Humans, Dogs, and the Biodiversity of Las Trampas

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ABSTRACT

Ecosystem disturbance often affects the biodiversity of species within that ecosystem. However, depending on the disturbance it is often hard to know the extent or nature of how disturbances influence biodiversity. Previous studies have shown that when there are dogs or humans in an area, wildlife species are impacted in various ways. I studied the effects of humans and dogs on the biodiversity of the pond ecosystems on Las Trampas. Using four different camera traps, I examined the date, time, species, and abundance of species that appeared at two different ponds over a five-month period(September 2021 to February 2022). There were more humans and dogs at site 1 than at site 2. I separated the data by day and ran a t-test to see if human interaction contributed to a significant difference in the biodiversity at each pond site. The *t*-value is 2.54651 and the *p*-value is .00628 which means biodiversity was significantly different between ponds with differing levels of human activity. Specifically, ponds with more human activity had lower biodiversity. By understanding how humans and dogs affect biodiversity, we can figure out how to make sure biodiversity is affected less by opening trails seasonally or closing off pond areas to the public.

KEYWORDS

Species, ecosystem, occurrence data, urban ecology, California Tiger Salamanders

INTRODUCTION

California is the most biodiverse state in the United States and is considered a biodiversity hotspot of global importance (Meyers et al, 2000). California contains offshore islands and coastal lowlands, large alluvial valleys, forested mountain ranges, deserts, and various aquatic habitats. There are 13 level III ecoregions and 177 level IV ecoregions in California and most continue into ecologically similar parts of adjacent States of the United States or Mexico (Griffith et al, 2016). These diverse ecoregions give rise to incredibly diverse native flora and fauna. There are more than 6,500 species of plants alone in California (CDFW, 20XX), which is already a lot of biodiversity without even looking at fauna. Now if we include animals the terrestrial mammal fauna of California includes about 160 species, with rodents making up more than half of this total. Counting residents, breeding, and migratory birds, about 350 total species can be found in California; there are 54 species of amphibians and 69 species of reptiles within the political boundaries of California, and finally, the native freshwater fish fauna of California includes 73 species of fish (Incomme, 2011). It's important to understand California's biodiversity because, without knowledge of what California is made up of, we would not be able to make accurate predictions or clear analyses of how California's environment might change moving forward. A big issue we are having with biodiversity is that it is declining. California has lost more than 1 million acres of natural area in the last twenty years (Gutierrez, 2020). Looking closer at California, Native species in California have declined by 20 percent, and over 600 California species are at risk of extinction.

Often, simply the presence of humans and their pets in a natural space influences wildlife. For example, there is evidence that dogs negatively impact wildlife is overwhelming. It is clear that people with dogs – on leash or off – are much more detrimental to wildlife than people without dogs (Hennings, 2016). Dogs can be very aggressive and can not only put fear into certain animals who live near an area that they frequent, but also those animals could be killed. The presence of dogs, therefore, creates a fear response in wildlife that can impact their behavior. In a study done by Cooper, Christopher A., et al. in 2008, squirrels were tested in two areas for their alertness based on human activity. Alert distance in the habitat with higher levels of human activity was significantly shorter than the alert distance in the habitat with lower levels of human activity. We can see how just the appearance of humans can change the way an animal interacts with its environment. Black bears have also been influenced by human interaction. Most of them near places where humans are active are nocturnal and visit campsites at night. But when there are fewer humans, their foraging behavior is diurnal or crepuscular (Ayres et al, 1986). Humans have a very big effect on the animals and the environment around them and they need to become more aware of the consequences of their actions.

