INCREASING NIGHT HOURS MINIMALLY IMPACT NOCTURNAL MAMMALIAN DIEL ACTIVITY ON SUNY PURCHASE CAMPUS

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ABSTRACT

Globally diurnal animals have been observed changing their activity patterns in response to shifting hours of daylight. Some species in the Northeast will alter their diel activity as well if their period of activity is shortened. On SUNY Purchase campus I have studied how five common species of nocturnal animals (skunks, opossums, raccoons, bobcats, and coyotes) respond to longer hours of night. I have found that there is a slight impact on the frequency, abundance, and diversity of nocturnal animals on Purchase campus as the hours of night increase.

Key Words: Day Length; Diel Activity; Nocturnal; Shortened days

INTRODUCTION

Every year as the earth rotates around the sun on its tilted axis the duration of daylight and nighttime hours fluctuate leading to periods of long nights and short days for several months. Many different global animal populations fall between the spectrum of diurnal or nocturnal regarding diel cycles and respond to these seasonal day-length changes by altering their diel activity. There are nocturnal, diurnal, and crepuscular animals (Ikeda et al.) For instance, chacma baboons in South Africa, which are a diurnal species, exhibit heightened nocturnal activity in response to shorter days (Ayers et al.) Baboons were also separately observed changing their behavior and diet as a result of changes in day-length (Hill et al.) Other traditionally diurnal species have also been recorded shifting their usual activity hours as a result of shortening day-light periods. A diurnal South American rodent called *Necromys lasiurus* experiences heightened nocturnal activity in the countries dry period when days are shorter than the wet period when days are the longest (Vieria et al.) Even a species of fish called arctic char highly rely on seasonal conditions to form their diel activity patterns (Hawley et al.) The same can be seen in a tropical snake in the dry tropics of Australia (Abom et al.) These are all examples of primarily diurnal animals transferring to nocturnal tendencies due to seasonal changes in day-length, which suggests that varying hours of light throughout a 24-hour-cycle can impact an animals wakefulness period. These studies explore diurnal responses to shortening days, but little research has been released explaining how or if nocturnal animal activity is enhanced or changed as a result of longer nights from seasonal changes.

There is research which suggest that nocturnal animals display significantly less flexibility towards seasonal variations in day and night lengths compared to diurnal animals which adapt with more ease (Kronfeld-Schor et al.) This raises the question of how nocturnal animals adjust to their diel period being extended, if at all. It's important to note that in the northern hemisphere there are considerable shifts in the hours of daylight and hours of night as the year progresses either towards the winter or summer solstice. Therefore, nocturnal animals in the United States are faced with comparable daylight variations to the diurnal species discussed above. Peregrine falcons on the Empire State building in New York city have even resorted to some nocturnal hunting habits in the fall months during migration (DeCandido et al.)It is unclear if extended periods of night would favor nocturnal diel activity by providing a wider period of darkness, or if the stubborn nature of nocturnal seasonal flexibility would result in shorter days having little to no impact on their diel responses.

On SUNY Purchase campus specifically, some local nocturnal animals which would be subject to such impacts include skunks, opossums, raccoons, bobcats, and coyotes. These species have all been observed across campus, specifically overnight. Throughout this study trail camera data from a prolonged camera trapping session will be analyzed in search of trends between hours of night and nocturnal presence. I hypothesize that as the night hours grow longer from September 9 to October 21, more nocturnal activity will occur and be documented on the existing trail cameras.

