WILDLIFE PRESENTATION ABSTRACTS
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Title:
Supporting Pollinator Protection and Monarch Conservation

Abstract:
The monarch butterfly occurs globally, however the subspecies that inhabits North America, *Danaus plexippus plexippus,* is imperiled. North American monarch populations have declined by over 85 percent in the last two decades. In an effort to support and increase population sizes, the Department of Energy's Pollinator Protection Plan is part of a national strategy to protect pollinators and enhance their habitats. This plan includes efforts such as planting native species, removing invasive species, roadside mowing management, and trying to minimize pesticide use. As part of this initiative, biologists at Los Alamos National Laboratory have been exploring various avenues to support pollinator protection and monarch butterfly conservation. Conservation initiatives include 1) protecting milkweed on site, 2) identifying potential areas where seeding native wildflowers, shrubs, and milkweed is possible, 3) engaging the local community through outreach, and 4) contributing data to migration and observation studies.

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Title:
Comparison of Sampling Methods for Herpetofauna in the Sonoran Desert

Abstract:
Knowledge of the distribution and abundance of species is central to our ability to effectively manage populations and develop conservation plans for threats such as habitat loss, disease, or global climate change. Reptiles and amphibians can be particularly difficult to detect because they tend to be cryptic and their activity is tied closely to temperature and weather conditions. Previous studies of trapping methods for herpetofauna have typically occurred in temperate climates where amphibian biomass is high. However, desert environments are dominated by squamate reptiles and capture efficiencies may differ from temperate areas. We used species inventory data from three years of surveys in southwestern Arizona to compare differences in the communities of reptiles and amphibians captured using three survey techniques. We found that visual encounter surveys conducted on foot detected the most species, and were the most efficient method. Drift fences detected the fewest species, but also found five snake species that were not captured using any other method. We suggest using a combination of drift fence and visual encounter surveys combined with multiple site visits to accurately characterize desert herpetofaunal communities.

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Title:
Predicting Bird Guilds Using Vegetation Structure and Woody Composition on a Wild and Scenic River in Arizona

Abstract:
Riparian areas are among the most ecologically diverse aridland ecosystems. The structure and composition of near-stream, riparian vegetation is intimately tied to hydrology and, as a result, is highly sensitive to anthropogenic water uses. Riparian forests and mesic woodlands offer complex structure that many species of wildlife use for foraging and breeding. We investigated the vegetation structure and composition of flow response tree guilds at three study reaches along the Wild and Scenic portions of the Verde River. We surveyed bird abundance during the breeding season and categorized species into guilds based upon types of habitat used for breeding, foraging, and nesting. Our top three most abundant birds were yellow warbler, chipping sparrow, and Wilson's warbler. We found that habitat structure was the most complex at plots located in gallery forest dominated by the tall tree guild that includes cottonwood (*Populus fremontii*) and willow (*Salix gooddingii*). Both riparian composition and habitat structure were useful predictors of bird guilds. Abundance of riparian obligate breeders and birds that forage and nest in low and high vegetation were associated with riparian structure, such as dense canopy cover, the tall tree guild, and multiple canopy layers. Our findings demonstrate the value of intact riparian habitat to wildlife and highlight the importance of both vegetation structure and woody composition. Our findings will be used by natural resource managers to inform riparian management practices.

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Title: Thirty years of connectivity conservation plans: an assessment of factors influencing implementation plans.

Abstract:
To identify attributes of connectivity conservation plans (CCPs) that correlated with conservation action, we gathered 263 CCPs from around the world, asked authors to characterize attributes of 109 plans, and interviewed authors and implementers of 77 CCPs to learn more about how the plans were produced and implemented. Production of CCPs started about 1990 and increased markedly on all continents. Europe, the United States and the Republic of South Africa were leaders in CCP production. Most plans were followed by implementation actions such as highway crossing structures, ecological restoration, land purchases or easements, or recognition of corridors through zoning or government designation. Broad-brush vision plans were useful decision-support tools for transportation and land-planning agencies. Interviewees highlighted the need for transportation, land-use planning, or regulatory agencies to request development of a CCP. Stakeholder involvement was also important late in CCP development, but not during the intermediate phases. Types of data and models used to develop the CCP were unimportant as long as procedures were transparent and repeatable. Other factors favoring plan implementation were leadership continuity, providing specific recommendations for implementation, and the existence of enabling legislation and policy.

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Title:
Effects of Urbanization on an Assemblage of Sonoran Desert Snakes

Abstract:
Since Arizona became a state in 1912, human population has increased exponentially, resulting in massive expansion of urban areas. This dramatic growth had had a negative impact on biodiversity and richness due to habitat loss and fragmentation and increased wildlife mortality. Multiple studies have demonstrated these impacts on mammals, birds and fish, but reptiles, and snakes in particular, are often underrepresented in the literature. To help address the lack of research on snakes, we monitored a Sonoran Desert snake assemblage comprised of 21 species in an urbanizing residential development. We conducted nightly road cruising surveys from May-August from 2002-2019 as the development grew from 18 to 289 homes. Using number of houses as a proxy for urbanization, we examined changes in species diversity, richness, evenness and biomass, to make inferences about potential effects of development on herpetofaunal communities.
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Title:
Cause-specific Mortality and Survival of Elk in the Mexican Wolf Recovery Area in New Mexico and Arizona

Abstract:
Since the reintroduction of Mexican wolves in 1998, there has been limited investigation into the potential influence of Mexican wolf recovery on vital rates of elk populations. Scat analysis studies have revealed that elk comprised greater than 70% of the Mexican wolf diet, but the population-level impact of wolf recovery on elk is unknown. Further, the Mexican wolf population has more than doubled from an estimated 42 individuals in 2009 to a minimum of 131 individuals in 2019. Given the recent increase in Mexican wolf population and the expectation of future growth in both size and distribution under the current recovery plan, it is important to understand if Mexican wolf predation is an additive, compensatory, or partially compensatory source of mortality for elk. Starting in February of 2019, 427 iridium GPS collars were placed on adult, female elk to monitor survival across western New Mexico and eastern Arizona in the Gila, Cibola, and Apache-Sitgreaves National Forests. In addition, we captured 229 elk neonates and fitted them with VHF ear tags during the 2019 calving season. Data collected from these collared individuals will be used to estimate survival rates and determine cause-specific mortality. Preliminary results will be presented.
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Title:
It's Good to be Home Again: PIT Tags Document Cave Myotis Activity at Kartchner Caverns, AZ

Abstract:
Banding or other visual markings are effective for monitoring vertebrates but are less successful for bats. Between 1932 and 1972, approximately 1.5 million bands were applied to bats across North and Central America. Unfortunately, recovery rates for bat bands are extremely low (0.3% ±) and bands have caused serious wing injuries. Because of these injuries, a bat band moratorium was declared in 1973 by the American Society of Mammologists. Fortunately newer passive integrated transponder (PIT) tag technology has offered a tremendous tool to monitor bat activity without repeat captures. In 2008, R. Sidner and D. Buecher began a pilot PIT tagging project on the cave myotis (*Myotis velifer*) at Kartchner Caverns State Park (KCSP), Benson, Arizona. That project ran each summer until the death of R. Sidner in 2014. Since 2018 the project has gained renewed energy aided by the huge support of KCSP's Cave Unit. We will show the effectiveness of PIT tagging for monitoring cave myotis accessing a small cave entrance. Between years 2008-2013, 66 PIT tagged bats were detected 1,815 times exiting or entering the cave. When the study was renewed in 2018 we discovered cave myotis, with PIT tags injected during 2009, 2012, 2013, and 2014, that were still using Kartchner Cavern. During 2018 and 2019 we tagged an additional 37 cave myotis and recorded >1,000 events by these bats accessing the cave entrance. Given on-going threats from white-nose syndrome and climate change, the PIT tag data will provide critical information regarding KCSP's maternity bat colony.

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Title:
Sound Intensity and Audibility of Masked Bobwhite Vocalizations

Abstract:
Many bird surveys are dependent upon audible detection of calls. Detection of sound is determined by its intensity and frequency, observer's distance from sound source, and weather. We measured call intensity of masked bobwhites (*Colinus virginianus ridgwayi*), an endangered quail. Then we simulated their calls during audibility trials. Audibility trials were designed to test the ability of autonomous recording units (ARU) to detect calls at various distances with various weather conditions. Each trial consisted of four transects oriented in Cardinal directions and intersected at plot center where an ARU was placed. A technician played an electronic game call which broadcast masked bobwhite calls at predetermined distances from the ARU. A weather station at plot center recorded weather conditions. We modeled detectability of calls using logistic regression with distance and weather as covariates and plot as a random effect to account for dependencies among subsamples within each trial. We conducted 17 audibility trails. Our best model indicated detectability was a function of distance, wind speed, and wind direction. As distance and wind speed increased, detectability declined. As wind blew from the sound source to the receiver, detectability increased over other wind directions. Our model revealed that detectability of a masked bobwhite call is >30% as long as wind speed is <8 km/hr in a 500-m radius plot. However, in a 1000-m radius plot, detectability falls below 20% even with no wind. Our model can be used to optimize tradeoffs among survey logistics and detectability helping with future survey design.

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Title:
Habitat Selection by Female Mule Deer in Relation to Prescribed Fire, Forest Thinning, and Wildfires

Abstract:
Decades of fire suppression, logging, and overgrazing have altered the conditions of southwestern forests resulting in reduced biodiversity, impaired habitat quality for many wildlife species and more frequent and severe wildfires. Land managers are implementing landscape-scale forest restoration treatments (prescribed fire and thinning) to mitigate the risk of catastrophic wildfires and improve habitat conditions for a variety of wildlife species. We monitored responses of female mule deer (*Odocoileus hemionus*) to forest restoration treatments and wildfires in northern New Mexico. Our goals were to: 1) assess changes in forage abundance; 2) estimate differences in forage quality; and 3) determine habitat selection patterns in relation to recent wildfires and forest restoration treatments. Biomass of herbaceous forage and oak were greater in wildfire-burned as than prescribed burns, forest thinning, and untreated areas; thinned areas tended to have higher oak forage biomass than untreated areas. Mule deer selected areas burned by prescribed fire and avoided wildfire burned and thinned areas <5 years old. Mule deer strongly selected for thinned areas >5 years old. At both the landscape and within home range scale, grasslands were avoided, pinyon-juniper woodlands were selected in winter, and oak vegetation and mixed conifer forests were selected during summer. Data collected during our study suggests mule deer benefit from recent prescribed burns and older forest thinning. Knowledge of the short- and long-term effects of restoration treatments will allow managers to make more informed decisions regarding implementation of vegetation treatments to benefit mule deer.
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Title:
How Far Do Bats Take It? A Review of Home Range Studies

Abstract:
Variation in home range sizes for terrestrial wild animals is attributed primarily to body size (larger body size increases home range size) although factors such as trophic level (species in higher trophic levels use larger home ranges), climate, breeding status, predator risk, and habitat quality (poor quality increases home range size) can influence home range use. Are home ranges for highly volant species such as bats also a reflection of animal size or trophic level? I reviewed publications to identify which peer-reviewed studies of bats focused on use of radio telemetry and identified home ranges. I categorized publications by location and decade that the study started, recorded bat species, home range sizes, method for describing home range, and focus of the study (habitat use, behavior, thermoregulatory patterns, energy balance, other). Of 1266 publications, 46% used radio telemetry to study bats but only 165 of these specified home range sizes. Number of publications per decade increased dramatically following the development of transmitters small enough to be used on bats (number of publications work conducted in the 1970s, 1980s, 1990s, 2000s, 2010s were 1, 11, 30, 92, and 31, respectively) and occurred on almost all continents. Most used Minimum Convex Polygons to estimate home range size. Bats from a variety of families and feeding guilds were studied; however, home range sizes were not always related to mass of the bat studied or feeding guild.

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Title:
Environmental DNA metabarcoding detects waterbirds in a complex assemblage: a case study from Willow Lake, Arizona

Abstract:
The use of eDNA analysis is growing rapidly in the field of wildlife and fisheries biology, and this study is one of the first to demonstrate the utility of eDNA metabarcoding as a tool to monitor waterbirds. Over the past year, we developed a 16S rRNA vertebrate metabarcoding protocol, and pilot studies resulted in eDNA detections from all vertebrate taxa, including a number of waterbirds. Based on these results, we examined whether this technique could identify members of a complex assemblage of waterbirds. During 2018, we conducted traditional waterbird surveys and collected samples for eDNA analysis from Willow Lake in Prescott, Arizona. Willow Lake is part of the Watson and Willow Lakes Ecosystem Important Bird Area, and is a waterfowl and wading bird concentration site, especially during the winter months. Traditional surveys consisted of a two-hour point count conducted by four teams at points along the shoreline. Water samples for eDNA analysis were collected in triplicate at 8 sites spanning littoral and limnetic lake zones. Traditional surveys resulted in the detection of 26 water and wetland-associated species, of which, 16 were also detected via eDNA analysis. eDNA detections included 12 species of waterfowl, and the American Coot *Fulica americana*, Pied-billed Grebe *Podilymbus podiceps*, Great Blue Heron *Ardea herodias*, Double-crested Cormorant *Phalacrocorax auritus*, and Red-winged Blackbird *Agelaius phoeniceus*. Only one species, the Wood Duck *Aix sponsa*, was detected only by eDNA. Based on these results, we believe this is a valuable tool with applications for waterbird monitoring.
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Title:
Modeling Golden Eagle Nesting Habitat Presence/Absence Across Five Bird Conservation Regions

Abstract:
We used the location of 914 golden eagle (GOEA) nests in the southwest to create a nest presence/absence predictive model. We created independent models for four Bird Conservation Regions (BCR) and a global model to predict golden eagle nest presence/absence. We used a pseudo-absence framework to create 914 paired absence points. Our analysis consisted of a binomial backwards stepwise logistic regression with 1828 points (914 = 1 and 914 = 0) related to 10 predictive spatial covariates. We ran a discrete model for each of the four BCRs and a global model with all 1828 (914 = 1 and 914 = 0) data points combined. The top fit model for the global analysis included a positive relationship with terrain ruggedness, annual precipitation and annual mean temperature and a negative relationship with maximum temperature of the warmest month and minimum temperature of the coldest month. We used GOEA locational data from White Sands Missile Range along with a bootstrap analysis to test the inferential value of these five models. The BCR-specific models performed well identifying the training data set, but the inferential value of the models varied. These findings indicate that the best use of these predictive models was to apply them only to very similar habitat and climatic types as the BCR.