The effects of humans and dogs on wildlife are critical to understand, and one of the best places to explore this dynamic is in urban areas, where people, pets, and wildlife tend to coexist and collide. One of the ways we can look at this is with urban ecology. Urban ecology is the study of ecological processes in urban environments. This includes all aspects of the ecology of any organisms found in urban areas as well as large-scale considerations of the ecological sustainability of cities. Prior studies in urban areas have shown that human growth and activity have negative effects on biodiversity and wildlife. Taking a look at Southern California, there was a study done where 50 bobcats and 86 coyotes were captured and radio-collared, and the home ranges of 35 bobcats and 40 coyotes were determined and the amount of urban area that was a part of their natural range was determined in a percentage. From this study, we were able to observe that human-dominated areas were less suitable than natural areas due to a lack of secure resting and denning areas and less willingness to scavenge when around humans. Mortality rates from human-related causes such as vehicle collisions and incidental poisoning were also independent of urban association. In this region, even the few animals that had almost no human development within their home range were vulnerable to human-related mortality (Riley et al, 2003). Both making environments more unsafe for all animals, regardless of interaction with humans, and taking away natural range from animals is a consequence of putting humans around wild animals. There were more negative effects than positives. When looking at LA specifically, the species and richness of certain trees in urban areas are solely dependent on managers' and residents' preferences and perceptions of urban tree traits (Avolio et al, 2015). This study demonstrates how humans are disproportionately influential on urban ecosystems. We don’t even think about the species surviving off of or living in these ecosystems. When looking at herbivorous arthropods in urban areas, there are a lot of changes that happen to their ecosystems such as water availability, pollution, and habitat fragmentation, and they have resulted in changes in physiology, behavior, and population abundance. Native species richness tends to decline in urban areas; however, changes in abundance appear to be species-specific (Miles et al, 2019). If the bugs and plants do not adapt to the insane new changes around them, they will suffer and their interactions will drastically change, decreasing the biodiversity, along with the evenness and richness of each species. With all of this, we will look at it on a smaller scale than California as a whole. We will look at how it works in a park in Las Trampas. It is important to understand how humans and pets influence animals in urban areas in California because if we don't then we can see a severe decline in biodiversity in certain areas surrounding our urban areas. We will also see more human-wildlife conflicts which result in more deaths and injuries for either humans or the wildlife.

My central research question is how human presence affects local wildlife biodiversity. To answer this question I will be looking at two different pond sites at Las Trampas and investigating what wildlife species appear in each area respectively. I will also investigate how much outside interaction is had with humans and dogs at each site and if the biodiversity at higher human traffic ponds is affected more than at lower traffic ponds or vice versa. I predict that there will be more biodiversity at the pond with less human interaction because more human interaction means more disruption within the pond ecosystem. I also predict that if more humans are around then more dogs are around and that will lead to more deaths, less reproductive success, and more stress for the animals in the pond area. I will address these questions by setting up four cameras in total, two at each pond site that is at two different spots along a trail. The first is a couple of dozen feet off the trail and open so that humans and dogs can walk freely to it. The second is further down the trail and is fenced in with all but a gate door that remains open for access. I believe the gate will deter many more people from entering where the pond is but there will still be some access since it is technically open. There will be one high sensitivity camera and one medium-high sensitivity camera at each pond that capture pictures based on the movement they sense in front of them. I will go out to the sites every two to three weeks to check on the cameras, collect the SD cards that are full of photos, replace them, and weed any shrubbery that has grown in front of the cameras so they don't capture blank pictures of plants blowing in the wind. I will also be trying to obtain phone activity data along the trail to compare with the photo occurrence data we obtain.

