Asclepias speciosa	2	2.6
Bidens laevis	2	2.6
Bromus japonicus	2	2.6
Calamagrostis sp.	2	2.6
Calochortus sp.	2	2.6
Carex microptera	2	2.6
Carex occidentalis	2	2.6
Carex stipata	2	2.6
Castilleja linariifolia	2	2.6
Cercocarpus montanus	2	2.6
Cirsium parryi	2	2.6
Cryptantha setosissima	2	2.6

Danthonia parryi	2	2.6
Elaeagnus angustifolia	2	2.6
Eleocharis bella	2	2.6
Eremogone fendleri	2	2.6
Eremogone sp.	2	2.6
Erigeron vreelandii	2	2.6
Festuca idahoensis	2	2.6
Galium bifolium	2	2.6
Galium mexicanum	2	2.6
Geum sp.	2	2.6
Glechoma hederacea	2	2.6
Gnaphalium sp.	2	2.6
Hedeoma oblongifolia	2	2.6
Juglans major	2	2.6
Juncus nevadensis	2	2.6
Lappula squarrosa	2	2.6
Lathyrus graminifolius	2	2.6
Lithospermum sp.	2	2.6
Lupinus caudatus	2	2.6
Lupinus concinnus	2	2.6
Lysimachia hybrida	2	2.6
Mertensia sp.	2	2.6
Mimulus glabratus	2	2.6
Monarda pectinata	2	2.6
Muhlenbergia sp.	2	2.6
Mulgedium oblongifolium	2	2.6
Oenothera cespitosa	2	2.6
Osmorhiza sp.	2	2.6
Oxalis dillenii	2	2.6
Panicum sp.	2	2.6
Pedicularis sp.	2	2.6
Pinus flexilis	2	2.6
Plantago eriopoda	2	2.6
Potentilla rivalis	2	2.6
Pseudostellaria jamesiana	2	2.6
Ranunculus uncinatus	2	2.6
Ribes leptanthum	2	2.6
Salix geyeriana	2	2.6
Salix ligulifolia	2	2.6
Schedonorus pratensis	2	2.6
Solidago canadensis	2	2.6
Solidago lepida	2	2.6
Sonchus oleracea	2	2.6
Stellaria sp.	2	2.6
Symphyotrichum falcatum	2	2.6

Symphoricarpos rotundifolius	2	2.6
Trifolium neurophyllum	2	2.6
Trisetum spicatum	2	2.6
Unknown Cactaceae	2	2.6
Unknown Shrub	2	2.6
Valeriana arizonica	2	2.6
Valeriana edulis	2	2.6
Veronica arvensis	2	2.6
Veronica sp.	2	2.6
Wyethia arizonica	2	2.6
Acmispon oroboides	1	1.3
Agropyron cristatum	1	1.3
Agrostis idahoensis	1	1.3
Allium bisceptrum	1	1.3
Alopecurus sp.	1	1.3
Amaranthus albus	1	1.3
Anaphalis margaritacea	1	1.3
Anemone cylindrica	1	1.3
Antennaria rosulata	1	1.3
Arabis pycnocarpa	1	1.3
Argemone munita	1	1.3
Arnica sp.	1	1.3
Arrhenatherum elatius	1	1.3
Artemisia sp.	1	1.3
Asclepias tuberosa	1	1.3
Astragalus argophyllus	1	1.3
Astragalus gilensis	1	1.3
Astragalus humistratus	1	1.3
Atriplex canescens	1	1.3
Avena barbata	1	1.3
Bromus commutatus	1	1.3
Calochortus ambiguus	1	1.3
Camelina microcarpa	1	1.3
Campanula rotundifolia	1	1.3
Capsella bursa-pastoris	1	1.3
Carex aquatilis	1	1.3
Carex aurea	1	1.3
Carex diandra	1	1.3
Carex interior	1	1.3
Carex siccata	1	1.3
Centaurea solstitialis	1	1.3
Cerastium texanum	1	1.3
Chenopodium rubrum	1	1.3
Chimaphila umbellata	1	1.3
Cichorium intybus	1	1.3