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Title:
Spatial Ecology and Resource Selection of an Isolated Edge-Population: The Endemic White-bellied Vole (*Microtus longicaudus leucophaeus*) in Southern Arizona

Abstract:
Populations on the periphery of their species' distributions often exhibit unique and variable behavioral and physiological adaptations. Such populations can provide insight into species responses to shifting habitats due to large disturbances, climate change, and direct anthropogenic modifications. The Madrean Sky Island Complex is a collection of mountain islands in the American Southwest, separated by seas of desert and grasslands, representing the confluence of many different ecosystems. This region is the terminus for multiple species' distributions. Mount Graham white-bellied voles (*Microtus longicaudus leucophaeus*) are endemic to the Pinaleño Mountains in southeastern Arizona and represent the southernmost population of long-tailed voles. We radio collared 31 individuals and tracked them from May to August of 2019. To assess *M. l. leucophaeus* spatial ecology and behavior, we paired telemetry data with vegetation surveys. Average home range size did not differ significantly ($t=0.56$, $df=11$, $p=0.59$) between males ($n=5$; 200.82 ± 134.38 m^2) and females ($n=8$; 245.58 ± 144.73 m^2). We found that at the home range scale, *M. l. leucophaeus* selected for wooded areas more than open meadow areas, while at finer scales voles selected for areas with higher understory. Edge-populations are at risk, more than ever, of being lost due to climate change and habitat loss. Understanding how this edge-population responds to the multitude of threats it faces, we can better inform management and conservation actions for similarly imperiled species.
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Title:
Evaluating Risks Associated With Animal Capture and Handling

Abstract:
The ability to capture and handle animals using helicopter net-gunning has revolutionized the way we manage and conserve wildlife. Through this method of capture, we now have the ability to track the life history of animals by recapturing the same individuals for several years, and the benefits to advancing science and management that stem from such longitudinal research are vast. Yet, there are corresponding risks to study animals, associated with physical trauma or exertional myopathy, that can occur during or following capture events, and it is the responsibility of the researcher to know the risks and minimize them wherever possible. We used data collected from 1607 capture events to evaluate how animal age, nutritional condition, and various methods used in capture and handling affect survival of mule deer during and following a capture event. No methods used during capture and handling had an effect on survival. Methods we evaluated included handling time, time of year of capture, tooth extraction, and the number of times an animal had been recaptured. Although age and nutritional condition do influence annual survival of mule deer, it had no effect on the probability of a capture-related mortality. Interestingly, survival rates following capture returned to pre-capture survival rates in just three days. This finding contrasts to the two week period often used by researchers and managers for censoring mortalities following capture, and supports previous notions that censorship of all mortality data in the two weeks following capture is unnecessary and risks removal of meaningful data.

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Title:
Shepherding Students From the Lab to Publication: Teaching Students Conservation Genetics in the Laboratory Setting With Actual Case Studies

Abstract:
We developed and designed a new course to teach undergraduate students what is required to complete a laboratory research project. Two conservation genetic laboratory projects involving DNA extraction, DNA sequencing, genotyping microsatellite markers, and resulting data analyses were performed as part of a Conservation Genetics laboratory course at the University of Arizona (RNR 430/530). In addition to laboratory experience gained in collecting data, the students analyzed data, and published a peer-reviewed journal article on the results. The undergraduate students under the guidance of two PhD graduate student TAs, gained experience in all aspects of scientific research and publishing. The 2016 course investigated whether gene flow from an outside population had occurred into an Arizona Desert bighorn sheep population (*Ovis canadensis*), as a potential empirical example of genetic rescue. In 2018, our study investigated scat samples of Argali sheep (*Ovis ammon*) from the Kangai and Altai regions of Mongolia, to examine if these two regions are consistent with 1 or 2 genetic populations. What we learned from the laboratory teaching experiences will be discussed, as well as the management implications of the two research projects.
*Oral

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Title:
Assessing the impacts of a recovering predator population on prey behavior

Abstract:
Predators change prey behavior, demographics, and movements. These changes have the potential to decrease the overall fitness of prey through a reduction in foraging time, increased stress levels, and use of lower quality habitat. Although the magnitude of these indirect effects are still debated, if strong enough, they can reduce birth rates and decrease neonate survival. Prey have the ability to reduce the indirect effects of predators through behavioral changes, such as increased vigilance. This study aims to quantify the effects of the Mexican gray wolf (*Canis lupis baileyi*) reintroduction to Arizona and New Mexico on elk (*Cervus canadensis*) behavior. This ecosystem, in which the density of this recolonizing predator varies spatially, allows for a unique opportunity to better understand this relationship while simultaneously testing if elk behavioral responses to wolf risk is similar to that reported for other areas. We captured adult female in relative high and low wolf density areas and fitted them with GPS collars. We captured and VHF ear tagged a portion of the collared females' calves to determine maternal status. Lastly, we are conducting behavioral observations on known individuals to investigate the effect wolves have on elk vigilance due to the risk of predation and its interaction with offspring presence/absence. Data collection and analysis is on going with an expected completion of May 2021.
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Title:
Save the Dells: Leveraging municipal planning frameworks for habitat conservation in Prescott

Abstract:
Wildlife conservation in Arizona is largely accomplished on federally owned land, which accounts for 41% of the state. Public lands are subject to environmental laws that mandate consideration of species protection, such as the National Environmental Policy Act, the National Forest Management Act, Endangered Species Act, and others. Habitat protection on non-federal lands poses challenges, as the state of Arizona lacks land use planning frameworks that require consideration of habitat connectivity, functionality of open space, or other aspects of habitat quality. However, non-federal lands, which often occur in valley bottoms and along streams, can provide some of the best habitat in the state. Despite this, few tools exist to protect habitat on private lands, which account for 18% of the state. In Yavapai County, residential development of private land is eliminating habitat for numerous species lacking protections, including pronghorn, mule deer, and grassland birds. In Prescott, our organization, Save the Dells, is working to protect a high-priority 500-acre portion of a large proposed development by arguing that habitat conservation mandates exist within the City General Plan, Open Space Master Plan, and Land Development Code requirements for open space preservation. The priority land being sought for public open space protection is the largest private parcel in an area called the Granite Dells, a convoluted 2,500-acre landscape of granite domes, canyons, wooded valleys and creeks. In this presentation, we describe how conservation advocates can succeed in protecting functionally significant private lands by blending traditional conservation planning principles, community organizing, and grassroots political action.

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Title:
Habitat partitioning by sympatric congeners, the Mesquite Lizard (*Sceloporus grammicus*) and Crevice Swift Lizard (*Sceloporus torquatus*), in the Trans-Mexican Volcanic Belt

Abstract:
Large assemblages of sympatric congeners can persist over time via resource partitioning. Here, we sampled 100 field sites during the spring season, used habitat and meteorological measures, visual encounter surveys (No. of observers = 6), and species occupancy models to determine more specifically which variables predict the presence of these *Sceloporus* lizard species in the Trans-Mexican Volcanic Belt. Using occupancy models, we found that neither species occurs often in agricultural areas or in regions with abundant shrub cover. We found *S. grammicus* more often in forested areas with plenty of leaf litter, whereas *S. torquatus* was more often in disturbed areas (although not agricultural fields) with more rocks. In addition, we found that the probability of detecting both species increased with increasing relative humidity. Prior studies disagree on whether these two species are most common in forested or rocky areas. Our results suggest that *S. grammicus* occupies forested areas, whereas *S. torquatus* occupies more open, rocky and disturbed habitats. Our results also highlight the absence of both species in agricultural and dense shrub areas with low relative humidity. Maintaining areas with high leaf litter and boulder cover should be the primary foci of future conservation efforts for these two *Sceloporus* species.
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Title:
The spatial ecology of two endemic California Channel Island carnivores, the island fox and island spotted skunk

Abstract:
The island fox (*Urocyon littoralis santacruzae*) and island skunk (*Spilogale gracilis amphiala*) are endemic to Santa Cruz Island, one of the California Channel Islands. Listed as endangered in 2004, the island fox was delisted in 2016, but long-term population monitoring indicates that as fox populations increased there was a steady decline in spotted skunk captures, hypothesized to be due to competition with foxes. Although the two species overlap considerably in diet, little is known about spatial use patterns. We tested the hypothesis that skunks would select steeper slopes and denser cover based on GPS data from 11 individuals (8 foxes and 3 spotted skunks) from Fall 2018. We found that foxes moved widely through their home range, covering 60% of their home range during one week of movements. In contrast, skunks were more restricted in movements, covering only 16% of their home range in one week. We also found support for our hypothesis; fox locations were in areas with lower slope and lower vegetation cover compared to skunks. Overall, our results are consistent with spatial niche partitioning between foxes and spotted skunks and suggest that current population monitoring techniques designed for foxes may not adequately sample areas used by skunks. We provide recommendations for how skunk populations could be monitored to better determine if spotted skunk populations are truly in decline.
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Title:
The distribution of Jemez Mountains salamanders in relation to geology, topography and other biogeographical factors.

Abstract:
The Jemez Mountains salamander is a lungless salamander endemic to north-central New Mexico. Large and severe wildfires within its habitat have prompted its federal listing as endangered. Because of its limited movement habits, underground habitats, depending on geology and topography, might restrict its extent of occurrence. Our objectives were to evaluate whether and how the geology, geomorphology, topography and fault systems in the Jemez Mountains influence its distribution. To that end, we calculated detection and occupancy estimates throughout its area of occurrence and constructed models of potential landscape suitability at fine scales (5m). Preliminary results indicate that salamander occurrence is related to Bandelier Tuff in steep and topographically complex areas. In addition, models identify that areas suitable for the salamander are best explained by variables that describe precipitation, geology, and topographic complexity. Because our results suggest that geological features may exert an influence on salamander distribution, we suggest a thorough evaluation of its current extent of occurrence and a consideration of geology during study design and surveys for the salamander.

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Title:
Conservation and management of Flat-tailed Horned Lizards (*Phrynosoma mcallii*) in Arizona.

Abstract:
The Flat-tailed Horned Lizard (*Phrynosoma mcallii*) is distributed within a limited range, which includes extreme southwestern Arizona and southern California, United States and Baja California and Sonora, Mexico. Human expansion in these areas has caused significant habitat and range reduction. Here we discuss the conservation and management of *P. mcallii* in Arizona. We provide results on long-term monitoring of the lizard, including 12 years of demographic monitoring, nine years of occupancy monitoring, and a population viability analysis carried out on *P. mcallii* populations in Arizona. Our demographic dataset includes 2,438 captures with 796 individuals marked. Adult population size has fluctuated over time, including a decline since 2010. Though adult population trends were negative, recruitment remains viable. Occupancy declined from 2011 to 2019, with estimates of 0.89 ± 0.04 and 0.76 ± 0.05, respectively. Additionally, to determine the vulnerability of populations and relative risk of extinction for *P. mcallii* in Arizona, we carried out a structured population viability analysis using demographic and occupancy data. Results suggested a low risk of population extinction (0.07 ± 0.01) in Arizona over the next 100 years. Sensitivity analyses revealed the most important drivers of population growth are age of first offspring, clutch size, and mortality of juveniles. Our future efforts include a 3-year reproductive study on *P. mcallii* and continued surveys of our long-term monitoring plots.

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Title: Managing water to reduce unintended consequences for desert bighorn sheep

Abstract:
Wildlife managers aspire to increase populations of game animals, especially desert bighorn sheep (Ovis canadensis nelsoni), by establishing water catchments, translocation and conducting predator control. Water is provided year-round, raising concern over unintended consequences, like matching patterns of predator visits, potentially enabling predators to inhabit locations they otherwise could not. Increased predation, reduced game abundance, lower translocation success and additional predator control could result. Alternatively, restricting water availability to match the patterns of game visits might reduce predator distributions and predation. To inform these hypotheses, we identified when desert bighorn sheep, mule deer (Odocoileus hemionus), coyotes (Canis latrans) and mountain lions (Puma concolor) visited managed waters in three North American deserts (Chihuahuan, Sonoran, Mojave). We associated species visits with four weather variables using multi-site, multi-species models within a Bayesian hierarchical framework, to explain visit patterns. In the Chihuahuan, Sonoran and Mojave deserts, April-August, May-August, and the May-September periods captured 70% (SD 0.09), 85% (SD 0.07) and 83% (SD 0.11) of desert bighorn sheep visits, respectively. These same periods recorded 42% (SD 0.20), 54% (SD 0.14), and 32% (SD 0.27) of mountain lion visits, and 33% (SD 0.19), 56% (SD 0.11), and 52% (SD 0.21) coyote visits. Higher maximum temperatures and less long-term precipitation (prior 6-week total) raised visits for desert bighorn sheep and mule deer. Mountain lion visits increased with less long-term precipitation, more visits by mule deer (Mojave and Chihuahuan) and desert bighorn sheep (Sonoran). Mountain lions and coyotes visited water approximately two (Sonoran) – 70 (Chihuahuan) times, or two (Sonoran) – 28 (Chihuahuan) times more often than desert bighorn sheep and mule deer, respectively, for each unit decline in the amount of long-term precipitation. Providing water year-round appears unnecessary for desert bighorn sheep, but necessary for mountain lions and coyotes. Aligning water provision with visits by target species could reduce predation and alleviate predator control.

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Title: Effects of Urbanization on Three Sonoran Desert Rattlesnake Species

Abstract:
Among snake species, rattlesnakes are relatively well studied. However, there exist significant gaps in our knowledge of how urban development affects rattlesnakes. Understanding anthropogenic impacts associated with urban development is critical for developing effective conservation strategies. Since 2002, we conducted repeated surveys at Stone Canyon, an urbanizing residential development located at the base of the Tortolita Mountains near Tucson, Arizona. Making use of 1,397 rattlesnake surveys stretching from 2002-2019, we modeled count data and a suite of explanatory variables (e.g., temperature, humidity, precipitation) thought to have an effect on activity, to examine responses to urban development of Western Diamondback Rattlesnakes (*Crotalus atrox*, n = 260), Tiger Rattlesnakes (*Crotalus tigris*, n = 502) and Black-tailed Rattlesnakes (*Crotalus molossus*, n = 217). We found significant and differential species-specific effects of increasing urbanization (from 17 to 278 houses). We discuss results as they relate to rattlesnake ecology in general, and to the influence of anthropogenic factors on populations over time.
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Title:
Springs of the Colorado River Basin: An examination of spring types and water characteristics across elevation, and human population density over time.

Abstract:
The Colorado River basin (CRB) is the primary water source for southwestern North America, with more than half of its baseflow provided by springs, whose flow, biodiversity, and socio-economics have received little attention. We used existing literature, available databases, and field inventories to report on the distribution and status of 20,872 springs in the CRB. Springs are nonrandomly distributed, with highest density in montane and cliff-dominated settings, and relatively few on valley floors. Here we look at elevational patterns of spring type, flow, pH, water temperature and specific conductance within the CRB as a whole, and separately within the upper and lower portions of the CRB. We also look at human population trends at spring sites. Rheocrene spring types are the most common in the CRB, followed by hillslope, helocrene and hanging gardens. We see an interesting elevational pattern with helocrenes occurring predominately at higher elevations, and hanging gardens in lower elevations. We find no statistical relationship with spring flow, but we see water temperature, pH and specific conductance declining as elevation rises. These patterns may be partially driven by a large number of relatively acidic boggy helocrene springs and fens at high elevations in the Ashley National Forest in northeastern Utah. We see human population densities increase at spring sites by between 0.11 and 0.12 people per km^2 per year, which is considerably lower than the general change in population density in the CRB (0.34) and lower basin (0.58), but slightly higher than that of the upper basin (0.05).