METHODS

Study Site

The study site is two different pond sites in the Las Trampas Regional Wilderness Park(Figure 2) located in San Ramon, California (Figure 1). The park is under the authority of the East Bay Regional Park District. The East Bay Regional Park District is a system of parklands and trails in Alameda and Contra Costa counties to the east of San Francisco. The system comprises nearly 125,000 acres in 73 parks, including over 1,250 miles of trails and 55 miles of shoreline (EBRPD). The Parks system acquire, manage, and preserve natural and cultural resources for all to enjoy now and into the future. Las Trampas Wilderness Regional Preserve offers 5,778 acres of wilderness and an expanded trail system that allows hikers and horseback riders to enjoy its remote and rugged areas (EBRPD). The park's size and terrain allow visitors a feeling of privacy and escape from urban hustle and bustle. The park's water supply is inconsistent and water may be unavailable at any time (EBRPD). According to the East Bay Regional Park District, The park's abundant wildlife includes raccoons, foxes, opossums, bobcats, skunks, squirrels... deer in the hill areas adjacent to the parking lot. Also, sightings of [mountain lions] have been reported in recent years. There are many species of hawks, and golden eagles are occasionally sighted. The East Bay Regional Park District leases some of the grassland areas for cattle grazing. To access this site, it is necessary to travel up the mountain between two closed-off gates. The gates indicate that this portion of the trails is technically not open to the public. However, people can still walk into the gated-off area because you can walk around the gate. There are no paved roads, it is just a dirt trail that is a little wider than a single truck width.

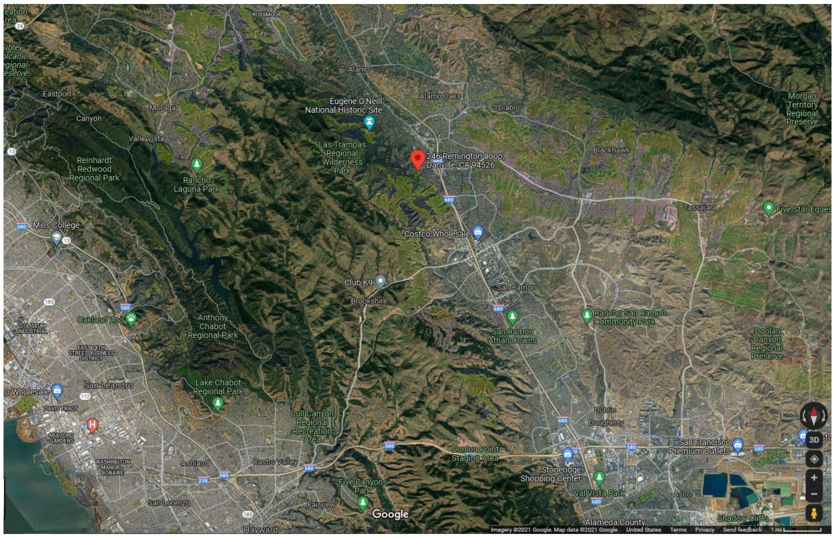

Figure 1: Map of Las Trampas location within San Ramon

*Figure 2: Map of pond sites from google maps * Map provided by Mentor Tammy Lim**

Data Collection Method

I chose two pond sites for this experiment, one being about a kilometer off the main trail, and the other being several kilometers farther and inside of a gated area. At each pond site, I installed two camera traps each that have at least a .5km distance between them. I attached the cameras to a wooden stake that had been hammered into the ground aiming toward the pond. The surrounding brush or high-standing weeds was cut so animals can be seen and the wind doesn't blow them to activate the camera trap. After the area was cleared and the camera was properly in place, I checked the batteries and sd cards to make sure they would be in working order. The camera then needed to be properly set up with the right settings for picture taking as follows: Camera mode: Camera, Image size: 6M, Video size: ignore, Capture number: 3 shots, Interval: 5 sec, Set time and date, Sensitivity level: High for one and High-Med for another, Timestamp: on, Timer switch: off. After the settings were set up, I recorded on the datasheet how many photos are left on the SD, all the data I had just fixed, and the quality of the camera set up. After each visit subsequent to the first setup, I switched out the SD card and recorded which one was taken and which one was replaced. I then took home the sd card and uploaded them to my computer and went through them to separate blank photos and photos with visible animals. I later updated them to a certain website to make sure to identify each animal and locate them to each pond. I also did an amphibian visual inspection of both pond sites to identify any frogs, newts, newt eggs, and California Tiger Salamander or their eggs.