Cirsium neomexicanum	1	1.3
Claytonia perfoliata	1	1.3
Corydalis sp.	1	1.3
Cosmos parviflorus	1	1.3
Crepis acuminata	1	1.3
Cryptantha cinerea	1	1.3
Cynoglossum officinale	1	1.3
Dalea sp.	1	1.3
Descurainia obtusa	1	1.3
Descurainia pinnata	1	1.3
Dianthus armeria	1	1.3
Draba aurea	1	1.3
Draba rectifructa	1	1.3
Drymaria effusa	1	1.3
Dryopteris sp.	1	1.3
Echeandia flavescens	1	1.3
Eleocharis parishii	1	1.3
Elymus repens	1	1.3
Epilobium sp.	1	1.3
Eragrostis mexicana	1	1.3
Eragrostis pectinacea	1	1.3
Erigeron grandiflorus	1	1.3
Erigeron versicolor	1	1.3
Erysimum repandum	1	1.3
Euphorbia chamaesula	1	1.3
Euphorbia dentata	1	1.3
Euphorbia fendleri	1	1.3
Euphorbia glyptosperma	1	1.3
Euphorbia spathulata	1	1.3
Festuca calligera	1	1.3
Fraxinus anomala	1	1.3
Fragaria sp.	1	1.3
Gentianella sp.	1	1.3
Geum aleppicum	1	1.3
Glandularia bipinnatifida	1	1.3
Glandularia goodingii	1	1.3
Glyceria sp.	1	1.3
Hedeoma sp.	1	1.3
Heracleum sphondylium	1	1.3
Heuchera parvifolia	1	1.3
Hymenoxys brandegeei	1	1.3
Ipomoea plummerae	1	1.3
Juncus bufonius	1	1.3
Juncus confusus	1	1.3
Juniperus osteosperma	1	1.3

Juncus tenuis	1	1.3
Juncus torreyi	1	1.3
Kochia scoparia	1	1.3
Laennecia coulteri	1	1.3
Lathyrus sp.	1	1.3
Lathyrus laetivirens	1	1.3
Lemna sp.	1	1.3
Lepidium ramosissimum	1	1.3
Lewisia pygmaea	1	1.3
Ligusticum porteri	1	1.3
Linum aristatum	1	1.3
Lithospermum cobrense	1	1.3
Lithospermum incisum	1	1.3
Lonicera arizonica	1	1.3
Malva parviflora	1	1.3
Malva sp.	1	1.3
Micranthes odontoloma	1	1.3
Mimulus primuloides	1	1.3
Montia chamissoi	1	1.3
Muhlenbergia andina	1	1.3
Muhlenbergia richardsonis	1	1.3
Munroa squarrosa	1	1.3
Nepeta sp.	1	1.3
Noccaea fendleri	1	1.3
Oenothera albicaulis	1	1.3
Oenothera villosa	1	1.3
Osmorhiza depauperata	1	1.3
Packera sp.	1	1.3
Packera multilobata	1	1.3
Persicaria sp.	1	1.3
Peritoma serrulata	1	1.3
Phacelia alba	1	1.3
Phacelia sp.	1	1.3
Phacelia neomexicana	1	1.3
Phemeranthus parviflorus	1	1.3
Phragmites sp.	1	1.3
Physaria sp.	1	1.3
Pinus sp.	1	1.3
Plantago sp.	1	1.3
Polygonum ramosissimum	1	1.3
Potentilla sanguinea	1	1.3
Primula tetandra	1	1.3
Prunus emarginata	1	1.3
Pyrola sp.	1	1.3
Ranunculus pensylvanicus	1	1.3

Rhus glabra	1	1.3
Rorippa curvipes	1	1.3
Rorippa palustris	1	1.3
Rosa sp.	1	1.3
Salix gooddingii	1	1.3
Salix lucida	1	1.3
Salix lutea	1	1.3
Salvia reflexa	1	1.3
Salsola tragus	1	1.3
Salvia sp.	1	1.3
Scleria lithosperma	1	1.3
Scutellaria lateriflora	1	1.3
Sedum sp.	1	1.3
Senecio arizonicus	1	1.3
Senecio eremophilus	1	1.3
Senecio spartioides	1	1.3
Sisyrinchium sp.	1	1.3
Solidago altissima	1	1.3
Solidago multiradiata	1	1.3
Solidago nana	1	1.3
Solidago velutina	1	1.3
Solidago wrightii	1	1.3
Sphaeralcea digitata	1	1.3
Spiranthes romanzoffiana	1	1.3
Sporobolus cryptandrus	1	1.3
Stellaria longipes	1	1.3
Thalictrum dasycarpum	1	1.3
Thelesperma megapotamicum	1	1.3
Torreyochloa pallida	1	1.3
Tradescantia sp.	1	1.3
Unknown Polemoniaceae	1	1.3
Veronica wormskjoldii	1	1.3
Xanthisma gracile	1	1.3
Yucca baccata	1	1.3
Yucca sp.	1	1.3

Table 5. Variables important in explaining occupancy by New Mexico meadow jumping mouse on the Apache-Sitgreaves National Forests, Arizona. Variables with cumulative AIC weight >0.5 were considered strong predictors and variables with cumulative AIC weight 0.3 to 0.5 were considered moderately strong predictors. Variables with cumulative AIC weights <0.3 were considered weak predictors.