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Title:
Monitoring Gila Monster Health in an Urbanizing Environment

Abstract:
From 2002-2005, we obtained cloacal and oral swabs from 162 Gila Monster (*Heloderma suspectum*) captures at an urbanizing study site near Tucson, Arizona. Cultures yielded 15 different genera of bacteria, three of which are known to be pathogenic to reptiles, including *Aeromonas, Salmonella* and *Pseudomonas*. We also discovered other bacterial genera that were previously unknown from *H. suspectum*. The results of our initial study failed to determine the "normal" flora comprising the microbiome of the species. Literature published on *H. suspectum* and other herpetofauna, has not considered health of wild *H. suspectum*, which may be of particular interest in the context of urbanization, which is a leading threat to this iconic species. Protected throughout their entire range in the US and Mexico, and listed as Vulnerable by the IUCN, populations of *H. suspectum* are likely declining in response to habitat destruction, road mortality, and climate change. Therefore, a more thorough understanding of the potential influence of urban development on bacterial pathogens has become increasingly important for conservation of the species. We discuss results from our previous research and outline follow-up efforts to re-examine pathogen levels in *H. suspectum*, as the development has expanded from less than 20 houses in 2002 to nearly 300 houses in 2020.

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Title:
Investigating vocalizations as a potential reproductive isolating mechanism of Gilded and Red shafted Flickers in Arizona

Abstract:
Gilded Flickers (*Colaptes chrysoides*) and Red-shafted Flickers (*C. auratus*) are two species of woodpeckers in Arizona. Gilded Flickers inhabit saguaro cactus forests of the Sonoran Desert and Red-shafted Flickers inhabit mixed conifer and pine forests in higher elevation woodlands. Historically, where their ranges overlap in mature riparian forests, hybrids between the two species have been observed. Current genetic studies indicate there is gene flow between the two species. It is predicted that the ranges of these two birds will overlap to a much greater extent in the near future as a result of changes to the climate. This could potentially increase the incidence of hybridization which would threaten the genomic integrity Gilded Flickers as a result of "genetic swamping". Hybridization is generally prevented by the presence of reproductive isolating mechanisms (RIMs), and in many bird species, vocalizations serve as an important RIM. RIMs, including vocalizations, between Gilded and Red-shafted Flickers have never been investigated. My objective was to evaluate the potential of vocalizations to serve as a RIM between Gilded and Red-shafted Flickers in Arizona. I conducted playback experiments presenting conspecific and heterospecific playback to each species at 39 different locations throughout the state. I recorded vocal and behavioral responses of the birds being presented with playback. Overall, I found no difference in responses to conspecific versus heterospecific playback, indicating vocalizations do not serve as a RIM, and hybridization may occur when the ranges of these two species overlap to a greater extent in the future.
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Title:
Fire severity influences habitat use of medium and large-sized mammals in the White Mountains of Arizona

Abstract:
Wildfires are reportedly increasing in extent, intensity, and frequency in the western US with substantial impacts to the environment and wildlife populations. However, relatively little is known about how a suite of mammals respond to landscapes experiencing mixed-severity fires. This information is critical for managing landscapes and wildlife populations. Across the gradient of fire severity, I evaluated how wildfire affected wildlife populations, specifically related to herbivores (e.g., elk and deer) and carnivores (e.g., mountain lions and wolves). In 2018, I deployed 50 wildlife cameras across the gradient of burn severity in the White Mountains of Arizona, which experienced the state's largest wildfire, the Wallow Fire, in 2011. To evaluate the response of wildlife to wildfire, I used occupancy models to estimate the relative use and abundance of animals in relation to fire severity. Although most wildlife species were observed across the entire gradient of fire severity, some species (e.g., mule deer and elk) demonstrated greater use of areas characterized by higher severity fires. This was likely related to the increased abundance of forage (e.g., grasses, forbs, shrubs, aspen trees) in these areas. I discuss management implications of this research and next steps for this project.

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Title: Micro-habitat selection by the Peñasco least chipmunk

Introduction

The Peñasco least chipmunk (*Neotamias minimus atristriatus*) is a candidate for federal listing under the Endangered Species Act (ESA) and is only known to persist in the Sierra Blanca subrange of the Sacramento Mountains, New Mexico. Sierra Blanca Peak is the highest mountain in the range at 3,649m (11,973 ft), and least chipmunks were recorded there in 1931, 1965 and 1985 (Frey & Boykin 2007; Conley 1970; Sullivan and Peterson 1988). Surveys in 2016 confirmed two subpopulations adjacent to Sierra Blanca Peak, known respectively as the Lookout Mountain and Ice Springs subpopulations (Frey & Hays 2017). Lookout Mountain is a sub-peak (3531m; 11,584ft) of Sierra Blanca, located within a large patch of subalpine meadow and tundra contiguous with that on Sierra Blanca Peak, and is characterized by rocky soil, sparse grass, alpine forbs, patchy gooseberry, and sparse Engelmann's spruce. Ice Springs is a lower wetter meadow site (3424m; 11,233ft), characterized by large old growth Engelmann's spruce, dense and abundant gooseberry, and grassy meadow patches. As part of a multi-scale study on habitat selection by the Peñasco least chipmunk, we collared and tracked a subset of individuals using radio telemetry to investigate micro-habitat scale selection (i.e. within home range selection), and to better understand habitat selection within these different habitat types.

Methods

We successfully collared and tracked 16 chipmunks in the Ice Springs (n=10) and Lookout Mountain (n=6) subpopulations between 31 May and 15 August 2019. Collared chipmunks were located via homing techniques ca once every two survey days. At a subset of temporally independent chipmunk locations (n=78) and at paired random locations (n=78), we collected ground cover and plant composition data along four 10m transects.

We performed a data exploration using univariate descriptive analysis to test the magnitude of difference in habitat covariates between used and available sites. We screened potential variables for inclusion in model selection based on significance in univariate tests, correlation with other variables, and biological interpretability. We retained seven explanatory variables for analysis, six of which were included in models for the Ice Springs population, and five of which were included in models for the Lookout Mountain population (Table 1).
We developed a list of conceptual a priori models to describe microhabitat selection within each subpopulation based on hypotheses about competition and predation. We used multiple logistic regression to compare variables collected at used locations to random locations. We assessed model fit using Akaike's Information Criterion for small sample size (AIC_c) and considered models with $\Delta AIC_c < 2$ as competitive models. We also calculated cumulative AIC_c weights to assess the relative importance of each predictor variable (Arnold 2010; Tipton et al 2008).

Results

In the Ice Springs subpopulation, the top model was the only competitive model, after screening for uninformative parameters (Arnold 2010). Large spruce, mean percent gooseberry cover, and vertical cover had the highest cumulative AICc weights and constituted the top model (Table 1). In the Lookout Mountain subpopulation, there were four top models, after screening for uninformative parameters (Arnold 2010). Boulder and vertical cover had the highest cumulative AIC_c weights (Table 1). Boulder appeared in all of the top models and vertical cover appeared in three of the four top models.

Model parameters	**Parameter definitions** (collected along four 10m transects)	**Cumulative model weights**	
		Ice Springs	**Lookout Mountain**
Large spruce	count of Engelmann's spruce DBH >30cm	0.76	0.47
Litter (sd)	standard deviation of % woody litter cover	0.33	0.54
Boulder	count of boulders 0.5m-5m width	--	0.94
Gooseberry	mean % gooseberry cover, primarily *Ribes montingenum*	0.74	--
Vertical cover	mean % vertical cover below 1m	0.92	0.7
Low spruce (sd)	standard deviation of % Engelmann's spruce cover below 1m	--	0.43
Grass	mean % grass cover	0.39	--
Iris	mean % iris cover	0.33	--

Table 1. Model parameters, definitions and cumulative model weights for both sub populations.

Conclusions and Implications

Across both sites, least chipmunks used areas with more vertical cover when compared to what was available. At Ice Springs they selected sites with high gooseberry cover, while at Lookout Mountain they selected sites with more boulders. We hypothesize that boulders and gooseberry may be functioning similarly at each site, as escape, refuge and den cover. Large spruce trees (>30-cm dbh) were included in the top model for the Ice Springs population, indicating the importance of old growth forest.

It is important to note the potential for source-sink dynamics. We recorded a single individual emigrating from Ice Springs to Lookout Mountain. Without data on survival and reproduction, we cannot identify a source population or measure habitat quality; however, it is vital to consider that one of the sites may represent relatively lower quality habitat (Johnson 2007).

This research provides the first rigorous insight into habitat selection for the species. Our results indicate that low cover (i.e. boulders or shrubs) and old growth forest are important for the species on the 10m microhabitat scale. Ice Springs represents one of the few remaining patches of old growth spruce-fir forest in the Sierra Blanca range. Maintaining old growth forests with an abundant shrub matrix may be vital for the persistence of this rare endemic subspecies.

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Title:
Assessing geographic variation in song structure and plumage coloration in the willow flycatcher (*Empidonax traillii*) species complex

Introduction
In birds, song and plumage coloration are important communication modalities. Signal divergence among populations may result in reproductive isolation when characters between populations become too different to be recognized as the same species (1). The southwestern willow flycatcher (SWFL, *Empidonax traillii extimus*) is a federally listed endangered subspecies of the willow flycatcher (*E. traillii*). The subspecies designation was largely based on genetics, because although the subspecies do not show reciprocal monophyly, the mtDNA C-haplotype is more frequent in SWFL populations. Recently SWFL taxonomy was challenged in part because song and plumage variation among flycatchers is incompletely known. One study found song differed in structure between *E. t. extimus* and *E. t. adastus* but did not assess song variation among the other subspecies, and importantly, whether individuals recognize those differences. Likewise, differences in plumage coloration among willow flycatcher subspecies were found based on qualitative and quantitative assessments, but these studies ignored UV spectra, which are invisible to humans, but are important signals in birds. In our study, we assessed song and plumage variation among willow flycatcher subspecies to better understand population divergence within this group and the potential conservation value of SWFLs.

Methods
To determine character divergence among willow flycatcher populations, we 1) assessed plumage differences by measuring spectral reflectance on museum specimens using spectrophotometry, 2) quantified subspecific song structure differences using field recordings from across the four putative subspecies ranges, and 3) tested for subspecific song recognition in male flycatchers across the four putative subspecies ranges using playback experiments.

Results and Conclusions
We found 1) subspecies did not show clear plumage differences based on spectrophotometry. 2) Song structure differed among subspecies and SWFLs sang the most unique song (Fig. 1), and 3) individual birds responded more aggressively to songs that were structurally more similar to their own during playback experiments (Fig. 2).

Significance and Management Implications

In 2015 the subspecific status of the SWFL was challenged (2) and SWFLs were subsequently petitioned to be delisted from the Endangered Species List. The study was based on genetics, morphology and ecological niche modeling, but did not assess song and recognition of song differences. Song in willow flycatchers is innate (3) so any structural differences in song may reflect under lying genetic structure among populations. Further, because flycatchers recognized subspecific song differences, this is strong evidence that willow flycatcher populations are on different evolutionary trajectories. Therefore our results support the decision by the USFWS that SWFLs harbor unique alleles and therefore deserve protection under the Endangered Species Act.

Figures

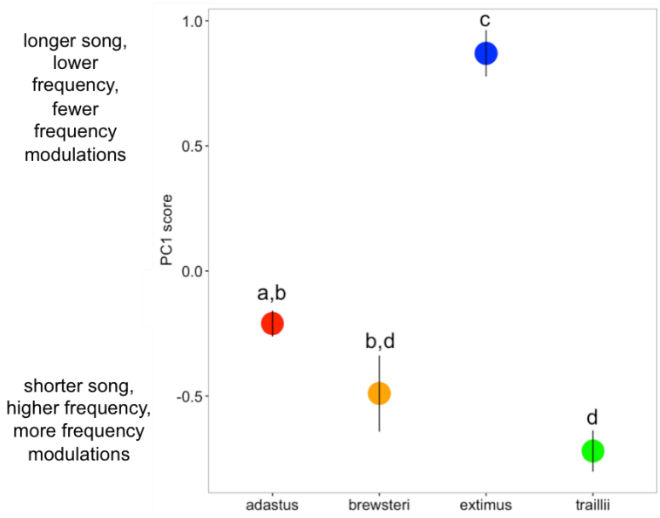

Fig. 1. Mean (±SE) song scores for the first principal component (PC1 score) for four subspecies of willow flycatchers (*Empidonax traillii adastus*, *brewsteri*, *extimus* and *traillii*). Important song characteristics from PCA are indicated on y-axis. Letters above points represent significant differences based on post-hoc Tukey pairwise comparisons.

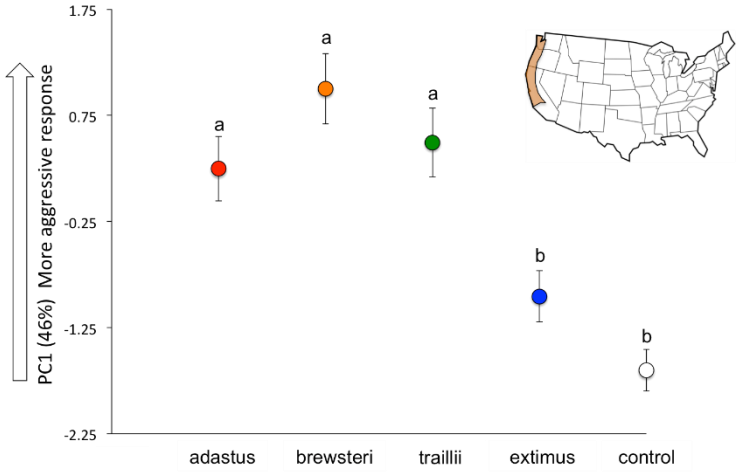

Fig. 2. Mean (±SE) behavior scores for the first principal component (PC1 score) for *Extimus traillii brewsteri* playback trials in response to Willow Flycatcher songs (*E. t. adastus*, *brewsteri*, *traillii*, *extimus*) and control white noise (control). The putative range for *E. t. brewsteri* within the U.S. is indicated by the map inset. Positive PC1 scores represent a more aggressive response. Letters represent statistical differences based on post-hoc Tukey HSD comparisons. *E. t. brewsteri* responsed more aggressively when played *E. t. brewsteri*, *E. t. adastus* and *E. t. traillii* songs and less aggressively when played *E. t. extimus* songs and the control. (Note: Playback experiments were conducted on individual *E. t. adastus*, *traillii* and *extimus* males during summer 2019 and results will be presented at the 2020 AZ-NM JAM meeting.)

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Title:
Springs stewardship through the lens of the Springs Dependent Species Project: understanding the scope of springs ecosystems as vital endemic habitats and wildlife pathways.

