

CALIFORNIA STATE UNIVERSITY, NORTHRIDGE

The Effects of Artificial Light at Night on Rodents' Perception of Risk

A thesis submitted in partial fulfillment of the requirements

For the degree of Master of Science in Biology

By

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ABSTRACT

The Effects of Artificial Light at Night on Rodents' Perception of Risk

By

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Masters of Science in Biology

Light pollution, or artificial light at night (ALAN), can increase an animal's sense of perceived risk while out foraging. This can cause them to leave more food at foraging sites or visit them less often in favor of safety from predation. For populations of small nocturnal rodents, this can cause negative trophic effects on plant communities in an ecosystem. To measure an increase in perceived risk from ALAN, I measured the giving up densities (GUDs) of small rodents foraging at six illuminated and six non-illuminated sand filled trays. I used low levels of light (0.5 lx) to illuminate the trays since nocturnal rodents have excellent night vision. Camera traps were used to measure how often the rodents foraged at illuminated and non-illuminated trays. This experiment was conducted at the University of California, Los Angeles

Stunt Ranch Reserve in the Santa Monica Mountains. Rodent GUDs were measured at the edges of oak woodland and shrubland habitats. Lunar illumination and cloud coverage at night were also recorded to determine how the increase and decrease of natural nocturnal light interacted with ALAN. ALAN was a risk factor in both environments. Rodent GUDs increased as moon illumination increased. Rodents also visited illuminated trays less often than non-illuminated trays. Understanding the impacts of ALAN on rodent foraging behavior and predation perception can help biologists protect these animals. This information can also help conservationists mitigate the negative effects of ALAN on wildlife living close to human developments.

INTRODUCTION

Since the 1970s, artificial light at night (ALAN) has steadily increased to the point where it was considered a type of pollution (Riegel, 1973; Bennie et al., 2015; Kyba, Kuester, et al., 2017). The United States National Parks Service has monitored ALAN since 2001 and recorded the glow from cities over 322 km away (National Park Service, 2023 and 2025). This increase in light pollution has not only been a problem for people for many decades but also has impacted nocturnal animals living near cities. ALAN can increase an animal's perception of predation risk (Bird et al., 2004; Zhang et al., 2020; Jolkkonen, 2023). High perceptions of predation risk can increase stress, which can negatively affect health and fitness (Schmitz, 1998; Pérez-Tris et al., 2004; Creel et al., 2007). The stress from predation risk and from human impacts, such as ALAN, can be mitigated by changes in behavior (Fardell et al., 2021; 2022). These changes in behavior from ALAN can affect how animals distribute themselves throughout their environment (Brown et al. 1988; Laforge et al., 2019). Some species of bats avoid habitats and foraging in areas illuminated by ALAN (Stone, 2009; Russo et al., 2019; Bhardwaj, 2020; Voigt, 2020; Hooker et al., 2022; Lewanzik, 2025).

Many nocturnal rodents have evolved good vision at night and special behaviors to help them sense and avoid predators at night. They have excellent night vision and have been recorded having an aversion to light levels as low as 1.076×10^{-5} lx to 1.0 lx (Campbell & Messing, 1969; Garcia et al., 2005). It is important for these rodents to see at such low levels of light because at ground level moonlight changes from 0.0001 lx to 0.1 lx from new moon to full moon (Kyba, Mohar, & Posch, 2017, Neale et al., 2019, Rathdach & Hvass, 2022). In the Great Basin Desert, kangaroo rats (*Dipodomys*), pocket mice (*Perognathus*), and deer mice (*Peromyscus*) use

different lunar phases for foraging at night (Upham and Hafner, 2013). Allenby's gerbil (*Gerbillus andersoni allenbyi*) in the Negev Desert will adjust their time foraging and being vigilant according to the phase of the moon (Kotler et al., 2010). In the Judean Desert, Cairo spiny mice (*Acomys cahirinus*) and golden spiny mice (*A. russatus*) express higher cortisol levels and reduced foraging behaviors during full moon nights when compared to new moon nights (Gutman et al., 2011).

Like moonlight, ALAN can change rodent foraging behavior (Bird et al., 2004; Zhang et al., 2020; Hoffmann et al., 2022; Shuai et al., 2023). This is because both increase perceptions of predation risk (Bird et al., 2004; Kotler et al., 2010; Gutman et al., 2011; Upham and Hafner, 2013; Zhang et al., 2020; Hoffmann et al., 2022; Shuai et al., 2023). This level of perceived risk can be measured by the giving-up density of an animal (Brown et al., 1988; Morris et al., 2000). Brown et al. (1988) found that rodents had increased GUDs (i.e., more food left in the foraging patch) when an artificial light source illuminated their environment. Other rodents have shown similar changes in behavior and GUDs. Beach mice (*Peromyscus leucocephalus*) and bank voles (*Myodes glareolus*) forage less at patches that are illuminated by ALAN (Bird et al., 2004; Hoffmann et al., 2022). Dwarf striped hamsters (*Cricetulus barabensis*) not only visit foraging sites illuminated by ALAN less often but will also spend less time at those patches (Shuai et al., 2023). Mongolian five-toed jerboas (*Allactaga sibirica*) also spend less time at foraging sites exposed to ALAN, and they spend more time being vigilant when foraging at those sites (Zhang et al., 2020). These changes in behavior result in rodents gathering less food, which can lead to lower fitness (Zhang et al., 2020).