Variable	Cumulative AIC weight	Response
Mean total vegetation height	0.995	positive
Mean stream width	0.983	positive
Percent alder cover	0.972	positive
Stream gradient	0.954	negative
Percent forb cover	0.877	positive
Wild ungulate grazing (deer, elk)	0.754	positive
Mean soil moisture	0.643	positive
Percent sedge cover	0.426	positive
Plant richness	0.203	positive
Cattle grazing	0.169	negative
Percent grass cover	0.089	negative
Distance to roads	0.019	positive
Distance from recreational sites	0.022	positive

Table 6. Variables important in predicting presence of New Mexico meadow jumping mice on the Apache-Sitgreaves (Arizona), Lincoln (New Mexico), and Santa Fe (New Mexico) National Forests from a preliminary logistic regression analysis comparing sites with to those without jumping mice.

Variable	Estimate	SE	X^2	P
Intercept	-15.95	3.44	21.54	<.0001
Plant species richness	+0.06	0.02	12.09	0.0005
% ground cover	+0.13	0.04	11.72	0.0006
Total vegetation height (cm)	+0.07	0.02	10.25	0.001
Average width of stream (m)	+0.45	0.20	5.27	0.02
% sedge cover	+0.04	0.02	4.36	0.04
% alder cover	+0.39	0.19	4.26	0.04
% water cover	+0.18	0.09	3.88	0.05
% forb cover	+0.27	0.15	3.25	0.07

Table 7. Families and potential plant species identified in the diet of New Mexico meadow jumping mice from fecal samples collected during live trapping on the Apache-Sitgreaves National Forests, Arizona, summer 2016. Metagenomics approach used for identification.

Family	Potential species
Salicaceae	willow
Solanaceae	wild potato and variations
Poaceae	grass
Amaranthaceae	amaranth
Phrymaceae	monkeyflower
Fabaceae	clover, legume
Brassicaceae	mustards
Linaceae	blue flax
Asteraceae	wild oysterplant, sunflower
Geraniaceae	wild geranium
Amaryllidaceae	wild onion
Boraginaceae	bluebell, starflower, combseed
Rosaceae	wild rose

Table 8. Summary of home ranges using Minimum Convex Polygon (MCP) and Kernel Density Probability (95%) in hectares (ha) for 7 New Mexico meadow jumping mice from Apache-Sitgreaves and Santa Fe National Forests, 2017. Sex is M = male and F = female. Number of locations for each animal (n) is adequate to calculate home range when n > 30 (150.180 lacks adequate sample size but is presented here). Mean and maximum distance from last location is the average and maximum distance between consecutive nocturnal locations. Maximum distance from centroid is the furthest distance observed relative to the center of the home range (centroid). Distance from stream is the distance, in meters, to the closest point on the nearest flowline. Maximum distance from stream is the furthest distance observed; mean is the average distance for all locations from flowline and SD is the standard deviation for mean distance from stream.

Animal ID	National Forest	Site	Tracking dates	Sex	n	Mean distance moved from last location (m)	Maximum distance from last location (m)	Maximum distance from centroid (m)	Maximum distance from stream (m)	Mean distance from stream (m)	SD of distance from stream (m)	MCP (ha)	95% (ha)
150.180	Santa Fe	San Antonio	30 Jul - 6 Aug	M	23	38	68	351	36	11	9	2.41	0.69
151.101	Santa Fe	Fenton Lake	30 Jul - 9 Aug	M	36	28	114	89	24	7	6	0.44	0.12
151.181	Santa Fe	Fenton Lake	30 Jul - 13 Aug	M	38	98	232	447	32	12	9	5.36	2.18
151.222	Santa Fe	San Antonio	30 Jul - 11 Aug	F	34	66	175	200	22	11	7	2.59	2.39
151.300	Apache	Nutrioso Creek	25 Aug - 8 Sep	M	54	31	76	96	18	6	5	0.58	0.54
151.342	Apache	San Francisco	28 Aug - 9 Sep	F	37	59	170	261	11	5	3	2.03	2.13
151.382	Apache	San Francisco	28 Aug - 9 Sep	M	42	36	153	121	16	7	5	1.00	0.49