Abstract:
Springs constitute some of the most important groundwater ecosystems in the world, particularly in arid regions such as the Southwest. In addition to being sites of cultural and economic importance, the diverse ecology of springs ecosystems also provide essential resources and habitats for migratory and endemic species. Through the Springs Stewardship Institute (SSI) database, springsdata.org, a platform with 977 users and over 157,000 reported springs, vital information on springs and spring environments are being collected by state and federal agencies, tribes, and the public. One of the many ways that SSI evolves the database to meet the needs of its many users is through the Springs Dependent Species (SDS) Project. The SDS Project is an ongoing documentation of all springs-dependent species, with over 1000 species documented thus far, more than 10% of which are federally threatened or endangered. The database not only enables users to report species in or around springs, but includes scoring systems that allow us to observe large-scale ecological patterns. We present some of these patterns that reveal biological and ecological trends, including differences in springs dependence from plants to animals, the changes in springs dependence across elevation, and the potential and observed impacts of climate change on spring dependent plants and animals. The value of springs stewardship through the use of this database is well emphasized through the lens of the SDS project, and the information gained through this collaborative effort will stimulate lasting conservation management for springs ecosystems.

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Title:
Illuminating knowledge gaps: effects of artificial lights on bats.

Abstract:
Artificial lighting at night (ALAN) is an anthropogenic disturbance currently impacting 20% of the Earth's surface. ALAN alters the interactions of organisms across many trophic levels and has been shown to have negative consequences for several species. Bats, in particular, may be especially sensitive to ALAN due to most species' nocturnal habitats. Bats provide a variety of ecosystem services that could be altered with exposure to light pollution, especially in areas where bats have diverse diets. We conducted a systematic review regarding ALAN impacts on bats to identify gaps and bias in the literature, summarize management and research implications, and suggest standardized metrics for ALAN research in relation to bats. We found that most studies focused on short term impacts (< 1 year; 66.6% of papers) on European bat species (67.4% of papers) detected by acoustic monitoring (80.9% of papers). Many metrics such as distance from sampling locations and light source, dark scenario presence, light wavelength or bulb type were not consistently reported. We provide a list of standardized metrics for future research and topics that should be explored to expand the current knowledge of ALAN related impacts on bats.
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Title:
Camera trapping and non-target species: the crested porcupine in Italy

Abstract:
The study of species presence, abundance, distribution and habitat use is the basis for effective conservation and management actions. Camera trap surveys have a wide range of research application but they are often an under-exploited source of valuable information on a wider spectrum of sympatric species beyond the focal species for which camera traps were deployed. Occupancy modelling using by-catch data can be a valuable resource to gain information on these species maximizing the scientific effort and efficiency of wildlife surveys. We assessed the ecological features of detection and occupancy of the biggest Italian rodent, the crested porcupine (Hystrix cristata), using by-catch data from a European wildcat (Felis silvestris silvestris) survey on the volcano Etna in Southern Italy. We recorded 33 detections at 17 out of 51 cameras (naïve occupancy = 0.33). The best models fitted the data well and porcupine occupancy estimate was 0.58 (SE ± 0.09) with a detection probability of 0.11 (SE ± 0.03). Average model showed that woodlands and number of shrub patches increased porcupine occupancy, while the reverse was true for altitude. Our results have improved the insights on the habitat use and ecological needs of this understudied species and it is the first study that develops occupancy models for the porcupine using presence/absence data obtained from a camera trap survey. We also identified minimum requirements for a camera trap survey to provide robust occupancy estimates for non-target species.

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Title:
Managing Springsnails of the Southwest: A multi-agency and multi-state Springsnail Conservation Strategy

Abstract:
The southwestern United States is home to at least 178 springsnail species. The declining health of these tiny, aquatic, springs-dependent gastropods and their habitats has led the US Fish and Wildlife Service, state wildlife agencies, and other NGOs to invoke protection of some species of springsnails under the Endangered Species Act and state statutes. In 2018, the Springs Stewardship Institute (SSI) initiated development of the Springsnail Conservation Strategy for the states of Nevada and Utah, to better manage and protect 93 springsnail species and their ecosystems. We compiled existing research, published literature, and additional datasets in our Springs Online database to build a comprehensive dataset of population distribution, habitat conditions, conservation status and survey history of each species. According to Springs Online, over 90 researchers have contributed to this robust dataset. A few springsnail species, such as *Pyrgulopsis gibba and P. kolebensis*, are widely distributed across the southwest, while 38 species are restricted to three or fewer spring locations and thus are highly vulnerable to habitat degradation or loss. Nineteen of these 38 species were last recorded prior to 2001. The current status of many populations and species remains unknown. To date we have generated extensive summaries of these 93 species and future work will further broaden our knowledge and provide a framework to improve the management and understanding of springs ecosystems in arid landscapes.

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Title:
Safe Passages for Wildlife: Progress on Interstate-10 within Arizona's Rincon-Santa Rita-Whetstone Mountains Wildlife Linkage

Abstract:
The 20-mile stretch of Interstate-10 (I-10) between Vail and Benson, east of Tucson, Arizona, divides the regionally important Rincon-Santa Rita-Whetstone Mountains Wildlife Linkage. This linkage is one of the few remaining north-south I-10 wildlife crossing points found between Tucson and New Mexico and it encompasses several protected areas and important waters, including Davidson Canyon and Cienega Creek, making it critically important for desert wildlife in the face of climate change. In the spring of 2017 we conducted comprehensive assessments and wildlife surveys of the nearly 80 existing underpasses and drainage culverts in the study area. Our results indicate that this wildlife linkage could be made safer for wildlife and motorists by 1) installing wildlife funnel-fencing to keep animals off the highway and to direct wildlife toward existing crossing points; 2) retrofitting and widening existing drainage culverts located in high volume areas; 3) construction of an additional wildlife crossing between Cienega Creek and Marsh Station Rd Exit 291. Now in Phase II, we are using wildlife camera monitoring and roadkill surveys, with community science engagement, to gather species-specific baseline data on wildlife passage rates and roadkill hotpots. Preliminary results, including two black bear mortalities, already begin to identify optimum locations for wildlife funnel-fencing installation, existing culvert retrofits, and new wildlife crossing structures. This data will inform State and County highway and wildlife officials on where to focus mitigation efforts to improve highway safety and minimize wildlife-vehicle collisions, and provide justification for project funding.

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Title:
Inundation Effects on the Ecology of Northern Mexican Gartersnakes

Abstract:
Understanding spatial ecology and habitat use of threatened and endangered species is imperative to effective conservation planning and species recovery. I used radio-telemetry to examine the spatial ecology and habitat selection of Northern Mexican Gartersnakes (*Thamnophis eques megalops*) in relation to water level fluctuations at lower Tonto Creek, Arizona, over three years, 2015–2017. Many aquatic habitats are subjected to flooding, either regularly through seasonal floods, or irregularly by periodic floods, but how animals respond to flooding has been rarely studied. I tracked 18 adult *T. e. megalops* to determine habitat use and movements under different water levels during their active season in 2016 and 2017. I found little evidence that microhabitat use changed during inundation; rather, macrohabitat selection, as measured by size of their activity range, increased to encompass areas with microhabitat features selected during non-inundation. I also found that *T. e. megalops* activity range sizes were largerat lower Tonto Creek than previous studies, and my results suggest that increasing water levelsthat covers more area can positively correlate with activity range size. This is the first study addressing how fluctuating water levels affect the habitat selection and spatial ecology of *T. e. megalops*, and helps to guide the species habitat requirements in inundation-prone streams.
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Title:
Mapping the spread and effect of chytrid in efforts to protect endangered species of amphibians across New Mexico

Abstract:
Chytrid (*Batrachochytrium dendrobatidis*) is a fungus that is a contributing cause to native amphibian population decline in the United States at a concerning rate. The dramatic decline of native amphibians is concerning in and of itself, but particularly as an impeding factor in attempts to reintroduce endangered species. This includes the Boreal toad (*Anaxyrus boreas boreas*), a New Mexico listed endangered amphibian whose population has severely plumented in its once native Southern Rocky Mountain habitat due to disease and habitat loss. The effort to map out what areas chytrid is affecting includes many different organizations as a large area of the region needs to be surveyed. Across several areas of concern within New Mexico we ethically caught amphibians. Each captured animal was swabbed for the presence of chytrid and promptly released. Collected swab samples were tested in the lab for the presence of chytrid. This information is then interpreted to conceptualize where the fungus exists, and what areas are unfit to release endangered amphibians such as the Boreal toad. This is part of a larger effort coordinated with the New Mexico Department of Game and Fish.
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Title:
Testing a new method for the census of Mt. Graham Red Squirrels, *Tamiasciurus hudsonicus grahamensis*

Abstract:
The Mt. Graham Red Squirrel (*Tamiasciurus hudsonicus grahamensis*) is a federally endangered species that is endemic to the Pinaleño Mountains of southeastern Arizona. Since it was listed in 1987, recovery efforts have been hindered by a series of loss of habitat due to insect pest outbreaks and multiple catastrophic wildfires, as well as continuing competition with introduced Abert's Squirrels (*Sciurus aberti*). Recent population estimates using surveys of known red squirrel middens indicate the population has declined from a high of over 560 individuals in the 1990s to a current estimate of 78 individuals. However, existing population monitoring relies heavily on return visits to known middens and does not incorporate any active searching for new middens, nearly guaranteeing a declining estimate even if the population were stable or increasing. We are attempting to improve the estimate of red squirrel population size by using an area-search approach that does not rely on the location of known squirrels or middens. We present three different estimates of squirrel population size from these area searches, which collectively indicate that previous estimates may have underestimated population size by 58 to 253%. We discuss the strengths and weaknesses of each of these three approaches, and present plans for future improvement of our estimates.

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Title:
Assessing dietary habits of Rio Grande Cooter (*Pseudemys gorzugi*) and Red-eared Slider (*Trachemys scripta*) using carbon and nitrogen stable isotope analysis

Abstract:
The Rio Grande Cooter (*Pseudemys* gorzugi) is one of the least studied freshwater turtle species in the United States, with a single study describing its dietary habits through fecal content analyses. In New Mexico, *P. gorzugi* is native to the southeastern portion of the state where it co-occurs with other freshwater turtle species, primarily Red-eared Slider (*Trachemys scripta*). In 2019, we collected 239 claw, 45 carapace, and 247 blood samples of Rio Grande Cooters and Red-eared Sliders on the Black River, Delaware River, and Berrendo Creek, New Mexico. Using carbon and nitrogen stable isotope analyses of collected samples, our main goal was to study the occurrence of dietary overlap, estimate trophic positions and speculate intra- and interspecific relations. Our preliminary results from claw samples show that, overall, Rio Grande Cooters and Red-eared Sliders differ in both $\delta^{13}C$ and $\delta^{15}N$ values. *Pseudemys gorzugi* mean values for $\delta^{15}N$ were 9.68‰ (*sd*=±1.01) while *Trachemys scripta* had mean values of 11.94‰ (*sd*=±2.20). We also observed differences in $\delta^{13}C$ values, as *P. gorzugi* and *T. scripta* had mean values of 28.03‰ (*sd*=±2.67) and 21.49‰ (*sd*=±1.99), respectively. We were able to verify little dietary overlap between species, but our data suggests that C_3 plants compose most of both species' plant intake. This study provides new information about *P. gorzugi* dietary habits and ecological niche in comparison to other freshwater turtle species. Such information can aid conservation management practices of this state threatened species and assist US Fish and Wildlife Service in the Species Status Assessment process.
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Title:
Female Reproduction in Flat-tailed Horned Lizards

Abstract:
We investigated reproduction in female Flat-tailed Horned Lizards (*Phrynosoma mcallii*) on the Barry M. Goldwater Bombing Range near Yuma, Arizona from 2017-2019. We palpated and weighed females to determine gravidity. We affixed radio transmitters to the dorsal surface of lizards using silicone adhesive. Individuals were radio tracked two to three times per day until they laid their eggs. We placed nest enclosures around nest burrows using aluminum flashing and we checked the enclosures daily until hatchlings appeared or ten weeks had passed. We radio tracked 29 individual females in 2017, 17 in 2018, and 29 in 2019. Sixteen individuals produced one clutch, and two individuals produced two clutches in 2017. No individuals produced clutches in 2018 and 16 individuals produced one clutch in 2019. Females moved relatively long distances prior to oviposition, which may be a dispersal mechanism leading to increased genetic diversity. Upon exiting nest burrows, females backfilled the entrance to their burrows (25 of 35 exhibited this behavior). Hatchlings emerged from nest burrows approximately six weeks after oviposition. Clutch sizes ranged in size from 1 to 6 and there was an average clutch size of 4 ± 0.35. In addition to demographic and life history data, we are also examining population ecology, dispersal, and parentage using genomic analyses.

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Title:
Emerging Viral Diseases in At-Risk Populations of Felids and Ungulates

Abstract:
Sonoran felids and ungulates may be threatened by the emergence of new viruses associated with climate change and habitat encroachment. Populations of pumas (*Puma concolor*), jaguars (*Panthera onca*), and ocelots (*Leopardus pardalis*), in the Sonoran Desert are experiencing higher stress due to drought which may lead to decline, and the status of bobcats (*Lynx rufus*) in the Southwest is unknown. Sonoran pronghorn (*Antilocapra americana sonoriensis*), jaguars, and ocelots are endangered and are therefore likely to be at increased risk of susceptibility to emerging diseases due to decreased genetic variation. Additionally, individuals from the endangered and recovering Florida panther population have recently been observed to be affected by a neurologic disorder of unknown cause. The objectives of this study are to integrate population connectivity and virome composition for the Florida panther and five Sonoran species: puma, bobcat, ocelot, jaguar, and pronghorn. Population structure and connectivity, Hardy-Weinberg equilibrium departures, and inbreeding will be determined through RADSeq, and viromes will be characterized using a metagenomic approach. Additionally, novel viruses and viruses most likely to pose threats to population viability from disease outbreaks will be identified. Paired samples (scat with buccal swabs or muscle tissue) will be used to assess the reliability of using scat samples to identify host-specific viruses. Preliminary viromic analyses of puma and bobcat scats from Mexico suggest the presence of a novel feline circovirus in these populations. These findings may inform management decisions to supplement populations by translocation and take preventative measures, such as vaccine administration.
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Title:
News and Notes for the Amphibians and Reptiles of New Mexico in 2019

Abstract:
A presentation is given to provide updates on the important conservation projects to benefit the amphibians and reptiles of New Mexico, as well as other items of note, both serious and not so serious. Issues of concern will be discussed as well as potential areas of research and education, with particular emphasis given toward salamanders, toads, miscellaneous frogs, turtles, miscellaneous lizards, horned lizards, miscellaneous snakes and venomous reptiles.