METHODS

Field Location. This study was conducted across six sites containing some degree of open space within Purchase campus's deciduous forests. SUNY Purchase is about 30 miles north of New York City, in the town of Harrison, Westchester County, NY. The study sites -- Alumni (5.25 ha), Music (1.35 ha), Softball (0.35 ha), East 1 (0.36 ha), Woods (1.07 ha), and Loop (0.25 ha) -- all vary in structure and placement on campus and provide unique opportunities for local wildlife to utilize them. Alumni is an old growth forest which has been forested since at least 1985 with sizable native trees in the Northeast corner of campus. Music is also an old growth forest on the Northwest side of campus which has been forested since 1985 and hosts smaller trees than the ones in Alumni. Softball is a disturbed fragment in the middle of campus which has been forested since 2002 and is continuously interrupted by field mowing on all sides. East 1 is on the Southeast side of campus and has had shrubby coverage since 1991 and continues to lack developed trees- it is mainly comprised of common buckthorn. Woods which is removed from developmental elements of campus is further south from East 1 and has had shrub cover since 1985, and tree cover since 2006 making it an intermediate forest. Last, Loop is a very new growth southernmost site which lacked forest structure until 2007. The age and size of each site was determined using google earth pro satellite imagery and the ruler-polygon tool

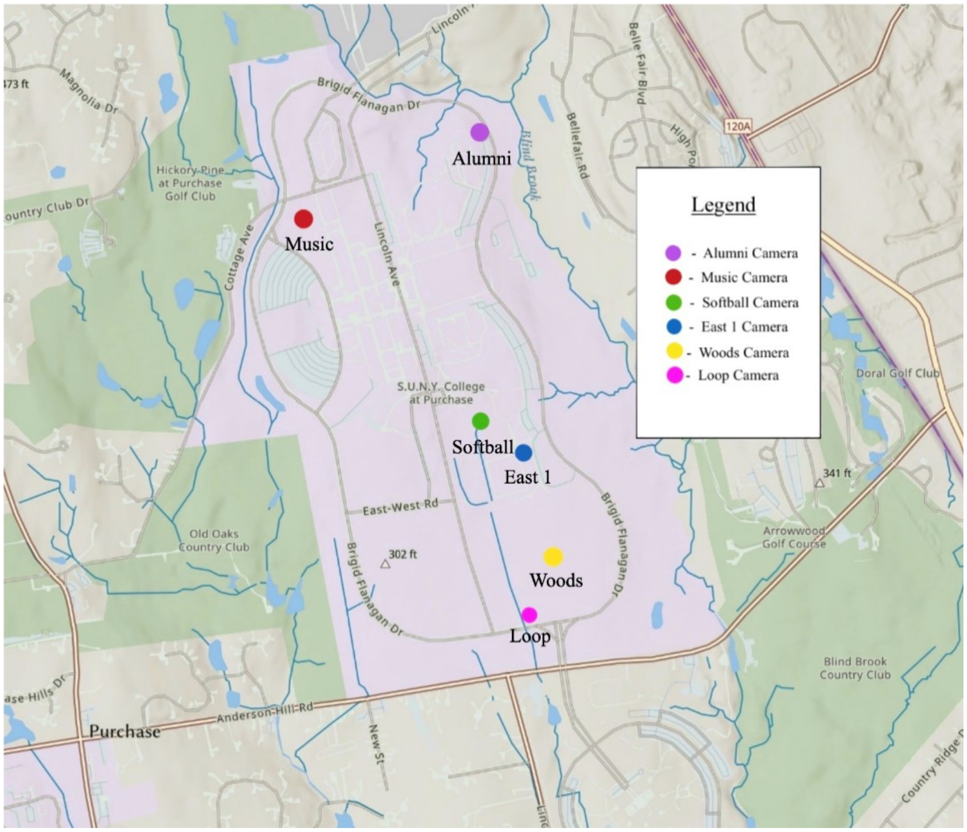

Fig. 1. Map of SUNY Purchase campus with the corresponding wildlife camera sites. This map was made using GIS and procreate to edit the colors of the points.

Field Sampling. We deployed field work techniques for this study on mild (low 70°**s** and sunny) days in September and October. We first explored the campus woods on Sept. 9 and noted areas of importance which would effectively represent the differing habitats found on campus- this is when we determined the six study sites. After confirming that each site was suitable, we looked for a somewhat hidden area to mount our trail cameras on and plotted each camera's GPS location with the Survey123 app on ArcGIS.