Data Analysis

I got rid of empty pictures that were taken by wind and plants and markdown which species show up at each site specifically. I identified animals in camera trap photos using online identification tools. After that, I made sure to put each picture into groups by the pond for things such as deer, rodents, pigs, coyotes, foxes, birds, humans, and dogs. Then I made sure that each group of photos is also categorized by a visit number and date. I then ran the data through R and ran t-tests (R Core Team, 2014). First, I performed a t-test that compares the average number of humans per day that pass by each pond. Then, I performed another t-test that compares species diversity between the two ponds. This helped me discern whether human presence influences wildlife use of pond habitats, to see if there is a significant difference between the two ponds. I also looked for changes in species behavior by categorizing the time stamp on the photos and comparing when certain types of species occupy each pond habitat.

RESULTS

When looking at the species diversity at both pond sites, we can see that there is an abundance of life among the mountains of Las Trampas. My analysis indicated which species occupied which pond sites (Figure 3). I also observed certain animals that showed up during specific times of the day at each pond. At site 1 there were more sightings during the evening or early morning, while at site 2 there was a wide variety of sightings throughout most of the day (Figures 4 &5).

Animal	Site 1	Site 2
Bird	yes	no
Cow	yes	yes
Coyote	yes	yes
Mule Deer	yes	yes
Dog	yes	yes
American Black Duck	yes	yes
Human	yes	yes
California Deermouse	yes	no
Wild Boar	yes	yes
California Striped Skunk	yes	yes
California Tiger Salamander	no	yes

California Newt	yes	yes
Newt eggs	yes	yes
Sierran Tree Frog	yes	yes

Figure 3: animals that appear at each pond site, with open access vs gated access respectively

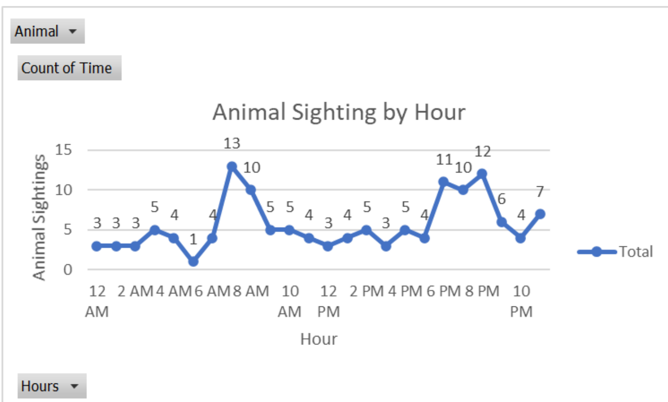

Figure 4: Animal Sightings by the Hour for Site 1

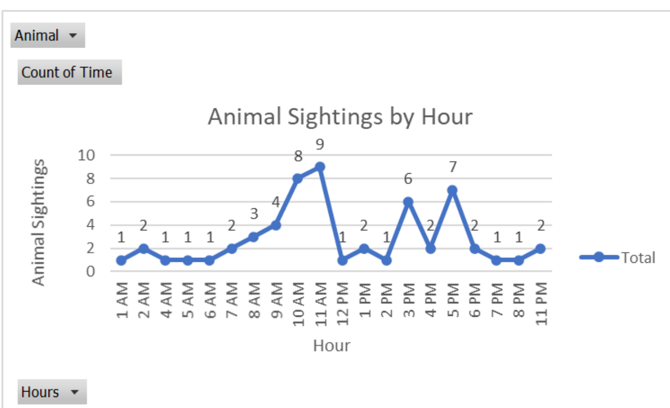

Figure 5: Animal Sightings by the hour for Site 2

Human and Dogs at Las Trampas

According to the camera data, we see that there have been multiple humans and dogs seen at pond site 1 (see figure 6). However, when I visited the sites in person to maintain cameras, I observed four to five humans would be walking around and making it to the first site. Surprisingly, there were a couple of humans and dogs that showed up at site 2 which was gated off meaning they opened the gate and let themselves in, despite whenever I walked the trail no one would walk past the first site.