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Title:
Habitat heterogeneity in the Chihuahuan Desert and puma diet diversity

Abstract:
Several studies report on puma diets in the arid regions of the southwestern United States within homogenously xeric locations, overlooking landscape diversity generated by riparian forests. Such habitat heterogeneity and corresponding prey diversity could influence puma habitat use, prey availability and diet composition. Therefore, we examined puma diet in New Mexico, at sites representing riparian areas adjacent to the Rio Grande and xeric Chihuahuan Desert uplands. We determined seasonal prey composition and describe differences in prey composition between pumas occupying distinct cover types. We collected prey composition data from 686 kill sites made by GPS-collared pumas on the Armendaris Ranch and Sevilleta National Wildlife Refuge from 2014 to 2018. Diet composition included 32 different avian, aquatic, small mammal and ungulate prey species. Prey composition varied, with more ungulate prey being consumed by pumas inhabiting the upland desert areas and more aquatic prey consumed in the riparian bosque. Prey composition differed between seasons, as ungulate prey decreased and aquatic prey increased during the hot-dry season. Diet varied between puma sex and habitat with females in the desert uplands consuming more small mammals than either males or females in riparian areas. Game managers remove puma primarily for livestock depredation and management of game species (e.g., bighorn sheep). We found, however, that pumas have generalist diets, strongly influenced by the habitat and corresponding prey community their home range encompass. Puma management can improve by accounting for puma habitat locations and their diet availability.
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Title:
Mexican Wolf Recovery Program Updates

Abstract:
The Mexican wolf (Canis lupus baileyi) was listed under the Endangered Species Act (ESA) as an endangered subspecies in 1976. A binational captive breeding program initiated in the late 1970's prevented the extinction of the Mexican wolf. The captive breeding program was established with 7 founding wolves with the intention to breed these wolves and their offspring to produce wolves for reintroduction to the wild. In 1998, we began reintroducing the wolves into the wild in Arizona and New Mexico as a nonessential experimental population pursuant to section 10(j) of the Endangered Species Act. The end of year count for 2018 was a minimum of 131 Mexican wolves in the wild (64 in AZ and 67 in NM). This was about a 12% increase in the population from a minimum of 117 wolves counted at the end of 2017. Updates on the Recovery Plan implementation, revised 10(j) designation, and cross-fostering will be provided.

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Title:
Community reorganization revealed by exploring shifts in the diet of an apex predator, the Golden Eagle (*Aquila chrysaetos*), with stable isotopes and prey remains.

Abstract:
Golden Eagles colonized the northern California Channel Islands, U.S.A., in the early 1990s. Eagles preyed on both feral piglets (*Sus scrofa*) and the endemic island fox (*Urocyon littoralis*), driving three fox subspecies (*U. l. santacruzae*, *U. l. santarosae*, and *U. l. littoralis*) toward extirpation. Using stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) measured from tissues of Golden Eagles and their prey, along with the proportion of prey consumed estimated from nest excavations as informative priors, we show that shifts in eagle isotopic signatures tracked community reorganization: when pigs and foxes were abundant, eagles consumed them in higher proportions than other prey; when foxes became scarce owing to eagle predation, eagle diet shifted toward pigs, but also diversified to include Common Ravens (*Corvus corax*) and seabirds (*Larus* spp. and *Phalacrocorax* spp.); and finally, after pigs were eradicated and 35 Golden Eagles had been captured and removed from Santa Cruz Island, a lone remaining pair of eagles reversed their diet to include more foxes. Shifts in stable isotope signatures from tissues of an apex predator may be used as a general proxy to monitor changes in the prey community; however, if sample sizes are small, informative priors are both essential and overwhelmingly influential, and changes in abundance of preferred prey may mask or fail to reveal changes in less preferred prey. Given that apex predators are often important drivers of community structure, and that they sample prey continuously from their community, isotopic signatures of their tissues may be useful for monitoring community change.

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Title: Habitat selection by the Organ Mountains Colorado chipmunk

Introduction

The Organ Mountains Colorado chipmunk, *Neotamias quadrivittatus australis*, is the southernmost subspecies of the Colorado chipmunk and is endemic to the Organ Mountains in southcentral New Mexico. The mountain range forms an isolated island of habitat separated from other chipmunk populations by vast areas of lower elevation desert landcover types. *N. q. australis* is listed as threatened by the state of New Mexico, predominantly due to its unique nature as an endemic subspecies and its small, isolated habitat that is vulnerable to habitat loss (Johnson 1980, NMDGF 1988, 2008). There is a need to better understand this iconic chipmunk's ecology and habitat selection in order to evaluate threats and make informed management decisions. The main goal of this study was to use radio-telemetry to evaluate habitat selection by the Organ Mountains chipmunk at multiple spatial scales including macro-habitat and microhabitat (Johnson 1980, NMDGF 1988, 2008).

Methods

We deployed 21 radio-transmitters and triangulated chipmunk locations ≥3 times per week from March – August 2019. To address macro-habitat selection, we compared remote sensed data at used telemetry and available locations using logistic regression. We used (AICc) to select the top model. Available locations were randomly generated points within the cumulative home range, which was consisted of the 100% minimum convex polygons (MCP) of all chipmunks plus a buffer of 175m, the farthest distance traveled between two points. To address micro-habitat selection, we compared fieldcollected vegetation data at locations where a chipmunk was observed and paired random locations. Chipmunks were opportunistically observed at 57 sites from July 2018 – August 2019. Random locations were determined by a random azimuth and a random distance within 93m from the chipmunk's location, which represents the radius of a 2.7ha home range for the Colorado chipmunk (Bergstrom 1988). We analyzed differences in habitat between chipmunk locations and random locations using logistic regression and used AICc to select the top model.

Results

At the macro-habitat scale, chipmunks were found to use sites that were at higher elevations but low-lying in the local terrain, had less variation in terrain, were cooler, had less green vegetation, and were closer to water (Table 3). Chipmunks did not display selection for lower montane scrub landcover types ($p = 0.4050$), cliff/rock, nor chaparral/open slope encinal/upper desert grassland but were negatively associated with riparian and deciduous woodland/ponderosa pine forest (Table 1). Based on the top model for micro-habitat selection, chipmunks were found to select sites that had greater coarse woody debris and rock cover, had greater levels of woody plant

diversity, were closer trees, and were representative of arroyo basins (Table 2). We considered distance to boulder to be uninformative because the 85% confidence interval overlaps zero.

Conclusions

The macro-habitat results are preliminary and as such, conclusions drawn from the results of that scale are subject to change. The Organ Mountains Colorado chipmunk exhibits selection for specific habitat components at micro-habitat and macro-habitat scales. At the macro-habitat scale, our results suggest that chipmunks were selecting sites that represent cooler, more mesic areas of the Organ
Mountains, such as along Sotol and Anvil creeks. These areas support a greater diversity of plants that could be used as food for the chipmunk. This is further supported by the micro-habitat results that suggest chipmunks are using sites with greater woody plant diversity. Interestingly, there was a negative association with greenness. The negative association with riparian landcover suggests that although chipmunks are selecting for arroyos, this selection is not due to riparian vegetation but rather that the arroyos are cooler and closer to water. Rock was important at both scales, which suggests chipmunks might be using rock as burrow sites and as cover from predation.

Significance/management implications

We have identified habitat features important to Organ Mountains Colorado chipmunk habitat selection, which can inform conservation plans. Understanding habitat selection by the Organ Mountains Colorado chipmunk will allow managers to more accurately model the distribution of the chipmunk. The results of this study are scientifically defensible information that can serve as a basis for managing this unique chipmunk.

Tables

Table 1. Macro-habitat selection.

	Estimate	Std. Error	Z value	P-value	Lower 85% CI	Upper 85% CI
Proportion riparian landcover	-0.34	0.11	-3.08	0.0021	-0.55	-0.12
Proportion chaparral/open slope encinal/upper desert grassland landcover	-0.25	0.16	-1.56	0.11964	-0.58	0.06
Proportion deciduous woodland/ponderosa pine forest landcover	-0.92	0.21	-4.28	1.85E-05	-1.39	-0.54
Proportion cliff/rock landcover	0.30	0.21	1.41	0.15811	-0.29	0.65
Elevation (10m)	1.35	0.15	9.01	< 2e-16	1.06	1.65
Hillshade (10m)	0.67	0.17	4.07	4.68E-05	0.35	1.00
Greenness (30m)	-0.45	0.14	-3.15	0.00162	-0.73	-0.17
Topographic Position Index (TPI) (10m)	-2.08	0.18	-11.27	< 2e-16	-2.45	-1.72
Vector Ruggedness Measure (10m)	-0.41	0.14	-3.00	0.00274	-0.69	-0.15
Distance to water	-3.93	0.41	-9.58	< 2e-16	-4.79	-3.18

Table 2. Micro-habitat selection.

	Estimate	Std. Error	Z value	P-value	Lower 85% CI	Upper 85% CI
Coarse woody debris cover	2.20	0.88	2.49	0.0126	0.97	3.52
Rock cover	0.79	0.27	2.92	0.0035	0.41	1.19
Woody plant diversity	1.06	0.55	1.93	0.0539	0.29	1.88
Distance to tree	-0.15	0.06	-2.59	0.0097	-0.24	-0.07
TPI	-0.64	0.32	-1.98	0.0479	-1.11	-0.18

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Title: CRASH! A suite of new tools for Carcass Reporting - Arizona Streets & Highways

Abstract:
AGFD has been using Esri Collector and Survey123 tools to document wildlife road mortalities for several years. A recently developed suite of Survey123 tools includes three streamlined user interfaces that allow for expedited field record generation by AGFD employees and partner organizations, and for record generation from independently generated image files. A future iteration tailored to law enforcement officers will also include the ability to issue salvage permits. A new Esri tool called QuickCapture facilitates instantaneous record generation directly tied to the Syrvey123 databank. The QuickCapture CRASH interface is in Beta testing and will soon be available to all AGFD employees to generate road mortality records without requiring a vehicle stop.

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Title:
Saving the world two evil plant species at a time: preliminary results

Abstract:
Non-native plant species can wreak havoc on the landscape, displacing native species, altering wildlife habitat, and spreading wildfire. Control of these species can be difficult due to the prolific nature of these plants and is further complicated by limited resources, including time, money, and workforce. Previous studies investigating control techniques have been short term, included only a partial suite of removal techniques, or did not determine effects on the native plant community. Our objective is to determine efficient, effective control measures for fountain grass (*Pennisetum setaceum*) and buffelgrass (*Pennisetum ciliare*) that best protect the native plant community over the long-term. We established 25m^2 plots in McDowell Sonoran Preserve in Scottsdale, Arizona, and are testing combinations of cutting, herbicide, and hand pulling for both species. These treatment plots are compared to uninfested control plots in similar habitat. Once per year, we document plant and ground cover on five transects in each plot, which allows us to compare treatment effects on native and non-native species. We record cost and effort for each treatment application. We have conducted two years of treatments and plant sampling. Initial results indicate that fountain grass responds favorably to all treatments, whereas multiple herbicide applications are necessary for buffelgrass control. Because plants must be photosynthetically active for most herbicides to work, drought may be a limiting factor in buffelgrass control. Results of this project will help land managers choose the most appropriate means to achieve long-term control of these non-native species in arid regions.

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Title:
Seasonal and daily basking pattern of the Rio Grande Cooter (*Pseudemys gorzugi*) using game cameras

Abstract:
Basking is essential for thermoregulation in many turtle species, particularly Emydids. Although basking is widely studied, this behavior varies among populations, habitats, and microclimates. New Mexico is home to ten turtle species, including the state-threatened Rio Grande Cooter (*Pseudemys gorzugi*). However, little is known about the species' year-round basking patterns and active periods. Monitoring of basking turtles is commonly done directly via binoculars; however, the presence of observers may disturb basking turtles and can be time-consuming. In this study, we monitored daily basking patterns of *P. gorzugi* from August 2018 to July 2019 using game cameras where images were taken hourly from 0700 to 1900 at three locations along the Black River. We used a generalized linear mixed effect model to find a correlation between basking pattern and environmental variables. *Pseudemys gorzugi* was active year-round with peak basking activity around April and September. Basking patterns were significantly correlated to air temperature, water temperature, light intensity, and time of day. Daily pattern varied among seasons due to the interactions between time of day and water temperature. The use of game camera was effective for a long-term monitoring of turtles in this study, although distance and angle of game cameras from basking structures could affect the ability to identify species, sex, and age classes. Nonetheless, the use of game cameras was less labor intensive and provided higher resolution data. Overall, understanding *P. gorzugi* basking habits can provide useful information about appropriate survey methods and aid in developing appropriate conservation strategies.

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Title:
Restoring and enhancing agave for migratory nectivorous bats in the Southwest U.S. and Mexico

Abstract:
The lesser long-nosed bat (*Leptonycteris yerbabuenae*) and the federally endangered Mexican long-nosed bat (*L. nivalis*) depend heavily on the fruit, nectar, and pollen of cacti and agave near their major roosts, and along their migratory corridors from Mexico to the U.S. The primary threats to these bats are roost disturbance and agave loss due to agricultural and urban development, overharvest for mezcal production, and climate-induced changes in fire frequency and agave flowering phenology. To address these threats, Bat Conservation International (BCI) has embarked on an ambitious Bats & Agave Restoration Initiative to plant thousands of agaves near major long-nosed bat roosts and along their migratory corridors from Central Mexico to the Southwestern U.S. BCI is working with agave and long-nosed bat experts, non-government organizations, communities, and government and industry partners in the U.S. and Mexico to increase capacity for agave propagation, prioritize restoration sites, support sustainable agave harvest practices, and raise awareness about the agave-bat connection. BCI is supporting the propagation of several thousand *Agave palmeri*, and A. *parryi* by the Borderlands Restoration Network (BRN) and Gila Watershed Partnership (GWP) for future restoration efforts, and has already facilitated the planting of more than 2,000 agaves near major roosts in Arizona with the BRN, GWP, National Park Service, Freeport McMoran, Pima County, and the Tucson Audubon Society. BCI is also developing an extensive agave restoration program with universities, local governments, conservation organization, and commercial agave growers in Sonora and Nuevo Leon Mexico.