The pressure from ALAN and moonlight together on rodent foraging behavior make it important to study due to the trophic effects that they can cause near human developments.

Additive and synergistic reactions have been reported for small mammals when exposed to multiple stressors in their environment (Geary et al., 2019; Legge et al., 2019; Fardell et al., 2020, 2021). Because moonlight and ALAN cause similar changes on rodent foraging behavior and predation perception, it is important to consider both simultaneously. I hypothesized that rodents would perceive ALAN as an added risk factor during foraging under moonlight, thus leading to reduced foraging activity. I had several predictions from this hypothesis that I expected to see. Rodents would have higher GUDs at sites illuminated by ALAN than at sites not illuminated by ALAN. Rodents would have higher GUDs during nights with full moons while ALAN is present compared to nights that don't have full moons and ALAN is present. Rodents would lower GUDs during cloudy nights as this should block moonlight from the habitat. Rodents would visit foraging sites less often and at different times of night if they are illuminated by ALAN. I planned to test this hypothesis by illuminating foraging sites and measuring the GUDs of rodents visiting these sites.

METHODS

Study Area

This study took place in the Santa Monica Mountains in southern California at Stunt Ranch Reserve (34.150000, -119.083333; elevation: 398 m; mean rainfall: 50 cm/yr) (University of California Natural Reserve System, n.d., The Stunt Ranch Reserve) from June – August 2026. The 1.25-km² reserve is primarily chaparral and oak woodland habitats (University of California Natural Reserve System, n.d., “Resources”). This plant community includes California sagebrush (*Artemisia californica*), laurel sumac (*Malosma laurina*), mountain mahogany (*Cercocarpus betuloides*), coast live oaks (*Quercus agrifolia*), and valley oaks (*Quercus lobata*). This habitat also includes invasive plant species such as smilo grass (*Oloptum miliaceum*), yellow starthistle (*Centaurea solstitialis*), and tree tobacco (*Nicotiana glauca*) (University of California Natural Reserve System, n.d., “Resources”). There is an ephemeral stream that cuts through Stunt Ranch and creates a forested riparian zone. There are 11 species of rodents in this reserve: California ground squirrels (*Otospermophilus beecheyi*), eastern fox squirrels (*Sciurus niger*), western grey squirrels (*Sciurus griseus*), dusky footed woodrats (*Neotoma fuscipes*), Botta’s pocket gophers (*Thomomys bottae*), western harvest mice (*Reithrodontomys megalotis*), California pocket mice (*Chaetodipus californicus*), California mouse (*Peromyscus californicus*), western deer mouse (*P. sonoriensis*), eastern deer mouse (*P. maniculatus*), and cactus mouse (*P. eremicus*) (National Park Service, 2022).

Experimental Design

To assess perceptions of predation risk, I deployed 12 illuminated foraging trays to measure GUDs. The trays had an alternating lighting schedule every four nights over a period of

16 nights. Trays that had their lights off would serve as control trays while trays with their lights on were treatments. The first four nights had all lights turned off at the trays. Six of the trays had their lights turned on after the four initial nights. After those four nights, the lights that were on were turned off and the remaining six lights were turned on. The last set of four nights would have all of the lights turned off. This lighting schedule allowed each tray to be a replicate when the lights were on or off.

Foraging trays were deployed on the first weekend of each month. Foraging trays consisted of a circular metal tray (5 x 30.5 cm) containing 2 L of sand and 10 g of buried black oil sunflower seeds. Additional sunflower seed (1 g) was placed on top of the sand and seed mixture to serve as a lure for the rodents. I anchored 91 x 31 cm chicken-wire (2.5-cm gauge) cages into the ground around the trays to keep non-target animals out.

Because nocturnal rodents can see well under low-light conditions and I wanted to reduce influencing behaviors outside of the trays, I used a dim directed light source to simulate ALAN. Specifically, a directional garden light (55 Lumen Black LED Weather Resistant Outdoor Solar Spotlight, Hampton Bay, Atlanta, GA, USA) was placed at each tray. These lights were attached to 0.9-m metal poles so they would shine down onto the tray and positioned 1 m from the top of the sand in the tray. The light surfaces were fitted with paper towels to soften the light intensity to 0.5 lx at the trays. Light was measured using a light meter (LT300, Extech Instruments, Nashua, NH, USA).

I initially deployed 10 camera traps (HC500, Hyperfire, Holmen, WI, USA) to record rodents that visited 10 of the 12 trays. These cameras were used to record the times rodents visited the trays and foraging frequency. The picture quality of these cameras was sufficient to distinguish mice, rats, gophers, and squirrels, but not suitable for identifying species. They also

were used to determine if non-target animals were eating the seeds in the trays. These cameras were fixed to metal poles and placed 0.5-m away from trays.