Trail Camera Survey. We used Strike Force HD pro model BTC-5HDP trail cameras to capture footage of wildlife at each of the six sites. Initially we decided on the following settings: one second capture delay, multi-shot on rapid fire (5 shots), and power save for flash. We started with 7 trail cameras (one which was on a walkway which was later dropped from the study) with those same settings and deployed them on Sept. 9. We secured each camera to a tree about 0.5 m off the ground, horizontally using a cable and lock, and jammed sticks between the camera and the tree to achieve an angle which would optimize the amount of footage captured (so it wasn't pointing too far down.) Each camera also had an SD card to collect footage, and a sign which identified the cameras as research equipment. We then left the cameras at their designated sites until Sept. 14 when we retrieved the SD cards to examine the photos taken. After looking through the photos we determined that our seventh site was collecting too many pictures (7,440), mainly of students walking past. We decided to get rid of this walkway camera because it was in an area with a lot of foot traffic and would continue to capture mass amounts of photos. We also switched the settings of all cameras to fast motion to make night vision clearer. We then replaced the SD cards on Sept. 16 and left them to collect photos until Oct. 7 when we retrieved them again. Oct. 21 was our last day out in the field, when we took down the trail cameras and retrieved the last data collected between Oct. 7 and Oct. 21. Throughout this process we were also scoring the photos we collected on a group data sheet where we would mark off how many people, leashed and unleashed dogs, chipmunks, squirrels, rabbits, skunks, opossums, raccoons, deer, bobcats, coyotes, birds, and vehicles the trail cameras captured every hour at each site. We used these standard guidelines while scoring: if nothing was captured fill out a zero, do not fill in a zero for times that occur before or after we set cameras, if the same animal occurs multiple times in the same minute score it as one, if the same human occurs multiple times in one event score as one, if the same subject goes past more than one minute apart score it as separate events.

Night Hours. The hours of night used throughout this study were calculated using timeanddate.com for New York, USA, Sunrise, Sunset, and Daylength from September to October of 2022. These calculations were then input onto a Microsoft Excel spreadsheet to create a table showing how many nocturnal animals were recorded per day. I also compiled tables for each individual study site with the corresponding total sum of nocturnal animals which had visited each site.

Analysis. R and R studio- We used the R statistical program version R 4.1.2 (or "bird hippie") and the wrapper of R Studio to create all ten graphs used throughout this report. We also used the package ggplot2. *Microsoft Excel*- We calculated the Shannon Diversity index and richness using excel spreadsheets.

RESULTS

There appears to be somewhat of an upwards trend between the increasing length of night hours and the sum of nocturnal animals observed on the trail cameras (figure 2). Nocturnal animal activity appeared to be at its lowest at 11.5 hours where it then increased linearly as the nights reached 11.9 hours (September 16- September 23) spanning from 0-3 observation. Nocturnal observations reached its peak at 12.067 hours on September 27 with a total of 7 observations (figure 3). After September 27, the upward trend switches to a more horizontal path even dipping downward near 12.5 hours. The date with the second highest number of observations was October 18 (12.983 hours) with 6 observations (figure 3). It is unclear if there is a correlation between nocturnal animal activity and increasing hours of night, however there is a visible increase in nocturnal animal sightings as the hours of night grow longer from 11.5 hours to 12 hours.