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Title: Influence of Mexican wolves on elk resource selection

Abstract:
Predation is a primary limiting factor for prey and in addition to direct impacts (killing of prey), it establishes risk, which indirectly influences prey resource selection strategies. Our objective is to determine the influence Mexican gray wolves (*Canis lupus baileyi*) have on resource selection and spatio-temporal predator avoidance strategies of elk (*Cervus canadensis*). We captured 427 adult female elk and fitted them with Iridium-GPS collars in the Apache-Sitgreaves, Gila, and Cibola National Forests in eastern Arizona and western New Mexico. GPS collar data are also being collected on individual wolves (n ~ 77) in collaboration with the U.S. Fish and Wildlife Service. Step selection functions for both Mexican wolves and elk will be assessed in relation to habitat attributes, climatic conditions, and diel activity patterns across areas of varying wolf densities to understand the extent the re-establishment of wolves influences elk populations. Multiple measures of predation risk will be examined in relation to elk resource selection, including an index of wolf presence—a function of wolf resource selection, utilization distributions, and pack size—as well as density of wolf-killed elk, openness, and predicted risky areas, modeled from attributes of known wolf-killed elk sites. It will be assessed if elk are using human refugia or areas of low wolf utilization as low-wolf risk “islands” to mitigate predation pressure. Seasonal selection, including migratory behavior, routes, and wintering grounds will also be determined. The collection of data is currently in progress, so preliminary results are pending.
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Title:
Livestock use of riparian habitat for endangered species on six southwestern rivers

Abstract:
Riparian and aquatic ecosystems on Southwestern public lands provide critical habitat for numerous threatened or endangered wildlife protected under the Endangered Species Act. Historic and current livestock grazing harms protected species and their habitats. In response, conservationists have long worked to improve riparian area management, including installation of exclosure fencing to protect listed species habitats and facilitate species recovery. From 2017 to 2019 we surveyed riparian exclosures along more 402 stream miles in 82 grazing allotments on five National Forests in Arizona and New Mexico. Surveys included portions of the Verde, East Verde, San Francisco, Gila, Blue, and Tularosa Rivers that contain critical habitat for aquatic and riparian-dependent species. Our objective was to determine the extent and impact of livestock grazing within riparian areas which have purportedly been excluded from grazing for up to twenty years. Surveys recorded livestock grazing impacts to riparian vegetation, soils, and streambanks. Data were collected in six categories and were scored based on the intensity and frequency of impacts. Stream reaches were ranked with absent, light, moderate or significant grazing impacts. We observed widespread cattle grazing and occupancy in most surveyed reaches. Approximately 56% of stream miles were ranked with moderate to significant grazing impacts. Just 19% of stream miles were absent of any signs of cattle at all. Livestock use of riparian exclosures was absent in just 12 of 82 allotments. Successful recovery of wildlife dependent on riparian and aquatic ecosystems in the Southwest requires that livestock exclosures are better monitored, maintained, and enforced.

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Title:
Current Status and Trends in Southwestern Willow Flycatcher and Western Yellow-billed Cuckoo Populations on the Rio Grande in New Mexico

Abstract:
The U.S. Bureau of Reclamation has conducted formal presence/absence surveys on the Rio Grande for Southwestern Willow Flycatcher (*Empidonax traillii extimus*)(flycatcher) since 1995 and Western Yellow-billed Cuckoo (*Coccyzus americanus*)(cuckoo) since 2006. The survey extent includes floodplain areas adjacent to the Rio Grande from Los Lunas, New Mexico, to El Paso, Texas. Habitat suitability mapping for both species was done in 2012 and updated in 2017. Also, in 2017, a telemetry study was initiated to refine knowledge of habitat use in cuckoo territories.

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Title: Life in the City: Ecology of Urban Desert Spiny Lizards (*Sceloporus magister*)

Abstract:
Urbanization is a major threat to wildlife worldwide, displacing, limiting, or modifying natural habitats on which species depend. Identifying and understanding responses of wildlife to urbanization can lead to management strategies that minimize anthropogenic impacts and create more wildlife friendly developments. We studied two Desert Spiny Lizard (*Sceloporus magister*) populations: one on the University of Arizona campus, a highly built environment, and one at Rio Vista Natural Resources Park, a modified, but more natural environment, both within the city of Tucson, Arizona. We sexed, weighed, measured, paint marked, and microchipped all lizards captured, and outfitted selected individuals with externally attached radio transmitters. We radio tracked 35 lizards on the UA Campus from 2017-2019 and 10 lizards at Rio Vista from 2018-2019. We recorded UTM coordinates using a handheld GPS receiver each time we located a lizard. We used their location data to compare behavior, habitat use, activity patterns and home range characteristics of lizards at the two study sites. We determined that S. magister maintain small home ranges, regardless of degree of urbanization. In addition, males tend to have larger home ranges than females, but not significantly so. We occasionally observed individual males move relatively long distances, which appeared to be in response to territorial disputes with other males. Our data provide insight how lizards coexist with humans in the built environment. We also developed an outreach program that included presentations to the public, school-aged children, and in courses taught at the University of Arizona. We also designed and placed an interpretive sign on campus in an effort to educate the public about urban lizards, urban ecology, and wildlife conservation.
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Title:
Coyotes (*Canis latrans*) in Arizona Exhibit Immune and Genetic Evidence of Rickettsial Infections

Abstract:
Rocky Mountain spotted fever (RMSF), caused by the bacterium *Rickettsia rickettsii*, has been a public health threat in Arizona since the early 2000's. The brown dog tick (*Rhipicephalus sanguineus sensu lato*) is the principal vector and domesticated dogs (*Canis lupus familiaris*) are the tick's main host. Peridomestic exposure on American Indian tribal lands with infected ticks and free-roaming dogs has been a well-recognized risk factor for human cases of RMSF. However, the emergence and long-distance dispersal of the pathogen have not been adequately explained, and one possible mechanism could include wildlife. Coyotes (*Canis latrans*) are wide ranging in Arizona and closely related to dogs, so it is possible that brown dog ticks parasitize and infect coyotes. Other spotted fever group rickettsial (SFGR) pathogens closely related to *R. rickettsii* occur in Arizona and antibodies generated against them are cross-reactive. We therefore more-broadly hypothesized that coyotes in Arizona are exposed to SFGR. Coyote blood and tissues were collected in spring 2016 and 2017. Sera were tested for antibodies to *R. rickettsii*; 9% (8/94) of samples were antibody-positive with titers ranging from 1:256-1:4096. Subsequent quantitative PCR analyses of skin showed evidence for *Rickettsia spp*. in 2.9% (4/138) of samples. These data suggest that coyotes are exposed to SFGR and serve a maintenance or spillover role in Arizona. Future research applying next generation genomic technologies can be used to better address this one health challenge (define SFGR distribution), as well as develop potential solutions (improved diagnostic tools) that ultimately advance population health.

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Title: The saltatorial, aquatic, and arboreal New Mexico meadow jumping mouse: home ranges and movements

Abstract:
The New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) is associated with perennial flowing water with tall, dense herbaceous vegetation. Jumping mice also require adjacent upland areas for maternal and day-nest sites in summer and hibernacula in winter. Because the species is federally endangered, knowledge of home ranges and movements can guide management decisions to conserve habitat and promote its recovery. We radio-tracked jumping mice in Arizona, New Mexico, and Colorado during its active season 2017-2019 to identify home range size, movements, and distances traveled in riparian areas. Home ranges calculated using Minimum Convex Polygon and 95% Kernel Probability averaged 3.96 ha (range 0.36 to 17.9 ha) and 3.35 ha (range 0.11 to 28.4 ha), respectively. Jumping mice stayed close to steams (average = 9 m; average maximum distance = 40 m), but not exclusively; they moved as far as 550 m from perennial flowing water and > 500 m in a single night. Mean and maximum distances moved from last location were 68 m and 310 m, respectively. Males appear to have larger home ranges in June and early July and moved longer distances from previous locations than females. However, neither sex showed much difference between maximum and average distances moved from stream. Not only are jumping mice saltatorial, but also aquatic and arboreal. We documented jumping mice regularly swimming, potentially using the downstream current to their advantage, and diving under water (>1 m). We also observed a jumping mouse about 2 m high in an alder (*Alnus* sp.)
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WILDLIFE POSTER ABSTRACTS
ORDERED ALPHABETICALLY BY LAST NAME OF PRESENTER
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Title:
Urban Heat Island Effect and Rodent Body Condition

Abstract:
Human-made surfaces and structures increase radiant heat exchange in urban areas by several degrees hotter compared to non-urban areas. Research has investigated how urbanization and heat affect human health; however, studies have not investigated the response of wildlife to urban heat. We examined the effect of Urban Heat Island (UHI) on wildlife, by evaluating animal body condition of rodents living in three different levels of heat. Animal body condition is storage of resources such as fat, which are important for survival and reproduction. We used accurate and noninvasive technology to quantitatively measure body fat, lean mass, and water content of rodents using a quantitative resonance machine. We tested the hypothesis that percent body fat, lean mass, and water content vary across three levels of temperature based upon mean daily summer temperature (i.e., 47.0-49.0 °C, 50.0-52.0 °C, and 53.0-55.0 °C). We captured 37 nocturnal rodents (Merriam's kangaroo rats, *Dipodomys merriami* and pocket mice, *Chaetodipus spp.*) using baited Sherman live traps from mid-July to mid-August in urban parks and open spaces. Our preliminary results show pocket mice and Merriam's kangaroo rats captured from cooler temperatures had more fat than rodents captured from hotter ranges; lean mass and water content show no significant difference between levels of heat. Preliminary findings will be further investigated this summer by sampling additional animals and expanding predictor variables to include vegetation cover, soil type, and land use/land cover. Our results will contribute to understanding the effects of extreme heat on urban wildlife body condition and health.
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Title:
Comparing Bat Species Detection Equipment and Diversity Along the Rio Grande Between 2012 and 2019

Abstract:
We sought to understand differences and similarities between bat species detection equipment and diversity through echolocation technology across 7 years along the Middle Rio Grande. Understanding the health of differing bat populations across the continental United States is imperative given their fragile standing with threats such as habitat loss, climate change, and White Nose Fungus placing many bats in peril. Tracking their presence is crucial in understanding the overall health of the habitats they occupy. We used bat echolocation to understand how bat species composition has changed within the Albuquerque section of the Rio Grande's riverside forest, known as the bosque. This study is a follow up to a previous study performed in 2012. We performed twice weekly echolocation recordings at the same location that was used in a 2012 study, as well as an additional location proximal to the Rio Grande Nature Center which had also been the site of previous bat detection work. We recorded each Wednesday and Saturday for thirty minutes directly following sunset. We did this process for a period of three months, and our preliminary results are consistent with 2012 results, showing a minimum of thirteen different bat species from thousands of detected calls.
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Title:
Evaluating breeding status and distribution of Yellow-billed Cuckoos in the mountains of southeastern Arizona

Abstract:
The western distinct population segment of the Yellow-billed Cuckoo (Coccyzus americanus) is federally listed as threatened, with widespread declines attributed to loss and degradation of cottonwood-willow riparian habitat. However, recent surveys in the mountains of southeastern Arizona have documented cuckoos during the breeding season in some upland xeroriparian drainages. If most of these cuckoos are breeding, this previously unknown population may have important implications for species recovery. Our objectives were to determine the breeding status and distribution of cuckoos occupying upland drainages by conducting intensive playback surveys and nest searching efforts in a subset of drainages and mountain ranges. We surveyed 90 sites with 52 being occupied. We confirmed 46 breeding territories in 9 mountain ranges (6 ranges with first breeding records), and also documented two new nest tree species (juniper and cypress). Most breeding territories were found in southern ranges between 2500 and 5500 feet in ephemeral or intermittent drainages dominated by oak, mesquite, or hackberry, with many drainages lacking a cottonwood-willow vegetation component. Our results suggest cuckoo habitat use in southeastern Arizona is more varied than previously known, and this upland population may play an important role in species recovery given continued threats to major riparian systems.
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Title:
Status and conservation of bank swallow populations in New Mexico

Abstract:
Bank swallows (*Riparia riparia*) nest colonially in excavated burrows on vertical or near-vertical banks and bluffs with silty, loamy, and sandy soils in lowland riparian, lacustrine, and coastal habitats. Within New Mexico, bank swallows rely on natural features within stream channels and arroyos that are inherently dynamic, created and modified by erosional, flood, and other fluvial processes. This species is currently listed as a Species of Greatest Conservation Need in the State Wildlife Action Plan for New Mexico due to perceived population declines and restricted distribution within the Rio Grande Valley. A systematic survey of bank swallow habitat within the middle and upper Rio Grande completed in 2008 found only 13 active nesting colonies that contained less than 2000 nest cavities and 304 breeding pairs. Since that time, 4 breeding colonies are known to have been impacted by artificial bank stabilization, collapse of banks, or are proposed for future habitat modification. Although there is little quantitative population data for this species in New Mexico, populations are vulnerable to nest site loss from erosion control, bank stabilization, and filling of arroyos for urban development. We present status information for populations within New Mexico, and discuss implications relevant to conservation and management.

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Title:
The effects of pack size in captivity in the Mexican gray wolves using faecal glucocorticoids

Abstract:
Stress can cause a variety of symptoms in the Mexican gray wolf (*Canis lupus baileyi*): weight loss, poor health, impaired growth, sensitisation to stressors, failure to adapt, and infertility. Isolation from a pack is a stressor but the impact is unknown. I researched the stress levels of captive wolves kept in packs versus isolation through faecal glucocorticoid analysis. Scats from the Sevilleta Wildlife Reserve and Ladder Ranch were collected during in 2019. Faecal matter collected from solitary wolves and communal wolves was compared for the number of glucocorticoids. Management implications of these findings can help guide captivity practices and release decisions of wolves held in temporary captivity.
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Title:
Factors Leading to Engagement of Minors in Wildlife and Environmentally-Oriented Political Activism

Abstract:
As our earth faces drastic change in the face of rising CO2 levels, wildlife and environmental health becomes more and more politicized. Thus, it is important to understand the future of wildlife and environmental political activism, as that information is also indicative of the future of wildlife and environmental security. Our project was designed to create data for New Mexico environmental education programs pertaining to why minors are becoming politically active. Our research consisted of short interviews conducted with several New Mexico adolescents who are environmentally active with wildlife and habitat issues. These interview questions surveyed at-home environmental learning, participation in environmental programs, and the nature of participants' activism. We were particularly interested in the reasons directly given by participants as to why they chose to become environmentally active. This data can be used by environmental learning programs to aid them in adjusting their curricula to foster greater chances of producing learners are engaging with the political side of environmental activism.
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Title:
Bat habitat use across the gradient of urbanization in the Phoenix Valley

Abstract:
Urbanization influences the distribution of bats, a diverse group of mammals that plays important ecological roles, such as pollinators, seed dispersers, and predators of night-flying insects. The response of bats to urbanization is species-specific, with some bats being more sensitive to urbanization than others. Bats can be categorized into urban avoiders, urban adapters, and urban exploiters based on their distribution across a gradient of urban intensity. Urban avoiders reach their highest relative density, or relative use, in wildland areas, urban adapters peak in relative use at moderate levels of urbanization, and urban exploiters reach their highest relative use in highly urban areas. Little is known about bat distribution along urban gradients, especially in understudied regions, such as arid environments. The goal of this research is to understand the effect of urbanization on bat habitat use in an arid region. To achieve this, we deployed acoustic bat monitors at 50 sites across the Phoenix metropolitan area in locations with varying levels of urbanization, from non-urban wildland habitat to highly urban cityscape. We expected bat habitat use to vary, consistent with the urban avoider, urban adapter, and urban exploiter framework. We found that occupancy of several bat species decreased across the gradient of urbanization, while occupancy of other bat species, such as the Mexican free-tailed bat (*Tadarida brasiliensis*), increased across the gradient of urbanization. Our findings revealed which bat species are most sensitive to urbanization, which can be used in management and conservation plans for bats across urbanizing landscapes.
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Title:
Spatial prioritization for endangered Yuma Ridgway's Rail habitat on the Gila River in Maricopa County, Arizona

Abstract:
The Yuma Ridgway's Rail (Rallus obsoletus yumanensis) is a subspecies of the Ridgway's Rail (Rallus obsoletus) that can be found in freshwater marsh habitats along the lower Colorado River, the Gila River, and the Salton Sea. However, due to the disappearance and deterioration of their habitats, they are listed as a federally endangered species. Emergent marsh habitats on the Gila River near Phoenix are in small patches and not adequately mapped. Because of changing land uses and water regimes on the Gila River west of Phoenix and above Gillespie Dam, a need exists for more accurate identification of emergent marsh. Although a predictive occupancy model exists (Glisson et al., 2017) and was considered for use by the project team, there were important habitat details lacking. Audubon Arizona initiated a habitat suitability project using Geographic Information Systems technology as the main tool for building a localized preliminary habitat model. This poster presentation expands on the development and workflow of refining the model, as well as the development of a field survey protocol compatible with the North American Marsh Bird Survey Protocols for verifying habitat features.
Funding for this project is provided by Sonoran Joint Venture and Arthur and Elaine Johnson Foundation.