Foraging Tray Locations

Plant community can alter the perceptions of rodents to predation risk in relation to moonlight and ALAN (Ceradini & Chalfoun, 2017; Shuai et al., 2023). Six foraging trays were each deployed in oak woodland and chaparral habitats that bordered grasslands. These edge habitats were chosen because they differ in the densities of their understories. The six trays along the oak woodland habitats were placed at the edge of the oak tree canopy. The six trays bordering the edge of the chaparral habitats were placed outside of the edge of shrubs. The chaparral habitats had much denser understories than the oak woodland habitats. Foraging trays were 40 m from each other to reduce the chance of double-counting the same individuals (Ceradini & Chalfoun, 2017).

Data Collection

Because moonlight has a significant effect on rodent foraging behavior (Kotler et al., 2010; Upham and Hafner, 2013; Johnson & De León, 2015), cloud coverage at night could inhibit the amount of direct moonlight hitting the environment and thus affecting rodent behavior. Each night, average percent cloud cover and moon illumination (percentage of moon surface that reflected light at night) was collected over the 16-night data-collection period. Cloud cover percents were gathered from a nearby NOAA weather station and moon illumination was gathered from NASA's website (*National Aeronautics and Space Administration, n.d.; National Weather Service, n.d.*). Seeds were sieved out of the trays and weighed every two days. Seeds

were weighed with a pocket scale (PPS200, Pesola, Schindellegi, Sweden). If the bait seeds at the top were still present, I assumed no rodents had foraged in the tray, and it was not sieved. Buried seeds and sand for the trays were refreshed every four days to align with the alternating light schedule. From these photos, individual foraging events were counted if rodents were in trays and all bait seeds had been removed. A new foraging event would be scored if the tray had ≥ 5 min without rodents.

Data Analyses

All statistical analyses were run in R Studio v. 2024.09.1 Build 394. Using the “fitdist” function in the “fitdistrplus” R package, I compared the AIC scores of distribution types for my data and found the four-night intervals best fit a gamma distribution (**Table 1**). I created three-way interaction and simpler models to analyze the influences of the environmental variables on rodent GUDs. I also compared these models to models that looked at cloud cover as either being above or below average rather than being a continuous variable. A chi-square test showed these models not being statistically different from each other. I chose to use the models that used cloud cover as a categorical variable as it would be easier to visualize on a graph and would still yield accurate results in statistical tests. I then ran these models through a chi-square test to check if the accuracy changed between the different levels of complexity. After doing this and comparing their AIC scores, I chose the two-way interaction model as it had a low AIC score, and the three-way model did not fit significantly better than the two-way model ($P > 0.05$; **Table 2**). A type 2 ANOVA was used to analyze this model. I also ran two-way models testing for differences among habitat types and cloud cover.

I created a four-way model as well as simpler models that included ALAN with environmental variables. Models using cloud cover as a categorical variable were also compared to models using cloud cover as a continuous variable. Chi-square tests showed that the models using cloud cover as a categorical variable were not significantly better or worse than the models that used cloud cover as a continuous variable. I also chose to use the models with cloud cover as a categorical variable as it would be easier to visualize on a graph and would still yield accurate results in statistical tests. I then ran these models through a chi-square test to check if the accuracy changed between the different levels of complexity (Table 3). I chose the two-way interaction model, which had a low AIC score as the three-way and four-way models and did not fit the data better than the two-way model ($P > 0.05$; Table 3). A type-two ANOVA test was also used to analyze this model. Simpler two-way models were also used to test the differences between the habitat types and cloud cover.

A binomial test was used to determine whether foraging events differed when lights were on or off. I used the “circular” function in R to convert foraging times into a circular format and a Rayleigh test to analyze if foraging events clustered around specific times when lights were on or off. A Watson two-sample test of homogeneity was used to test for differences in mean foraging times.

RESULTS

Overall, moonlight alone had a significant effect on rodent GUDs ($P < 0.01$; Table 4). As moonlight illumination increased for both habitats, rodents had higher GUDs (Fig. 1). The interaction between cloud cover (mean = 22.2N%) and habitat type had a significant effect on the number of seeds left in the trays ($P < 0.05$; Table 4).

Rodents foraging in the shrubland habitat were significantly affected by the amount of moon illumination. ($P < 0.05$; Table 5). Moonlight had a marginally significant effect on rodents that were foraging in the oak woodland habitat ($P = 0.08$; Table 6). Rodents in the oak woodland habitat had higher GUDs on nights with above-average cloud cover ($P < 0.05$; Tables 6, 7; Fig. 1). Moonlight on nights that had below-average cloud cover had a marginally significant effect on rodent GUDs ($P = 0.09$; Table 8).

Artificial light alone and the interaction with it and moon illumination affected the number of seeds remaining in trays ($P < 0.05$; Table 9). There was also a marginally significant effect on the GUDs from the interaction between cloud cover and artificial light as well as the interaction between cloud cover and habitat ($P = 0.10$; Table 9). Rodents that foraged in the oak woodland habitat were marginally influenced by the amount of cloud cover present ($P = 0.06$; Table 10). There was a marginally significant effect on the seeds left in the trays from the interaction between the lights and moon illumination ($P = 0.06$; Table 11). When cloud cover was below average, the lights significantly affected the number of seeds left in the trays ($P < 0.05$; Table 12). While cloud cover was above average, rodent GUDs were influenced by the habitat type and the interaction between the lights and moonlight in a significant way ($P < 0.01$; Table 13). The GUDs for rodents foraging in both habitats at illuminated trays during above-average cloudy nights dropped below the GUDs of rodents foraging at the non-illuminated trays

(oak woodlands: 92.1% moon illumination, 9.7 g of seeds; shrubland: 90.8% moon illumination, 6.0 g of seeds; Fig. 2). Rodents foraging at both illuminated and non-illuminated trays within the shrubland habitat during nights with above-average cloud cover showed a marginal trend for lower GUDs than those foraging in the oak-woodland habitat ($P = 0.07$, $P = 0.06$; Tables 14 & 15; Fig 2).