x	**occurrence**	**occurrence**
Animal	A	B
Bird	13	0
Cow	60	19
Coyote	17	2
Mule Deer	9	18
Dog	2	1
American Black Duck	1	8
Human	7	4
California Deermouse	11	0
Wild Boar	8	4
California Striped Skunk	3	1
California Tiger Salamander	0	1

California Newt	2	10
Newt eggs	4	15
Sierran Tree Frog	1	5

Figure 6: Total number of occurrence from every visit of Site 1 and Site 2

How Traffic affects Biodiversity

There are one more species that appear in the first site than the second. In addition to camera traps, I also surveyed amphibians in both ponds (Figure 4). I can see that the pond with more human interaction has fewer amphibians. Then to see if there was significance between the number of species in the first site vs the second, I performed a T-test of the species number for each visit over time. After three visits, I numbered how many species were at each site per visit (Figure 7). The t-value is 1.24393. The p-value is .150932. The result is *not* significant at $p < .05$. This shows the human presence at each site does not contribute to a significant difference at the visit level. However, when the test is done by how many species show up each day(Figure 8 and Figure 9), the t-value is 2.54651 and the p-value is .00628 which means the result is significant at $p < .05$. I noticed that even though the number of species at each site is 13 and 12 respectively, birds and mice did not show up at site 2 but there were sightings of California Tiger Salamanders.

Visit	Site 1 Species	Site 2 Species
Visit 0	7.00	0.00
Visit 1	7.00	7.00
Visit 2	9.00	6.00

Figure 7: Species present at each site at each visit

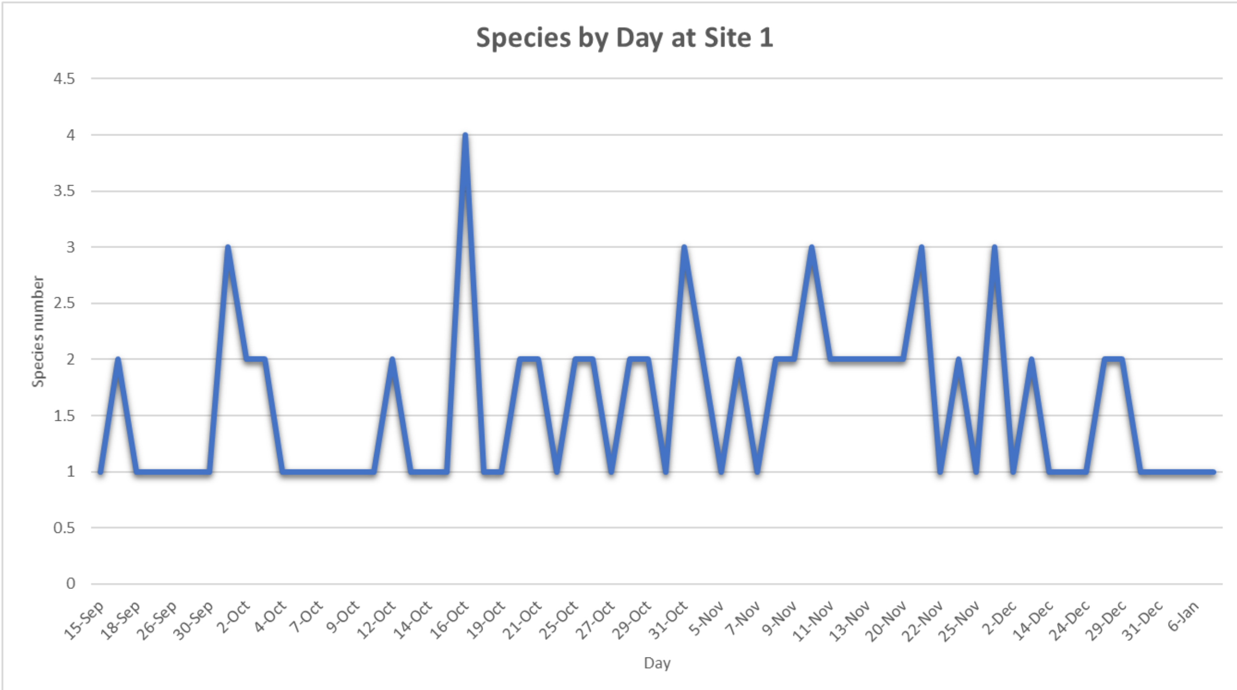

Figure 8: Species by date for Site 1. Please see Appendix for the data table.