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Title: Framing the Gap: An Examination of the Self - Efficacy of Wildlife Professionals in the Public Domain

Abstract:
Management and prevention of human-wildlife conflicts constitutes a significant challenge for wildlife agencies. There has been vast amounts of research relating to risk perception, attitudes, beliefs, educational programs, and communication campaigns in regards to human-wildlife conflict. However, research focused on the communication and public education skills and techniques of wildlife professionals themselves is scant. The need for such skills and knowledge is critical, as wildlife professionals are often charged with the dissemination of important information pertaining to wildlife-human conflict prevention and management. The purpose of the study is twofold. The first goal is to develop new insights into the professional development needs of wildlife professionals specific to communicating with the public about human-wildlife conflict. The second goal is to use these insights to generate recommendations for future professional development initiatives and resources specific to public communication and education that are directly responsive to the perspectives and needs of wildlife professionals. This research will focus on wildlife professionals in Arizona, Colorado, New Mexico, and Utah that conduct work relating to communication and public education within the context of human-wildlife conflict. Self-efficacy, which explains the relationship between expected personal abilities and coping behavior, is the theoretical framework that will guide the research (Bandura, 1977). A data collection instrument was constructed using the Borich needs assessment model as defined by Borich, 1980. Competencies addressed within the instrument were drawn from pilot interviews and existing literature, all regarding public education and communication skills within the context of human-wildlife conflict.
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Title:
Factors affecting Burrowing Owl Nest Site Selection in Artificial Burrows in Arizona

Abstract:
The Burrowing Owl (*Athene cunicularia*) is considered a Bird of Conservation Concern in the United States. Their decline is attributed to the eradication of fossorial mammals and habitat loss due to increased urbanization. Translocations of the Burrowing Owls to artificial burrows systems (ABS) aim to provide new habitats for the species, but few studies directly assess burrow features that play a role in nest-site selection. In this research, we aim to understand the local-scale factors affecting the nest site selection of Burrowing Owls at ABS. We conducted research at 4 sites across Maricopa and Pinal counties in Arizona. The factors included angle of the tunnel entrance, number of nearby perches, the height of the tunnel entrance, ABS configuration (single or double entrance to the nest chamber), as well as the nearest nest distance, the number of nests within 75 m and the number of satellite burrows within 75 m. We conducted a 16 a priori Bernoulli model that was assessed under a Bayesian framework, utilizing WAIC to determine its influences on nest-site selection. Our preliminary results show that owls select for: (1) single entrances, (2) shorter tunnel length, and (3) low nest density within 75m. Double-entrance burrows are constructed by wildlife managers to potentially provide additional escape for nestlings; however, based on our results, we recommend constructing ABS with single entrance and shorter tunnels in length, as well as to provide sufficient satellite burrows to allow the young to disperse and lower nest density, to increase the nest site selection.
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Title:
Testing the Acoustic Adaptation Hypothesis in the willow flycatcher (*Empidonax traillii*) species complex

Abstract:
In birds, song is an important signal in conspecific interactions. Song is typically used to attract mates and repel competitors. The Acoustic Adaptation Hypothesis (AAH) predicts that acoustic characteristics will change in response to the environment so as to optimize the transmission of a signal. Under this hypothesis, senders whose signals attenuate relatively quickly given environmental components such as vegetation structure, temperature, humidity will be selected out of the population. Senders who can optimize signal transmission through the environment will have relatively higher fitness, increasing the frequency of that signal in the population. For example, populations exhibit lower frequency songs in warmer, drier areas because song attenuates faster at higher temperatures and in low humidity and higher frequency songs cooler areas with higher humidity. Similarly, birds in densely vegetation habitats should exhibit songs with smaller internote intervals to minimize note overlapping. Because the species occupies different environments, it has been proposed that songs among populations have adapted to their environmental conditions, but this has not yet been tested. Based on the AAH, we predicted populations in mesic habitats will sing songs with higher frequency and populations in areas with more canopy cover will exhibit songs with shorter internote intervals. We assessed the AAH in willow flycatcher song in two ways. First, we assessed the relationship between song and climate using field recordings from across the willow flycatcher US range and climate data collected from the PRISM database. Second, we assessed the relationship between song and vegetation density by recording songs from focal males and by estimating canopy cover using a densiometer at the approximate center of an individual's territory. Consistent with our hypotheses, we found populations in more mesic habitats exhibited higher frequency songs with smaller internote intervals relative to populations in xeric habitats, after controlling for body size. Similarly, populations in areas with higher canopy cover exhibited songs with lower frequency and with longer internote intervals after controlling for body size. Our study suggests that climatic and structural differences among habitats may be driving signal divergence among populations of willow flycatchers. Because willow flycatcher subspecies show strict habitat selection, signal divergence is likely to continue. This may mean that SWFLs are on a separate evolutionary trajectory, and therefore deserve protection under the Endangered Species Act.
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Title:
Species Richness of Mammals and Terrestrial Birds Across a Gradient of Urbanization in Central Arizona

Abstract:
Urban ecosystems provide unique opportunities and challenges for the management of wildlife species and the services and disservices they provide. However, current wildlife management approaches in cities are often reactive, focusing on the removal of individual species when and where they are deemed to be a nuisance. Developing a more explicit, evidence-based management approach to managing urban wildlife requires knowledge of the social and ecological factors that drive the dynamics of broader wildlife communities in unique ecoregional contexts. In this research, we specifically ask how a community of mammals and terrestrial birds respond to urbanization in the desert context of Arizona's Phoenix metropolitan area. We have hypothesized that the species richness of the overall wildlife community and of its component guilds would vary significantly across two key environmental gradients associated with urbanization: urban land cover and vegetation cover. To assess this variation in the wildlife community, we have maintained a randomized array of 50 camera traps across the Phoenix metropolitan area since March 2019. Using a preliminary dataset of 16 observed wildlife species across 34 sites during April 2019, we have used multi-species occupancy modeling to evaluate how the wildlife community changes across urbanization gradients. Preliminary results demonstrate general decreases in species richness at sites located across gradients of urban land cover. Next steps for this research include evaluating additional social and ecological landscape characteristics that influence patterns of species occurrence and investigating how patterns of diversity relate to patterns of reported human-wildlife interactions.
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Title:
Detecting New Mexico Meadow Jumping Mice Using eDNA

Abstract:
The endangered New Mexico meadow jumping mouse (*Zapus hudsonius luteus*) resides in riparian areas in the southwestern United States. They are at risk from habitat loss; likely causes include over-grazing, wildfire, and recreation. Monitoring jumping mice would benefit from techniques that involve minimal training or human-power, such as detection via environmental DNA (eDNA). As the jumping mouse moves through tall, dense vegetation near streams, it leaves behind fragments of its DNA. These fragments can be used in addition to current methods (live capturing, track plating, camera trapping) to obtain information about the animal's presence. In the lab, we first developed a highly sensitive, species-specific assay that used quantitative real-time PCR. Through dilution tests, we determined that only 3 copies of target DNA within a sample were necessary for positive detection at 95% confidence. This procedure was used as a pilot in June 2019. We cotton-swabbed riparian plants 30 times along two streams in the Santa Fe National Forest, one where we did capture and one where we did not capture jumping mice. Nine additional swabs from the site with captured jumping mice were based on visual sightings of the mouse or information about their vegetation preferences. We successfully detected jumping mouse DNA from three substrates where a jumping mouse was observed beforehand and one substrate without prior observation in the positive-capture site. Our approach is promising, and we will continue in 2020 to experiment with an effective, systematic protocol that will facilitate integration of eDNA into jumping mouse monitoring.
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Title:
Parasite evaluation in endangered Mount Graham red squirrels (*Tamiasciurus fremonti grahamensis*) and invasive Abert's squirrels (*Sciurus aberti*).

Abstract:
Invasive species are among the leading global threats to native wildlife and are a factor in the decline of 42 percent of threatened and endangered species. Invasive species can influence the ecosystem health through parasite loads that they introduce during establishment in new areas. In the 1940s, Abert squirrels (*Sciurus aberti*) were introduced to the Pinaleño mountains in southeastern Arizona where they currently co-occur with endemic endangered red squirrels (*Tamiasciurus fremonti grahamensis)*. There is little understanding of parasite loads between invaders and imperiled endemic species, including S. aberti and T. f. grahamensis; we will identify and quantify parasites in this important system. We will analyze over 60 Abert squirrels from their breeding season, between late February and early June, and targeting both sexes as equally as possible. All samples of Mt Graham red squirrels (*T. h. grahamensis)* will be sampled regardless of dates collected or sex only because samples of the endangered red squirrels are only limited to natural, accidental, and predatorial deaths. The entire gastrointestinal tract is examined for endoparasites following standard parasitological procedures and fecal samples are analyzed through qualitative flotation methods. From the study we hope to gain a better insight into possible parasite transmission routes and the role that parasites play in biological invasion. We strive to understand all aspects of factors that place species at risk of extinction, so that we can provide future management and conservation strategies for similarly threatened or endangered species.
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Title:
Intraindividual Variation in the Calls of Non-passerines: A Study of Northern Flicker Calls

Abstract:
Variation in bird vocalizations can serve many functions. Birds and humans alike can distinguish between different species of birds based on differences in their vocalizations, and birds can likely distinguish between different individuals based on vocalizations. However, how much one individual's vocalizations vary, known as intraindividual variation, has received relatively little attention, but could serve important functions such as communicating different information using the same type of vocalization.
Intraindividual variation could be affected by how a bird acquires its song. Songbirds (oscines) learn their songs, but suboscines and nonpasserines generally do not learn their songs. Relatively few studies have examined intraindividual variation in nonpasserines, while there have been studies about intraindividual variation in suboscines and oscines.
Our objective was to establish baseline levels of intraindividual variation in a nonpasserine: a North American species of woodpecker, the Northern Flicker. Our aim was to compare our results to existing studies of intraindividual variation in the vocalizations of birds. We recorded nine adult male Northern Flickers around Flagstaff, Arizona, producing multiple calls in one session and analyzed the recordings using Raven Pro.
The variation we observed within and among individuals was similar to other non-passerine and suboscine vocalization studies. Our data showed less vocal variation compared to a study conducted on oscine songbirds. Our results support the hypothesis that birds that do not learn their songs (non-passerines and suboscines) have less intraindividual variation than songbirds, which do learn their songs.
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Title:
Home range and activity of the ornate box turtles in the high plains of eastern New Mexico

Abstract:
The ornate box turtle (*Terrapene ornata*) is a relatively small prairie species usually associated with sandy soils. In New Mexico, box turtles occur throughout the eastern portion of the state, preferring semiarid habitats. In the fall 2019, we radio tracked three box turtles, a male and two females, at a pristine location in Roosevelt County, New Mexico. Tracking was done daily until mid-October, when the turtles had gone underground for hibernation. For each day of tracking, we recorded GPS coordinates and weather measurements using a kestrel weather meter. We ran a logistic regression in R using humidity, time, and temperature as covariates, and turtle activity (above or underground) as a dependent variable. Our preliminary results for the male showed that humidity had a significant positive effect on activity ($p = < 0.01$), whereas time and temperature did not show significance ($p > 0.05$). We measured distance moved each day and found that, on average, the male moved 42.81m per day. We also constructed a kernel density map in ArcGIS to demonstrate centers of activity. Using minimum convex polygon, we calculated a home range of 12,075 square meters. When active, we witnessed a variety of behaviors including walking, basking, mating, burrowing, and feeding. This research will continue for the following two years in order to study seasonal differences in activity and movement. Understanding home range can provide insights to species' habitat requirements, resource availability, behaviors, etc.
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Title:
Winter ecophysiology of North American desert southwest bats

Abstract:
Hibernation ecology and physiology of northern Arizonan bats has not been completely studied, with only one work describing the presence and abundance of bat species in caves. Due to the spreading of WNS in different states in the U.S. and the recently discovering in northern California, acquiring this essential information would bring a broader panorama to the research community and know how to respond. We have conducted visual inspection in three hibernacula close to Flagstaff, Arizona, attached temperature transmitters to measure bats' body temperature, used passive acoustic monitoring to determine the length of hibernation and describe winter activities, and measured the whole-body fat content using a mobile EchoMRI unit. Data were collected from August 2018 to May 2019. We identified four different species and ~800 individual roosting in the three hibernacula. We successfully attached two temperature transmitters to one *Eptesicus fuscus* and one Co, but due to interference in the cave, we were able to record eight minutes of information. According to visual inspection, hibernation started between September 5 and November 16, 2018. We measured a total of nine species and 27 individuals in the EcoMRI during the pre-hibernation period (Oct-Nov 2018) and 3 species and 11 individuals during May 2019.
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Title:
Carbon, Hydrogen, and Nitrogen Stable Isotope Analysis of Select Albuquerque Riparian Breeding Birds

Abstract:
Stable isotopes from carbon, hydrogen, and nitrogen can be analyzed from organisms to give an understanding to a variety of ecological benchmarks within those organisms. In animals, carbon and nitrogen are used to assess diet and trophic level; hydrogen is used to assess migration pattern when applicable. I focused on representative local New Mexico breeding birds that were analyzed for each of these isotopes. Primary focus was on the Bewick's Wren (*Thryomanes bewickii)*, Lesser Goldfinch (*Spinus psaltria)*, Spotted Towhee (*Pipilo maculatus)*, and Yellow Breasted Chat (*Icteria virens)*. These birds were analyzed through data collected from a tail feather. These tail feathers were collected during the monthly mist netting and bird banding done at two Albuquerque Bosque Ecosystem Monitoring Program (BEMP) field sites from the months of June to September during the 2018 and 2019 breeding seasons.
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Title:
Spring diets of black-tailed and antelope jackrabbits