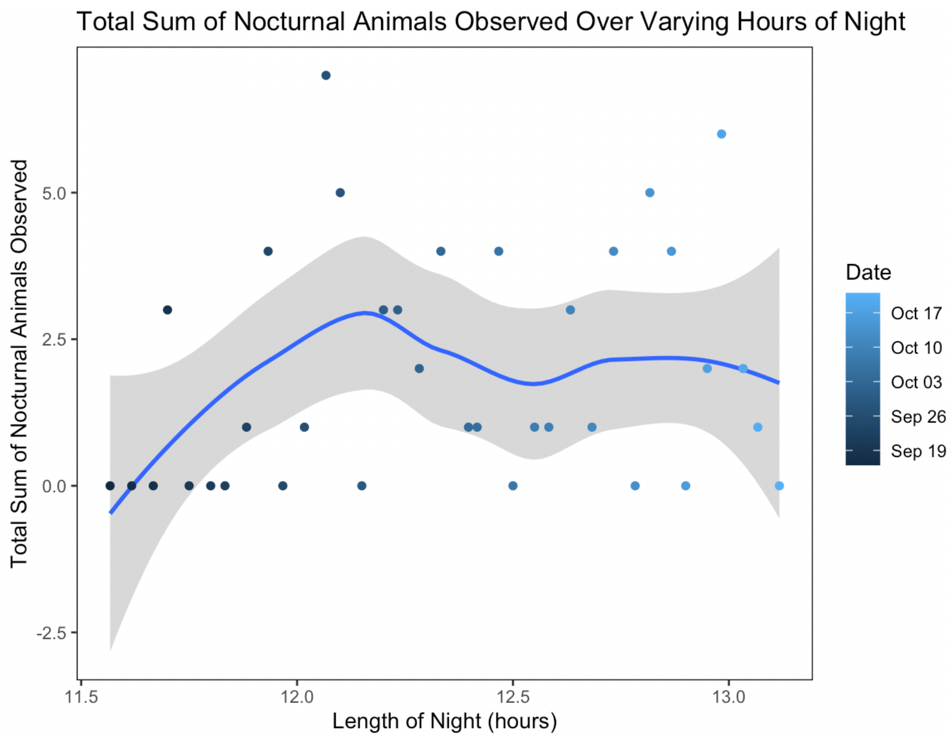

Fig 2. This line graph contains the total sum of nocturnal wildlife sightings caught on the trail cameras and their corresponding hours of night on the day they were recorded from 9/16-10/21. There is a visible correlation between the total sum of nocturnal animals observed and hours of night from 11.5 hours to 12.0 hours which seems to show a positive relationship between the two variables. The break in this positive correlation where the line appears to even out is likely due to chunks of data missing from the study sites near the end of the study.