Rodents foraged more often at trays when the lights were turned off (binomial test: $p < 0.01$). When the lights were turned on, rodents foraged at the trays more often at 0212 (Rayleigh test: $\rho = 0.71$, $p < 0.01$). While the lights were turned off, rodents foraged more often at 0215 (Rayleigh test: $\rho = 0.66$, $p < 0.01$). Although the presence of lights resulted in significant clustering around specific times at night, they were not different from each other (Watson two-sample test: $p > 0.10$).

DISCUSSION

I found that ALAN contributed to the perception of rodent predation risk (as estimated by GUDs) as an added risk factor and resulted in reduced foraging activity. This added risk was significantly influenced by the amount of moon illumination and partially influenced by cloud cover and habitat type (Tables 9–11). These environmental variables played different roles in influencing the perception of predation risk. Moonlight increased perceived predation risk (Table 4; Fig. 1), as reported in similar studies (Kotler et al., 2010; Gutman et al., 2011; Upham and Hafner, 2013; Rathsach & Hvass, 2022). Cloud cover may not have influenced rodent risk perception by blocking the moonlight and creating darker nights as expected. Instead, clouds may have made nights brighter. ALAN from cities is reflected off clouds and can amplify sky illuminance by a factor of 2.8 at 32 km away (Kyba et al., 2011; Ścieżor, 2020). This may have increased the amount of ALAN at Stunt Ranch from other sources, like Los Angeles and other cities. Rodents that foraged in oak woodland habitats had higher GUDs when cloud cover was above average (Table 6; Fig. 1). However, rodents that foraged in the shrublands were not affected by the amount of cloud cover (Table 5; Fig. 1). When cloud cover was below average for both habitats, rodent perception of predation risk did not differ (Table 8; Fig. 1). This difference between the habitats is most likely because of the differences in their understories. The oak woodland habitat had a less dense understory than the shrublands, providing less cover for the rodents. The cover provided by the shrubland understory could have mitigated the added risk from the additional ALAN. Vegetation structure, such as type and height of vegetation, has been shown to reduce the perception of predation risk in rodents (Ceradini & Chalfoun, 2017; Shuai et al., 2023).

Additional ALAN from cloud cover and differences in the understories of the habitats help explain the results from the night with above-average cloud cover from figure 2. When focusing on nights with above-average cloud cover (mean = 22.2%), rodents initially saw the light as an added risk (Table 13; Fig. 2). Though as moonlight increased the perception of risk decreased (Table 13; Fig. 2). They eventually had similar or lower perceptions of risk as the rodents that foraged at the non-illuminated trays (Table 13; Fig. 2). The added ALAN from clouds and the increasing moonlight effectively made the surrounding foraging locations as risky as the illuminated trays. This left habitat type being a significant determinant of risk assessment (Table 13; Fig. 2).

During nights with below average cloud cover, rodents showed different trends in GUDs as moonlight increased (Table 12; Fig. 2). The difference in trends was an unexpected result and goes against what was seen in figure 1 and in other research experiments (Kotler et al., 2010; Gutman et al., 2011; Upham and Hafner, 2013). This was likely an error caused by the small sample sizes for nights with below average cloud coverage. Although there was a difference in trends, ALAN demonstrated to be an additional risk factor for both habitats and resulted in higher GUDs when the lights were turned on (Table 12; Fig. 2). These findings parallels research into human stressors, including ALAN (Fardell et al., 2020, 2021).

This increase in perception of predation risk from ALAN was also noted in the number of visitations to the illuminated trays. Rodents visited foraging trays less often when lights were on ($P < 0.01$). This finding supports prior research that ALAN reduces foraging frequency (Bird et al., 2004; Hoffmann et al., 2022). However, despite the lights being on, this did not cause the rodents to forage at a different time of night ($P > 0.10$; Fig. 3).

Changes in foraging behaviors in populations of animals has been known to lead to trophic effects in their environment (Schmitz et al., 1997; Peacor & Werner, 2000; Geraldi & Powers, 2011;). ALAN has already shown to alter trophic level structures in coastal ecosystems (Bolton et al., 2017; Zapata et al., 2019; Maggi et al., 2020). The pressure from ALAN and its interaction with the environment make studying its effects a priority for mitigating negative trophic effects in and around human-built environments.