Abstract:
Jackrabbits are a key prey species in the Southwest; many populations of mammals and birds rely on jackrabbits as a food source. Over the past 50 years, populations of black-tailed jackrabbits (*Lepus californicus*) have declined, whereas the sympatric antelope jackrabbit (*Lepus alleni*) has remained abundant. The reason for this is not yet known. One hypothesis to explain the dissimilarity is that competition for limited forage resources is negatively impacting black-tailed populations. Based on preliminary studies, we hypothesized that antelope jackrabbit diets consist of more exotic, and potentially more abundant, plants than black-tailed jackrabbit diets. To investigate this, we characterized the spring diets of the jackrabbits by identifying the plants found in their scat using Next Generation Sequencing. We sequenced the plant DNA found in scat samples, and matched those sequences to a database of sequences of plant species suspected to be consumed by jackrabbits. Our results show that the antelope jackrabbit consumes a higher diversity of plants, but both species' first and second most frequently consumed plants (poplar and Bermuda grass respectively) are the same. Notably, we found that the majority of sequences for both jackrabbit species match nonnative plants, a finding that contrasts previous studies. Given that both jackrabbit species consume native as well as exotic plants, the hypothesis that limited forage of native plants drives the differential decline is not supported by this analysis. This study provides a foundation for further studies to explore differences in the diets of jackrabbits in response to season or exotic plants.
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Title:
Identification of Hantavirus strains in Eastern New Mexico rodent assemblages

Abstract:
Hantavirus is a globally distributed zoonotic RNA virus which can cause Hantavirus Pulmonary Syndrome (HPS) in humans. In the U.S., 728 HPS cases have been reported, with 36% mortality rate. Rodents of the family Cricetidae are known to be the main hosts for hantaviruses. Although studies on the prevalence of hantavirus in rodents have been increasing in the Southwestern U.S., little is known about the presence of the virus in eastern New Mexico where three hantavirus strains (i.e., El Moron Canyon, Sin Nombre, and Muleshoe) potentially overlap. A preliminary study of Hantavirus in eastern New Mexico reported positive Hantavirus antibodies in 13 rodent species including atypical host species such as spotted ground squirrel (*Xerospermophilus spilosoma*), Southern Plains woodrat (*Neotoma micropus*), and Ord's kangaroo rat (*Dipodomys ordii*). To further expand the knowledge on the presence of hantaviruses in rodent communities, we aim to genetically confirm the presence of the virus and identify specific strains. We will conduct high intensity small mammal surveys at 20 locations across 8 counties in eastern New Mexico. Captured rodents will be humanely euthanized, and blood samples will be tested for the presence of hantavirus antibodies via enzyme-linked immunosorbent assay and western blot analyses, while lung tissues will be used to sequence the virus. This study will elucidate the distribution, prevalence, and persistence of hantavirus across small mammal populations along with abiotic and biotic factors that facilitate overall prevalence in eastern New Mexico, which will aid in understanding the patterns of spread of these zoonotic pathogens.
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Title:
Evaluating Temporal and Spatial Distribution of the Lesser Long-Nosed Bat (*Leptonycteris yerbabuenae)* on the Barry M. Goldwater Range East

Abstract:
Understanding bat commuting corridors along migration routes and between roosting and foraging areas is fundamental for understanding the spatial and temporal distribution of lesser long-nosed bats (*Leptonycteris yerbabuenae*) [LLNB]. Recent detections of LLNB on the Barry M. Goldwater Range East (BMGRE) in southern Arizona indicate that LLNB are utilizing previously unknown travel corridors. Presence is almost certainly dependent on the phenology of blooming saguaro cactus and differs depending on location. We detected a LLNB early season roost on BMGR East during routine monitoring efforts in May of 2016. This detection was the first on BMGR East and represents a 22km northern range extension for this species. In order to further understand the spatial and temporal distribution and habitat use patterns for this species on BMGR East we focused on two primary methods; 1). Evaluation of potential LLNB acoustic calls across five long-term acoustic towers on BMGR East, and; 2). Tracking individual LLNB with the use of store on-board GPS transmitters. The two LLNBs affixed with GPS transmitters at Bluebird Mine traveled over varying average distances per night (Bat 9825 38.7km and Bat 6045 12.3km). These were shorter distances than observed from other studies (Horner et al. 1998, Ober et al. 2005, Lowery et al. 2009, Buechner and Sidner 2013 and Medellin 2018), but further monitoring is needed and ongoing due to our modest sample size (n=2) and number of nights tracked (avg. = 2.25 nights).

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Title: The efficacy of translocation to augment Gambel's quail populations

Abstract:
Translocation is a valuable management strategy that can be used to augment and replenish populations or increase the range of a species by establishing new populations. Gambel's quail (*Callipepla gambelii*) are native to the American Southwest and are a popular game bird among hunters. Due to recent drought conditions, Gambel's quail in Arizona have experienced a state-wide decline over the last 10 years. Gambel's quail populations are highly susceptible to variations in precipitation patterns and the loss and fragmentation of habitat can impede their ability to recover after patterns improve. Translocations are commonly used to replenish populations in fragmented habitats, however the efficacy of such to augment existing populations remains untested. Studies often focus on short-term survival and movement of translocated birds; however, the ability of an animal to reproduce in a new environment is imperative to their capacity to bolster wild population numbers. We have translocated 198 Gambel's quail into two distinct release sites in the Altar Valley to identify factors contributing to their survival, reproductive success, and to assess the ability of translocations to boost population growth beyond that experienced by non-augmented populations. Preliminary data collected in the first field season showed that between the two release sites, King's Anvil (KA) and Santa Margarita (SM), KA had greater apparent survival rates than SM (59% and 39% respectively), however had lower nesting effort of females that survived to the mating season (35% and 58% respectively). Furthermore, KA quail yielded 0% nesting success compared to 50% of SM nesting females.
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Title:
Isotopic Analysis of Porcupine Diets

Abstract:
Porcupines are a very common species in the southwest, but a species that is not researched very well in this region. The focus on this project is to analyze and compare quills from different porcupines to determine changes in their diets. The quills were from porcupines in the Albuquerque bosque and each quill provided a snap-shot of the last few months of the porcupine's diet. We were able to see how diets varied over time and by individuals in different parts of the Bosque. When the porcupine quills were collected, they were processed in addition to different plant samples to determine the Carbon and Nitrogen isotope levels in the plants and quills. This was done to see which plant species each porcupine relied on most. With the use of isotopic analysis of the quill and plant samples, we were able to determine the diet of porcupines by comparing Carbon and Nitrogen isotopic ratios. These ratios show the diffraction from C3 plants and C4 plants and the trophic levels of the specific porcupine. Currently, in the southwest with climate variation, the porcupines are in an area of concern, due to the reduction of resources available to them in the Bosque ecosystem. Porcupines are a vital species and poorly understood in our ecosystem and one that needs to continue to be researched and understood by fellow scientists.
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Title:
Linking bird activity to riparian vegetation using ecoacoustics on a Wild and Scenic River

Abstract:
The Verde River in Arizona is home to the largest expanse of Fremont's cottonwood in Arizona. More than 300 birds, including several listed and sensitive species, use riparian forest associated with the Verde River. Because of its outstanding wildlife and vegetation values, two reaches of the river have been designated under the Wild and Scenic Act in 1984. We established study plots at three study reaches along the Lower Verde River in 2018 and measured riparian vegetation and deployed passive acoustic monitors from May to September. We quantified activity of sensitive bird species such as Bell's vireo, summer tanager, and yellow-breasted chat in a range of riparian habitats. We collected aerial imagery using a small unmanned aerial system (sUAS) and classified woody vegetation into flow-response guilds using aerial orthophotos. Initial results highlight the importance of vegetation guilds composed of tall riparian trees such as Goodding's willow and Fremont's cottonwood, but also suggest that the full complement of riparian forests, such as mesquite woodlands, are important for sensitive bird species. Historic baseflows and native flood regimes directly shape riparian vegetation on the Verde River. Our findings suggest that sensitive wildlife are indirectly tied to hydrologic processes which shape the structure and composition of their habitats. These findings, along with future work, will be incorporated into a management tool for natural resource managers on the Wild and Scenic Verde River.

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Title:
Factors Affecting the Presence of Burrowing Owls at Artificial Habitat Sites in Arizona

Abstract:
The Western Burrowing Owl (*Athene cunicularia hypugaea*) is declining throughout its range due to loss of arid grassland habitat and declining small mammal populations. The relocation of owls to artificial habitat is a common conservation and mitigation strategy. Few studies have examined the influence of factors on artificial burrow presence. Our goal was to assess how habitat and site-specific factors influence owl presence at artificial habitat sites in the Phoenix, AZ area. Observations were conducted at 20 Wild At Heart artificial habitat sites for Burrowing Owl presence surveys. Each installed burrow was camera probed to discern which sites had available burrows to support owls. Burrow GPS points were used to digitize a 600-m radius around each site in ArcMap 10.6, which determined land-use types by separating different landscapes with the cut polygon tool using NAIP 2010 digital ortho quad tiles. Logistic regression models demonstrated that owl presence was negatively related to site age and positively related to burrow availability, albeit with large confidence intervals. Owl presence was also positively related to percent of agricultural land-use type, but this logistic regression model had the lowest fit among the models strongly supported by Akaike's Information Criterion (AICc). These findings will allow us to provide site selection and maintenance recommendations to improve methods for creating viable habitats for Burrowing Owls.
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Title:
Incorporating High Density Bat Roosting Habitat into Highway Bridge Construction

Abstract:
A large colony of Mexican free-tailed bats has been reliably observed throughout the entire length and width of the Ina Road Bridge in Tucson since its discovery in the mid-1990s. The bridge was scheduled to be torn down and replaced with 2 larger bridges by December 2018, displacing thousands of bats. AZGFD worked with the Town of Marana and the Regional Transportation Authority to design an approach that would incorporate bat roosting habitat into the new bridge. AZGFD, engineers, and construction crew utilized a new concrete bat box designed by Modern Bat™ to integrate suitable replacement habitat as part of the bridge structure rather than a post construction add on. Fourteen bat boxes were incorporated into the new bridges, each with a maximum capacity to house 3,000 bats. As of December 2019, all bat boxes had some level of use that varied from full saturation in the summer (up to 40,000 bats) to scattered use in mid-winter (approximately 7,000 bats). This project demonstrates that integrating bat habitat into bridge design rather than as a post hoc exercise has the potential to retain large populations of bats.

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Title:
Assessing Mexican Woodrat Movement over Patches of Different Burn Severity

Abstract:
The use of small mammals as indicators of disturbance has become popular in the field of ecology. Animal behavior may change as a result of stochastic environmental events. We examined how Mexican woodrats (*Neotoma mexicana*), a common but understudied species, respond to fire as measured by changes in path tortuosity when translocated over patches of different burn severity. The study was conducted on Mt. Graham, the site of the severe 2017 Frye Fire. Woodrats were captured, covered in fluorescent powder, and released 50 meters away from their middens across areas of low or moderate burn severity. The resulting powder trail was marked with pin flags, and bearing and vegetation were noted for each segment of the trail. Vegetation proportions were compared to proportions from randomized vegetation transects for both low and moderate burn severities. Preliminary analyses indicated higher tortuosity over areas of moderate burn severity as demonstrated by increased numbers of turns per straight-line distance. Logs were heavily selected, whereas grasses were avoided. This may be attributed to lower visual perception in dense vegetation, especially owing to the woodrat's size and preference to move freely over the landscape. With the potential for increased wildfires due to climate change, this work presents an understudied approach to understanding these disturbances and their effects on ecological communities. This research was supported by the University of Arizona's Undergraduate Biology Research Program with funds from the Office of Research, Discovery & Innovation, the USDA Forest Service, and the College of Agriculture and Life Sciences.
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Title:
Environmental DNA metabarcoding detects mammal use of stock tanks and natural springs on the Prescott National Forest

Abstract:
Recent research has shown the viability of environmental DNA (eDNA) analysis as a tool for identifying species presence in aquatic ecosystems. However, there is limited research indicating the feasibility of eDNA as a survey tool in water sources such as springs and stock tanks. Because of the scarcity of water in the high desert landscape of Arizona, natural springs and stock tanks are an important water resource. In this study, we examined whether 16S rRNA metabarcoding could detect mammal eDNA in springs and stock tanks in the Prescott National Forest. During summer 2019, we collected water samples at eight sites, including five natural springs and three stock tanks. Triplicate 250 mL water samples were collected and vacuum-filtered in the field. In the lab, eDNA was extracted, amplified using 16S primers, and sequenced using an Illumina MiSeq FGx. Across all sites, samples resulted in the detection of eight vertebrate species, including one amphibian, the American Bullfrog *Lithobates catesbeiana*, one bird, the Mallard *Anas platyrhynchos*, and seven mammal species, including the American Black Bear *Ursus americanus*, Mule Deer *Odocoileus hemionus*, and two squirrel species from the Genus *Sciurus*. However, of the 1.9 million sequences generated during sequencing, 1.85 million sequences belonged to invertebrate species. This suggests amplification of invertebrate eDNA associated with the 16S primers, which may interfere with the detection of vertebrate eDNA sequences in these systems. Next steps include reanalyzing samples using a new set of mammal-specific primers to see if they improve the recovery of mammal eDNA sequences.
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Title:
Using biologging devices to detect rhythms of activity in the golden mantled ground squirrel

Abstract:
The physiology and behavior of the golden mantled ground squirrel (*Callospermophilus lateralis*, GMGS) is well documented in laboratory settings, but much less so in free-living conditions. Using data collected from biologging devices (collar mounted light loggers and internally implanted temperature loggers), we are able to observe patterns in daily activity and body temperature from a previously unstudied natural population in northern Arizona. We present a preliminary dataset (eight multi-week light logs and one temperature log), from the late-summer fattening period for eight individuals, five females and three males. We examine patterns in activity onset and offset time, total time spent above ground, number of below ground visits, and circadian period length in relation to Julian date and photoperiod. Daily above-ground below-ground behavior roughly follows a 24-hour period, with GMGS showing robust daily patterns that vary with photoperiod and sex. Future studies seeking to understand biological rhythms can benefit from this novel combination of biologging devices. Continued analysis is dependent on collection of biologging devices in spring 2020.
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Title: Stream Vegetation Recovery in the Chiricahua Mountains Following a Forest Fire

Abstract:
Throughout evolutionary history plant communities have adapted to seasonal forest fires, however human interaction and fire suppression has left forest communities susceptible to major burns. The Horseshoe II fire in the Chiricahua Mountains of southeast Arizona was one such burn. A decade after the fire we chose this study site to determine how riparian habitats recover from forest fires. We hypothesized that changes in stream vegetation would be correlated to the intensity of the burn because of the change in competition following the fire. We predicted that as the burn intensity increased, we would see an increase in angiosperm richness and grass density with a decrease in canopy cover and tree density. Four 100-meter stream sites were subdivided into ten 64 meter2 plots within North-Fork Cave Creek and East Turkey Creek. We had five points of canopy cover and four points of grass density within the plots. Tree density and species were recorded with angiosperm richness across all four sites. Using ANOVA, we found that high burn sites had greater angiosperm richness than no burn sites (P=0.016). We also found that there is a linear trend for grass and tree density that suggest that at high burn sites there is more grass (P=0.215) and fewer trees (P=0.153). Canopy cover showed a downward trend from low to high burn sites (P=0.397). Future research would aim to explain fire intensity impacts at the next trophic level. From what we have found natural recovery following a forest fire alters stream species composition.
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