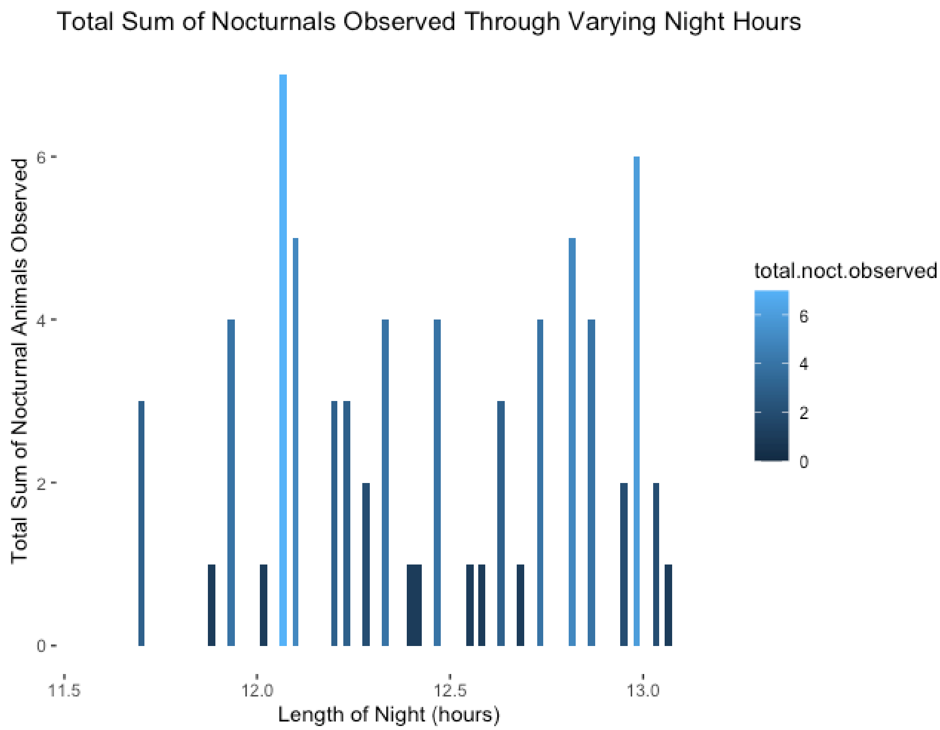

Fig 3. This bar graph depicts when the most nocturnal animals were observed in relation to the hours of night. The light blue bars represent the highest number of nocturnal animals that were observed whereas the navy bars represent nights when a low number of nocturnal animals were observed. Here you can see that both 12.067 hours and 12.983 hours hosted the highest amount of nocturnal activity. Sightings, even if they are only one of two animals per night also appear to occur more frequently after the 12 hour mark.

The total sum of nocturnal animals was highest in the following sites: Woods, East 1, and Alumni. The total sum of nocturnal sightings was lowest in Loop, Music, and Softball (figure 4). These sites experienced rather significant variations in the documented number of nocturnal appearances; the site with the highest number of nocturnal observations, Woods, had a total of 69 observations while the site with the lowest number of nocturnal observations, loop, reached only 12. The rest of the sites had the following number of nocturnal observations: Alumni had 55, East 1 had 60, Music had 17, and Softball had 33. It is important to note that the Loop site lost a substantial amount of data towards the end of the study so the observations don't necessarily represent the true amount of nocturnal animals which utilized the site.

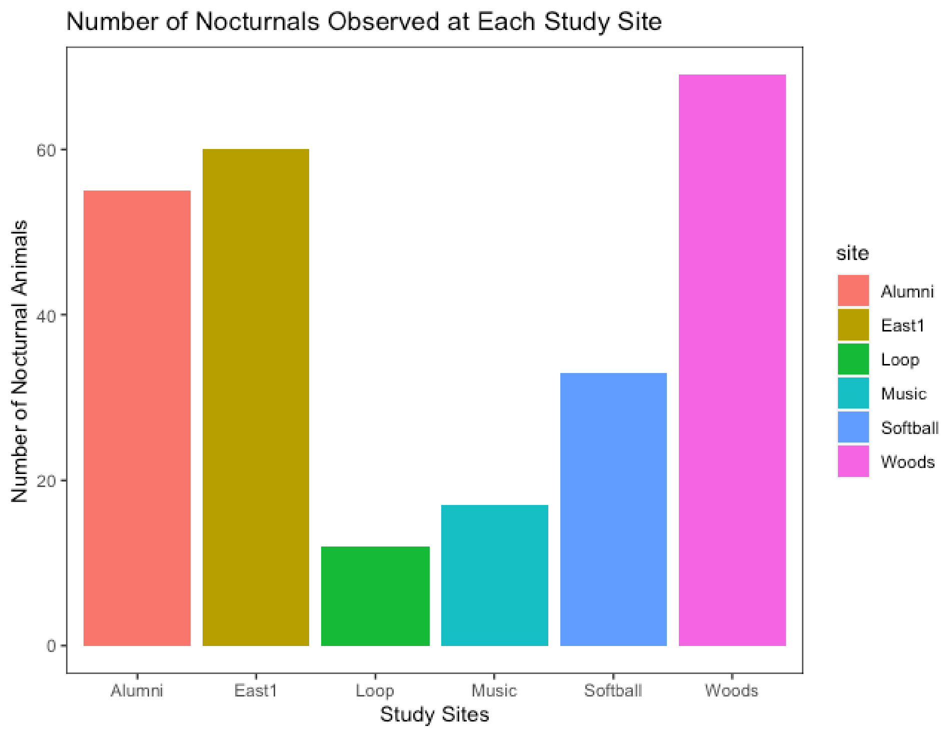

Fig 4. This bar graph shows the total sum of nocturnal animals observed at each of the six study sites. Woods has the highest number of nocturnal observations reaching over 60, whereas Loop has the smallest number of observations, not even reaching 20. The sites appear to be split in half when it comes to the number of animals which were observed. The three sites with a high concentration of observations are Alumni, East 1, and Woods and the sites with a low concentration of observations are Loop, Softball, and Music.