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APPENDIX

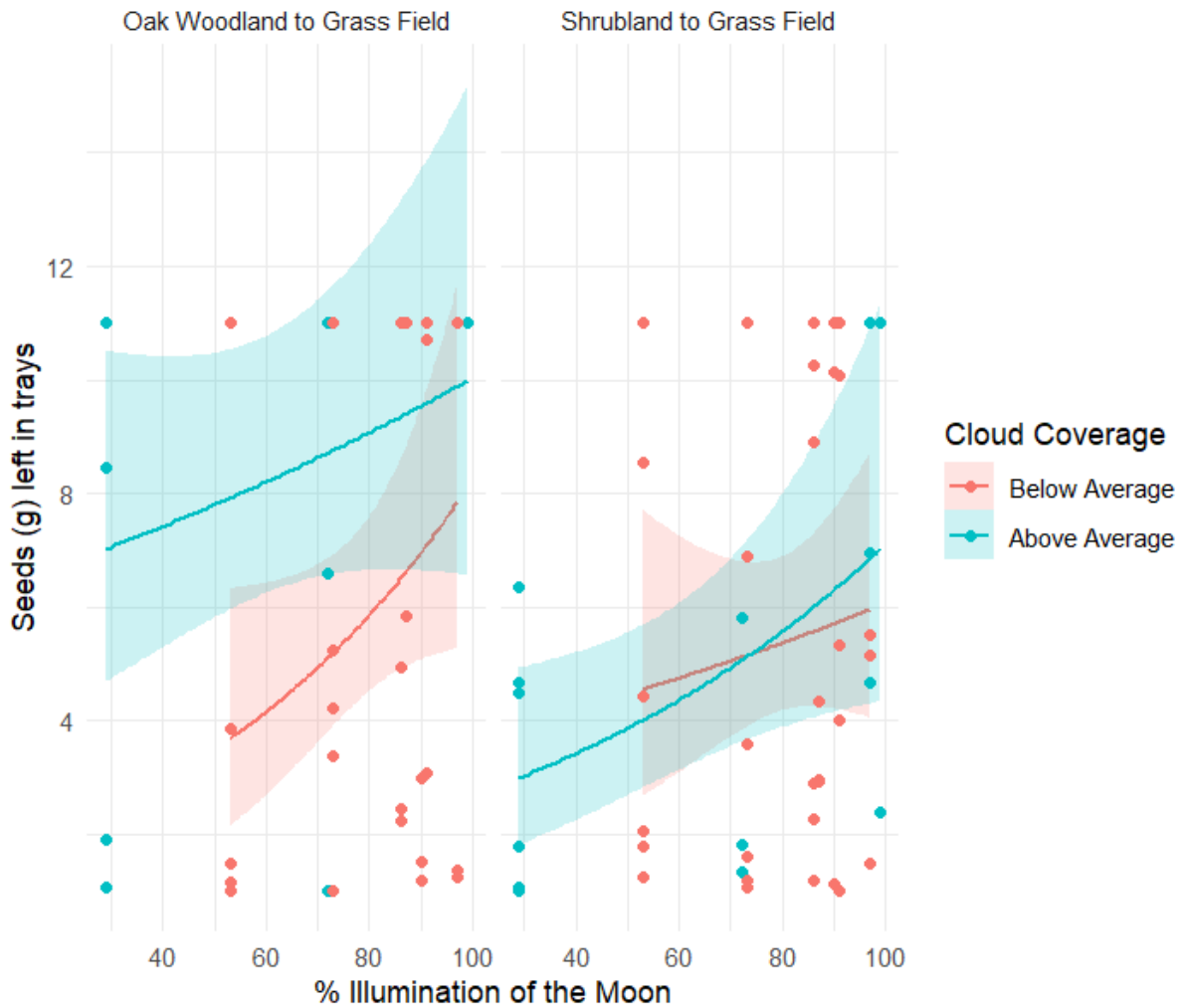


Figure 1: Effects of environmental variables on rodent GUDs separated by habitat type. Shaded regions show the variation in seeds left in the trays based on cloud cover (%) above or below the average (22.2%). As the amount of moonlight increased, rodents have greater GUDs ($P < 0.05$). Rodents that foraged in the oak woodland habitat had greater GUDs when cloud cover was above average ($P < 0.05$).