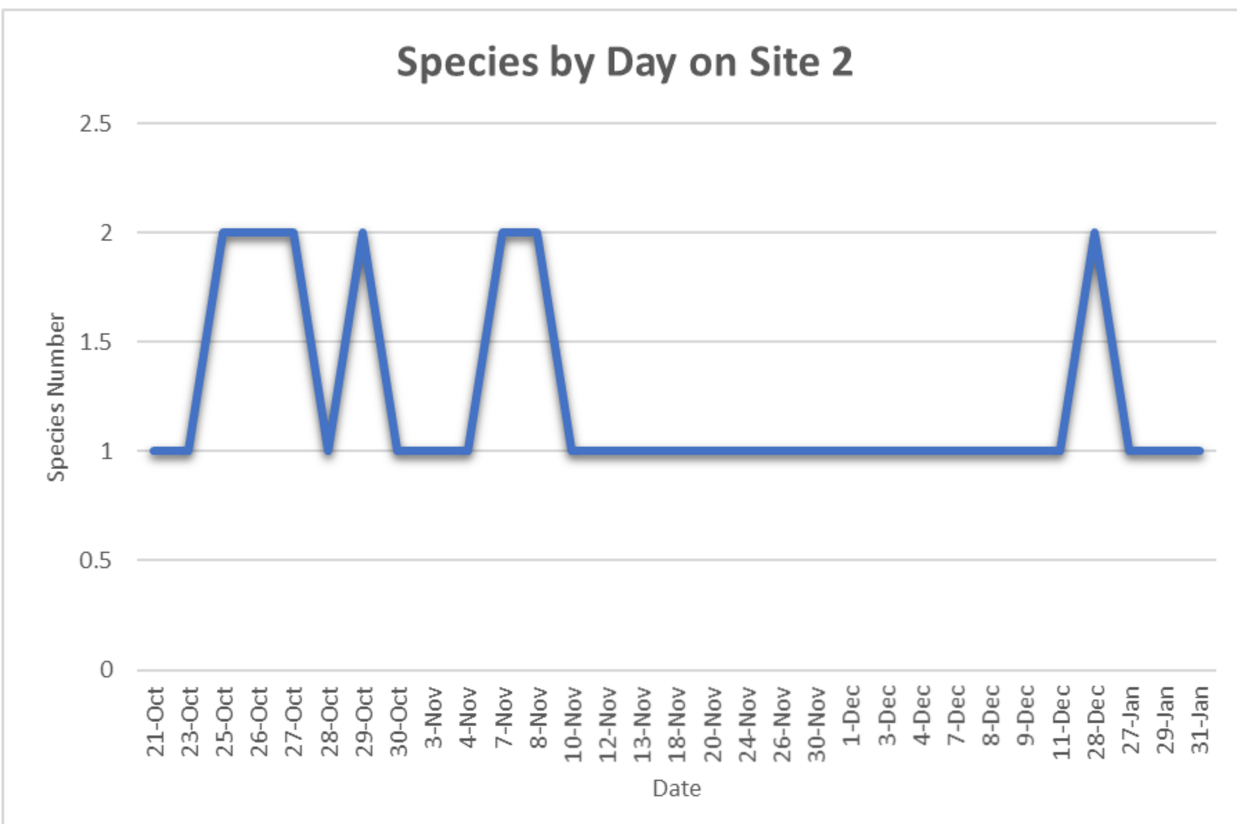

Figure 9: Species by Date for Site 2. Please see Appendix for the data table.