I took a closer look at the month of September because it contained consistent footage which was collected without any gaps in the data. Near the end of October some of the data sets were lost due to camera malfunctions so focusing on September offered a more reliable representation of how nocturnal animals were utilizing the different study sites. Raccoons were the most common animal which came up on the trail came footage multiple times a night followed by coyotes. Skunks, bobcats, and opossums were all viewed less often. There doesn't appear to be any connection between the increasing hours of night as the dates progress and the type of animals utilizing each of the six sites. The date with the highest number of nocturnal animals' sightings was September 28 with over 9 observations.

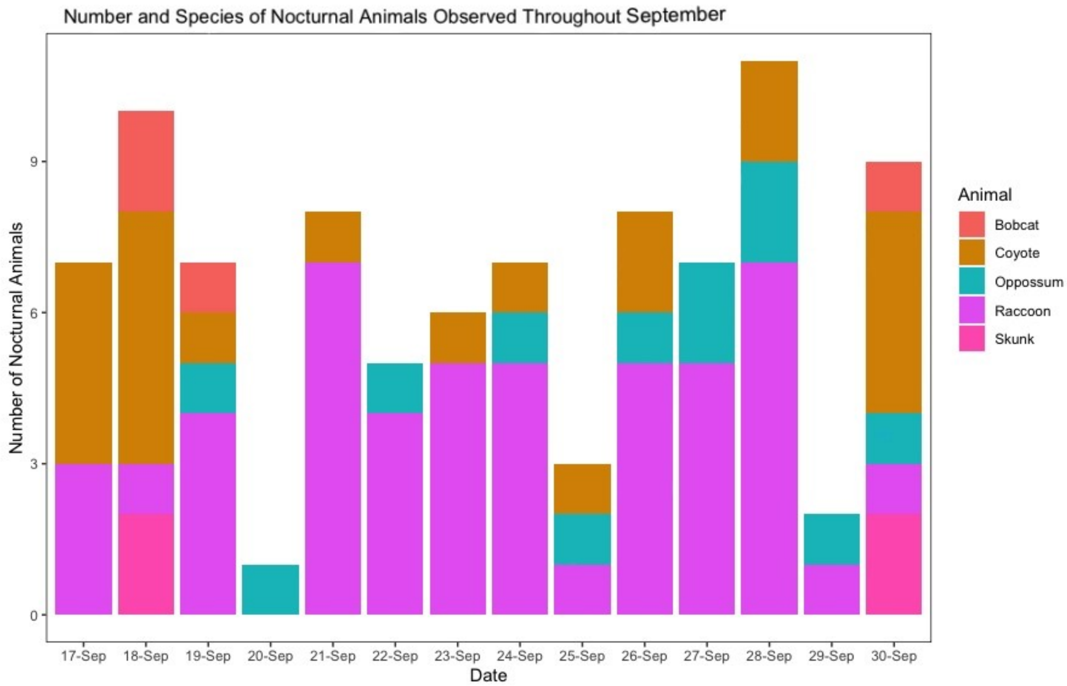

Fig. 5 This bar graph shows the number and species of nocturnal animals on each of the dates in which we conducted this study in the month of September. As can be seen above, the day with the most nocturnal animals observed was September 28 with over 9 observations and the day with the least nocturnal animals observed was September 20 with less than 3 nocturnal observations. The day with the widest variety of animals was September 30 which had at least 1 skunk, raccoon, opossum, coyote, and bobcat.