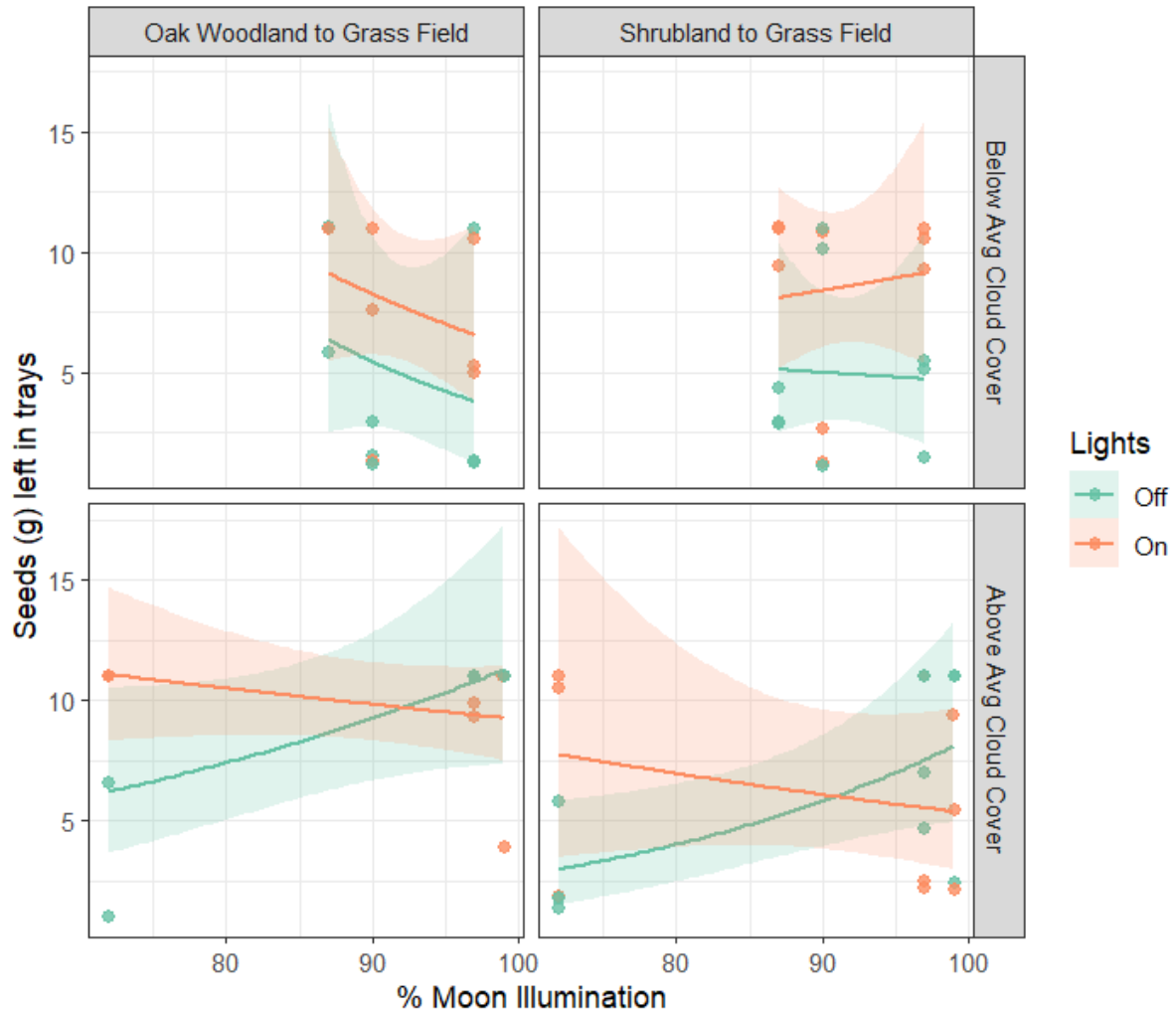


Figure 2: Effects of environmental factors and lights on rodent GUDs separated by habitat type and cloud cover. Shaded regions show the variation in seeds left in the trays based on the presence of ALAN. When the lights were turned on during nights with below average cloud cover, rodents would have greater GUDs ($P < 0.05$). Nights that had above average cloud cover showed GUDs in illuminated trays decreasing below the GUDs in non-illuminated trays as moon illumination increased ($P < 0.01$).