DISCUSSION

Introduction

Humans and dogs influence wildlife with their presence alone and generally negatively affect the environment. I studied the effects of humans and dogs on the biodiversity of the pond ecosystems on Las Trampas. Using four different camera traps, I examined the date, time, species, and amount of species that appeared at two different ponds over a five-month period(September to February). There were more humans and dogs at site 1 than at site 2. I separated the data by day and ran a t-test to see if human interaction contributed to a significant difference in the biodiversity at each pond site. The t-value is 2.54651 and the p-value is .00628 which means the result is significant at $p < .05$. This means that there was a pretty significant difference between both sites. With this information, I can conclude that humans and dogs have an effect on the biodiversity of animals, how many species of animals appear, and the time of day that animals appear.

Human Traffic and Animal Behavior

I found that there were a total of 134 individual animals at Site 1 and 57 animals at Site 2. Originally, I predicted that there would be a high frequency of human and dog visits to site 1, but I was surprised to see that there were very few humans or dogs at either site. However, compared to site 2 there were more humans and dogs at site 1, which likely influenced the time of day when animals visited that camera. At site 1, there were more sightings in the early morning and late at night while with site 2 there were more sightings in the afternoon. This type of pattern might explain why there was a different pattern of use timings in site with more people. However, the presence of both dogs and humans likely still had an effect on the animals, especially their behavior. According to a study that looked at latrine use patterns for raccoon dogs in the Imperial City of Japan, there was a shift from the day to the night due to human presence (Tsunoda et al, 2019). The raccoon dogs saw human interaction as a potential predation threat and moved temporally. Other studies have found similar behavior in deer, which were also frequently present at the Las Trampas study sites. In one of these studies, translocated deer deviated from a crepuscular activity pattern and became increasingly nocturnal, and most active when villagers were not (Pan et al, 2011). We can see a pattern that is reoccurring which is that humans have forced many animals to become nocturnal so that they will not run into them and have to deal with their predatory behaviors or dangers.

Dogs in Las Trampas likely contributed to this issue as well, because habitat loss has been accredited to their interaction with wild animals. Despite my initial hypothesis that there would be a significant amount of dogs rushing into the pond, there were no pictures of dogs getting into the pond. All were walking at the side of their owner on a leash. In the Andean foothills transition of Los Lagos, Chile they used camera traps to survey the landscape and see how domestic dogs and habitat destruction affected foxes and wild cats. They were able to see a detection rate increase for both foxes when dogs were around and domestic dog use of land made spatial use for the wild animals decrease. They concluded that there was a positive correlation between dog occupation and habitat loss (Malhotra et al, 2021). Both dogs and humans are very detrimental to an ecosystem and even with just there being more of them in an area, it will make it so animals will not want to be in that area or be there at the time of day when the humans and dogs are. If not for both the dogs and humans, there may not have been a significant difference in how many species show up at a site and when they show up.

Traffic levels and Urban Ecology

I found a statistically significant difference between the number of species that show up at Site 1 vs Site 2 from Visit 0 to Visit 2 based on the day. Overall, this is because of the difference in human and dog occurrences at each site. This result follows along with my hypothesis and is similar to other studies as well. Human traffic and human disturbance generally have many negative effects when animals come in contact with a lot of humans or human settlements and a lot of behavior is changed, like temporal behavior discussed in the previous paragraph. A study about how raccoons are affected by human disturbance is a starting point for understanding this. Raccoons in human-populated areas had a 52.5% annual mortality rate compared to the 26.5% which was in less populated areas (Robel et al, 1990). A bigger look at human disturbance on animals would be a study in the Peru rainforest to see how human disturbance affects terrestrial and arboreal mammal biodiversity. They set up camera traps to directly compare the communities to the degradation and disturbance of the rainforest. They see that based on the camera the arboreal mammals are more susceptible to disturbance and the largest-bodied ones were the ones affected the worse (Whitworth et al, 2019). Obviously, whole communities were being upset by this human disturbance and it was affecting the health of the ecosystem. A more zoomed-in version was happening here in Las Trampas, where humans and dogs were disturbing the biodiversity of animals that I was recording.