DISCUSSION

Throughout this study I have explored how nocturnal animals are impacted by extended hours of night as the fall months progress towards the Winter Solstice. I hypothesized that as hours of night increase, nocturnal animals would be observed more frequently on the trail cameras which were set up along 6 sites on SUNY Purchase campus. I have found that there is a slight trend between increased nocturnal activity and increased nighttime hours from 11.5 hours of night to 12.0 hours of night (figure 2). For the rest of the study period there is not a clear correlation between the hours of night and increased nocturnal activity. The hours with the highest amount of nocturnal activity are 12.067 hours and 12.983 hours which both have over 6 total sum observations. Sightings became more frequent after the 12 hours per night mark which suggests that nocturnal activity became more consistent as the hours of night increased. When it comes down to the specific nocturnal activity at each site, Woods, Alumni, and East 1 all experienced the most activity which is likely related to their forest composition and general set up which contains more open space than the other sites. The sites with the least nocturnal activity are Loop, Music, and Softball which are all sites with a less developed forest structure. I also found the general composition of summed animal life which visited each of the sites. Raccoons were the most common nocturnal animal observed on campus and were observed in all the study dates in September except for September 20. Coyotes also frequently visited the trail cameras and were seen in 10 of the 14 days which this study was executed on. The least common nocturnal observed were skunks and bobcats.

It is important to note that chunks of the data sets were missing from the total sum of data. The following study sites were missing data: Alumni stopped data collection on October 14, Loop stopped data collection on October 6, and Music started recording data on September 17. These all led to there being significant gaps in data. For instance, Alumni which generally has a lot of animal activity stopped collecting data before the projected date of ending the study on October 21 so the representation of total sum nocturnal animals observed is missing a significant section of data which would have likely provided a lot of insight into how nocturnal animals respond to lengthening nights. Another notable piece of information which is necessary to mention is that the diversity of animals observed at each site is probably more connected to the forest composition and age instead of the hours of night specifically. We have seen in previous studies that old growth forests such as the ones seen in Alumni and Woods host a high diversity of life so the same can be assumed for the diversity of nocturnal life. Therefore, the diversity of nocturnal animals is not necessarily correlated to the hours of night. Another thing to note is that we did not catch foxes on any of our trail cameras, which is odd since they are one of the other non-generalist predator species which should be in this area. We likely either missed them on our trail cameras or they are not present in this area, which is something that should be looked into in studies to come (Lonsinger et al). Animals like coyotes have also been observed in high concentrations in the SUNY Purchase area which may be due in some part to the increased hours of night but is likely also attributed to the fact that there is an abundance of prey animals for food (Henger et al.) A flaw when using the trail cameras is that they will not catch every animal in the area either because they are out of frame, too far, or because animals are using other pathways than the main trails around campus.

CONCLUSION

Overall, this study has gained some insight into how nocturnal animals respond to the diel period changes due to extended hours of nighttime. I have found some evidence to support the idea that nocturnal animals are more active during the months leading up to the winter solstice when nights are long, and days are short. I have also discovered some correlation between the different nocturnal species and number of nocturnal in general which utilize the different parts on campus. Raccoons were found to be the most common nocturnal animals' species at the different sites. I strongly encourage other researchers to further this study through a longer study period or more trail cameras set up throughout campus to determine if nocturnal animals are impacted by lengthened nighttime hours. This research can be considered on a global level since there is not a lot of research pertaining to how nocturnal animals are impacted by shifting diel periods. As seen in the research papers cited throughout this journal most of the data which has currently been collected relates to diurnal activity so this study would offer a unique viewpoint of how nocturnal animals react.

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It is also important to note that this land was originally inhabited by the Siwanoyof the Wappinger federation who called it Quarropas. I recognize that this land has been colonized and respect and honor the Wappinger land and it's indigenous caretakers.

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