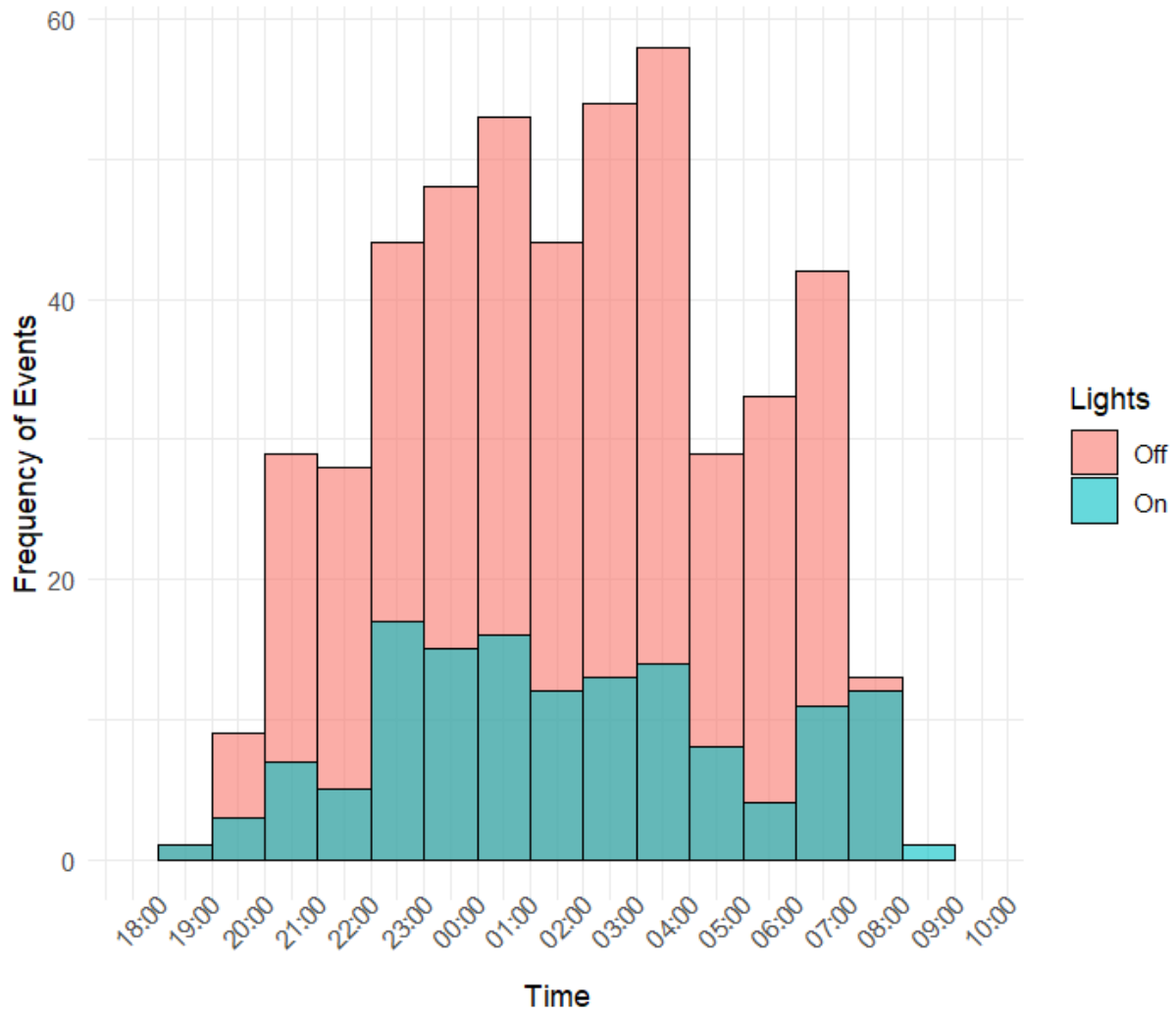


Figure 3: This histogram shows the frequency of foraging events during different times of the night and morning. Each bar represents an hour block of time. The mean foraging time for when lights were on was 2:12 ($\rho = 0.71$, $P < 0.01$) and 2:15 ($\rho = 0.66$, $P < 0.01$) for when lights were off.

Table 1: Akaike's information criterion (AIC) scores and Bayesian information criterion (BIC) scores were taken for candidate distributions of the giving up densities data. The data best fits the gamma distribution since it had the lowest AIC and BIC scores.

Candidate Distribution	Normal	Log-normal	Exponential	Gamma	Cauchy
AIC	733	742	746	725	829
BIC	739	748	749	731	835

Table 2: Candidate models used to evaluate how GUDs were affected by environmental variables were compared against each other. K = number of parameters, AIC = Akaike's information criterion, Δ_i = Change in AIC, w_i = AIC weights. The two-way interaction model was selected for analyzing data as it had a lower AIC score than the three-way model and was more biologically relevant than the independent factor model. The three-way model also yielded ANOVA results similar to the two-way model and showed the interaction of all three factors had no significant effect on the GUDs of the rodents

Candidate Models	K	df	AIC	Δ_i	w_i
Moonlight + Cloud Cover + Habitat	5	90	514	0.00	0.70
Moonlight + Cloud Cover + Habitat + two-way interactions	8	87	517	2.59	0.19
Moonlight + Cloud Cover + Habitat + two-way interactions + three-way interaction	9	86	518	3.74	0.12

Table 3: Candidate models used to evaluate how GUDs were affected by environmental variables and the presence of lights compared against each other. K = number of parameters, AIC = Akaike's information criterion, Δ_i = Change in AIC, w_i = AIC weights. The two-way interaction model was selected for analyzing data as it had a lower AIC score than the three-way and four-way models and was more biologically relevant than the independent factor model.

Candidate Models	K	df	AIC	Δ_i	w_i
Lights + Moonlight + Cloud Cover + Habitat	6	65	404	0.00	0.781
Lights + Moonlight + Cloud Cover + Habitat + two-way interactions	12	59	406	2.73	0.100
Lights + Moonlight + Cloud Cover + Habitat + two-way interactions + three-way interactions	16	55	412	8.03	0.014
Lights + Moonlight + Cloud Cover + Habitat + two-way interactions + three-way interactions + four-way interaction	17	54	414	9.98	0.005

Table 4: This ANOVA table shows the effects of habitat type, cloud cover, percent moon illumination, and the two-way interactions of these variables on rodent GUDs.

	LR Chiq	<i>df</i>	Pr(>Chiq)
Moon Illumination	7.899	1	<i>P</i> < 0.01
Cloud Cover	1.751	1	<i>P</i> = 0.19
Habitat	2.383	1	<i>P</i> = 0.12
Moon Illumination x Cloud Cover	0.009	1	<i>P</i> = 0.92
Moon Illumination x Habitat	0.365	1	<i>P</i> = 0.55
Cloud Cover x Habitat	3.502	1	<i>P</i> = 0.06

Table 5: This is an ANOVA table looking at the effects of moonlight and cloud cover on rodent GUDs in shrubland habitats.