Overall, I was able to answer my central research question about how humans and dogs affect biodiversity in Las Trampas, but I was surprised by the specific results of my study. It is clear that the species that showed up in the park were different at each site and that the biodiversity was different as well. When looking at high traffic areas vs low traffic areas we were able to see a difference however there were more species in the high traffic areas rather than the low traffic areas contrary to my predictions.

Limitations and Future Direction

One limitation of this study design is the limited amount of cameras that I had to work with and the number of people working on the data collection. With more cameras and more people looking through them and identifying animals, there would be more visits, more species to look at, and more opportunities to take pictures. However, there is an error with the data collection that needs to be acknowledged. For Site 2, there is a missing camera for the last trip which may have skewed the results a bit. If there were four cameras at each site aiming at different areas of the pond, that would be sufficient to fully be able to study the site.

The findings could move forward to a more in-depth study on more ponds with more cameras and more data collection. If we were able to track humans independently, outside of just using cameras we could see how human interaction affected the ponds better.

Broader Implications

The East Bay Regional Park District is currently developing a new land-use plan amendment that is deciding on if the conservation parcel from the land development that was given to them should be opened as a trail. This could have very dire consequences due to the fact that there are species such as the California Tiger Salamander, that are of the vulnerable class, living in these ponds and human disturbance could destroy their reproduction. This is something that needs to be addressed and considered if the park really wants to open up a trail around these ponds. If anything, I think there should be seasonal openings or the trail should not be developed, only opened so it is used less by humans and dogs. Overall this study provides a look into how important it is to protect wildlife and what we are protecting it from. Humans and dogs both can be detrimental to a species and we need to figure out how to make sure the environment can thrive while we live in harmony with nature.

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APPENDIX

Date	Species	Date2	Species2	Date3	Species3	Date4	Species4
15-Sep	1	12-Oct	2	31-Oct	3	24-Nov	2
16-Sep	2	13-Oct	1	1-Nov	2	25-Nov	1
18-Sep	1	14-Oct	1	5-Nov	1	1-Dec	3
23-Sep	1	15-Oct	1	6-Nov	2	2-Dec	1
26-Sep	1	16-Oct	4	7-Nov	1	3-Dec	2
29-Sep	1	17-Oct	1	8-Nov	2	14-Dec	1
30-Sep	1	19-Oct	1	9-Nov	2	20-Dec	1
1-Oct	3	20-Oct	2	10-Nov	3	24-Dec	1
2-Oct	2	21-Oct	2	11-Nov	2	28-Dec	2
3-Oct	2	23-Oct	1	12-Nov	2	29-Dec	2
4-Oct	1	25-Oct	2	13-Nov	2	30-Dec	1
6-Oct	1	26-Oct	2	17-Nov	2	31-Dec	1
7-Oct	1	27-Oct	1	20-Nov	2	4-Jan	1
8-Oct	1	28-Oct	2	21-Nov	3	6-Jan	1
9-Oct	1	29-Oct	2	22-Nov	1	1-Feb	1
10-Oct	1	30-Oct	1				

Figure A: Species by day for Site 1

Date	*Species*	*Date2*	*Species2*
21-Oct	*1*	*18-Nov*	*1*
23-Oct	*1*	*20-Nov*	*1*
25-Oct	*2*	*24-Nov*	*1*
26-Oct	*2*	*26-Nov*	*1*
27-Oct	*2*	*30-Nov*	*1*
28-Oct	*1*	*1-Dec*	*1*
29-Oct	*2*	*3-Dec*	*1*
30-Oct	*1*	*4-Dec*	*1*
3-Nov	*1*	*7-Dec*	*1*
4-Nov	*1*	*8-Dec*	*1*
7-Nov	*2*	*9-Dec*	*1*
8-Nov	*2*	*11-Dec*	*1*
10-Nov	*1*	*28-Dec*	*2*
12-Nov	*1*	*27-Jan*	*1*
13-Nov	*1*	*29-Jan*	*1*
		31-Jan	*1*

Figure B: Species by day for Site 2