	LR Chiq	<i>df</i>	Pr(>Chiq)
Moon Illumination	4.680	1	<i>P</i> = 0.03
Cloud Cover	0.002	1	<i>P</i> = 0.97
Moon Illumination x Cloud Cover	0.365	1	<i>P</i> = 0.55

Table 6: This is an ANOVA table looking at the effects of moonlight and cloud cover on rodent GUDs in the oak woodland habitat

	LR Chiq	<i>df</i>	Pr(>Chiq)
Moon Illumination	2.984	1	$P = 0.84$
Cloud Coverage	4.380	1	$P = 0.04$
Moon Illumination x Cloud Cover	1.301	1	$P = 0.25$

Table 7: This is an ANOVA table looking at the effects of moonlight and habitat type on rodent GUDs during nights with above-average cloud cover.

	LR Chiq	<i>df</i>	Pr(>Chiq)
Moon Illumination	6.504	1	<i>P</i> = 0.01
Habitat	7.434	1	<i>P</i> < 0.01
Moon Illumination x Habitat	1.117	1	<i>P</i> = 0.29

Table 8: This is an ANOVA table looking at the effects of moonlight and habitat type on rodent GUDs during nights with below average cloud coverage.

	LR Chiq	<i>df</i>	Pr(>Chiq)
Moon Illumination	2.813	1	$P = 0.09$
Habitat	0.230	1	$P = 0.63$
Moon Illumination x Habitat	0.734	1	$P = 0.39$

Table 9: This ANOVA table shows the effects of the lights, environmental factors, and the combined effect of all factors on rodent GUDs.

	LR Chiq	<i>df</i>	Pr(>Chiq)
Lights	4.029	1	<i>P</i> = 0.04
Moon Illumination	0.319	1	<i>P</i> = 0.57
Cloud Cover	1.103	1	<i>P</i> = 0.29
Habitat	2.429	1	<i>P</i> = 0.12
Lights x Moon Illumination	4.413	1	<i>P</i> = 0.04
Lights x Cloud Cover	2.735	1	<i>P</i> = 0.10
Lights x Habitat	0.061	1	<i>P</i> = 0.80
Moon Illumination x Habitat	0.348	1	<i>P</i> = 0.56
Cloud Cover x Habitat	2.670	1	<i>P</i> = 0.10
Moon Illumination x Cloud Cover	1.409	1	<i>P</i> = 0.24

Table 10: This ANOVA table shows the effects of the lights, cloud coverage, and moon illumination on rodent GUDs in the oak woodland habitat.

	LR Chiq	<i>df</i>	Pr(>Chiq)
Lights	1.744	1	$P = 0.19$
Moon Illumination	0.003	1	$P = 0.96$
Cloud Cover	3.572	1	$P = 0.06$
Lights x Moon Illumination	1.126	1	$P = 0.29$
Lights x Cloud Cover	1.028	1	$P = 0.31$
Moon Illumination x Cloud Cover	2.351	1	$P = 0.13$

Table 11: This ANOVA table shows the effects of the lights, cloud coverage, and moon illumination on rodent GUDs in the shrubland habitat.

	LR Chiq	<i>df</i>	Pr(>Chiq)
Lights	2.063	1	$P = 0.15$
Moon Illumination	0.471	1	$P = 0.49$
Cloud Cover	0.137	1	$P = 0.71$
Lights x Moon Illumination	3.456	1	$P = 0.06$
Lights x Cloud Cover	1.331	1	$P = 0.20$
Moon Illumination x Cloud Cover	0.005	1	$P = 0.94$

Table 12: ANOVA table showing effects of lights, habitat type, and moon illumination on rodent GUDs during nights with below-average cloud cover (mean = 22.2%).

	LR Chiq	<i>df</i>	Pr(>Chiq)
Lights	4.323	1	<i>P</i> = 0.04
Moon Illumination	0.564	1	<i>P</i> = 0.45
Habitat	0.016	1	<i>P</i> = 0.90
Lights x Moon Illumination	0.122	1	<i>P</i> = 0.73
Lights x Habitat	0.049	1	<i>P</i> = 0.82
Moon Illumination x Habitat	0.642	1	<i>P</i> = 0.42

Table 13: ANOVA table showing effects of the lights, habitat type, and moon illumination on rodent GUDs during nights with above-average cloud cover (mean = 22.2%).

	LR Chiq	<i>df</i>	Pr(>Chiq)
Lights	0.175	1	$P = 0.68$
Moon Illumination	1.021	1	$P = 0.31$
Habitat	6.967	1	$P < 0.01$
Lights x Moon Illumination	7.319	1	$P < 0.01$
Lights x Habitat	0.0001	1	$P = 0.99$
Moon Illumination x Habitat	0.066	1	$P = 0.80$

Table 14: ANOVA table showing effects of habitat type and moon illumination on rodent GUDs during nights with above-average cloud cover (mean = 22.2%) when the lights were off.

	LR Chiq	<i>df</i>	Pr(>Chiq)
Moon Illumination	7.146	1	<i>P</i> < 0.01
Habitat	3.343	1	<i>P</i> = 0.07
Moon Illumination x Habitat	0.500	1	<i>P</i> = 0.48

Table 15: ANOVA table showing effects of habitat type and moon illumination on rodent GUDs during nights with above-average cloud cover (mean = 22.2%) when the lights were on.

	LR Chiq	<i>df</i>	Pr(>Chiq)
Moon Illumination	1.026	1	$P = 0.31$
Habitat	3.618	1	$P = 0.06$
Moon Illumination x Habitat	0.117	1	$P = 0.73$