Cynomys Summer: A Photojournalistic Reflection and Data Analysis of an Ongoing Prairie Dog Plague Study

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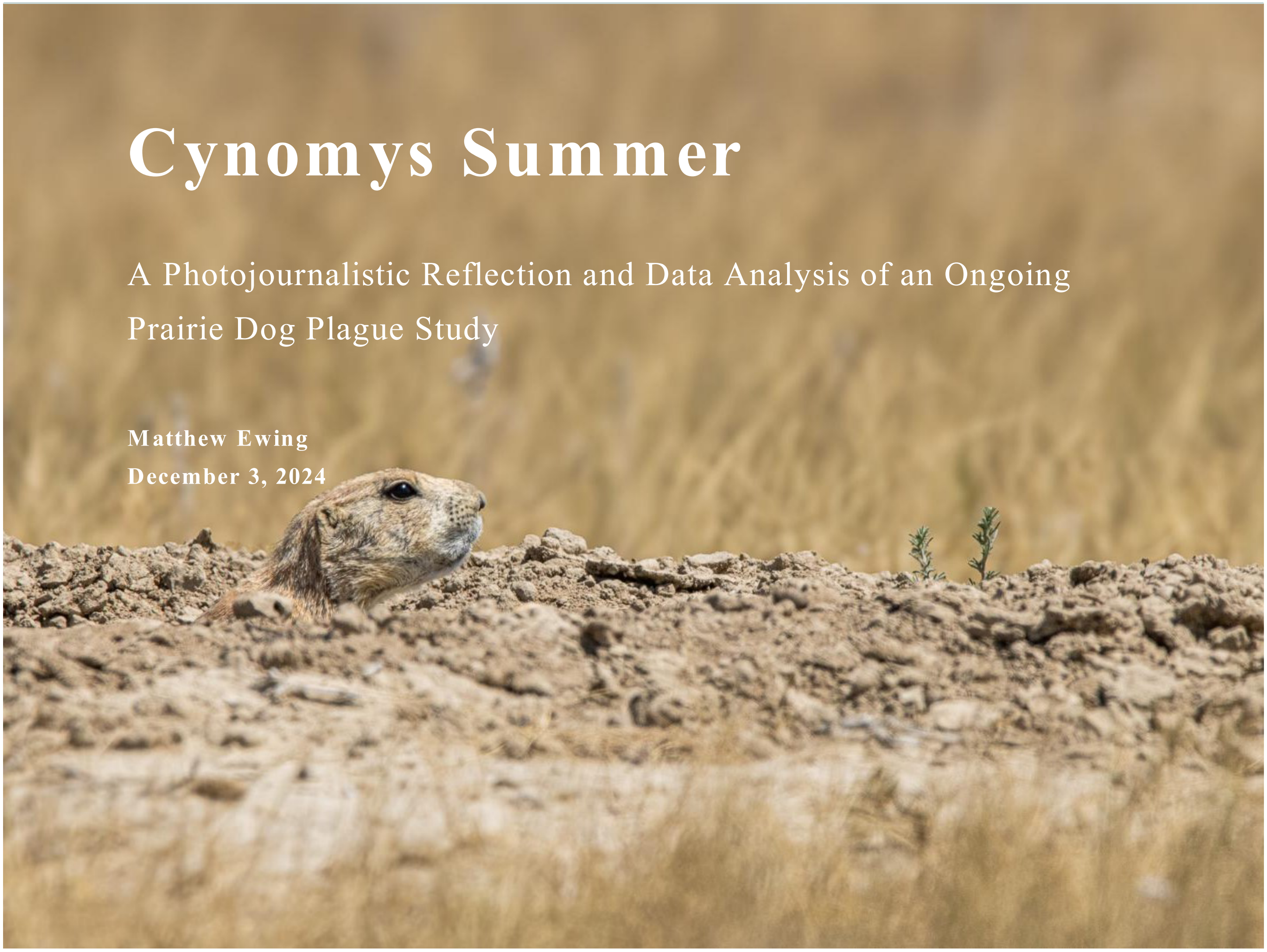

Over the summer of 2024, I was a Siegele intern at the Colorado Natural Heritage Program (CNHP) at Colorado State University (CSU). Because of my interest in wildlife ecology, my role as a Siegele intern was to participate in a field-based research project to uncover the genetic resistance to sylvatic plague in black-tailed prairie dogs (*Cynomys ludovicianus*). This study was funded by the National Science Foundation and led by Drs. Ana Davidson at CSU and Loren Cassin-Sackett at University of Louisiana, with Dr. Lise Aubrey from CSU serving as co-PI. While trapping and studying prairie dogs, I used my photography skills to document some of my experiences, as well as to showcase some of the wildlife that depend on prairie dogs and live alongside them. Throughout my thesis, I will provide a photojournalistic account of my participation in this project, including context on prairie dog ecology, as well as an analysis of prairie dog growth rates collected over the summer.

Figure 1. A black-tailed prairie dog on the lookout in Thunder Basin National Grassland

The Bubonic Plague, a disease caused by the bacterium *Yersinia pestis*, caused one of the worst pandemics in history, the Black Death, which is estimated to have killed up to half of the population of Europe. The plague is transmitted to humans from fleas on the backs of rats and other rodents (Black Death 2024). Plague does not only negatively impact humans, but can have devastating effects on wildlife. Plague was introduced to North America in the early 20th century, and has slowly spread eastward, devastating prairie dog populations along the way (Davidson et al. 2022, Keuler et al. 2020). Prairie dogs face many threats, such as overhunting and habitat fragmentation. They only occupy 2% of the habitat they once did, with historic populations succumbing to these threats as well as plague, which is one of the greatest threats today (Hoogland 2006). Further, the many species that associate and rely on prairie dog colonies decline alongside prairie dogs. (Duchardt et al. 2023).

Plague outbreaks often cause over 99% mortality of a prairie dog colony. It is unknown why some prairie dogs can survive the outbreaks, but recent research by Rocke et al. 2012 and Cobble et al. 2016 have demonstrated that some level of genetic resistance to the plague is emerging. The research project that I helped with over the summer seeks to pursue this very hypothesis. The principal investigator, Dr. Ana Davidson, will analyze genetic samples taken from prairie dogs, attempting to uncover information about these possible resistance genes, such as rate of evolution of resistance, potential fitness cost, and spatial distribution of resistance alleles. My role in the project was to help with the collection of the genetic samples and other data from the individual prairie dogs, as well as larger scale demographic and spatial information. Although I only worked with black-tailed prairie dogs during my time on the project, there are four other prairie dog species in North America (Hoogland 2003). In future years, this study will also take samples from Gunnison's prairie dogs (*Cynomys gunnisoni*). Our field team consisted of four people, with Galen Burrell as our field lead, Brooke Dodge as a field technician, and Charlize Haynes and I participating as interns.

Figure 2. An American dipper under Rifle Falls in Rifle, CO

The only reason that I was able to have this amazing opportunity was because of the Colorado Natural Heritage Program, through their Siegele Conservation Science Internship. The goal of CNHP is to find and catalog Colorado's rare species and habitats, and to use that information to protect and conserve these natural wonders. The Siegele Internship involves taking undergraduate students and exposing them to in-the-field conservation work, as well as connecting them with figures in the field. This internship sent its interns across the state of Colorado, as well as outside of state lines. Project goals ranged from performing "bio-blitzes" where all the organisms in an area are cataloged and identified, to identifying plants in grasslands, and even tracking owls in the Rocky Mountains. I was fortunate enough to be assigned to the prairie dog project for the entire summer. However, before I started working with prairie dogs, CNHP hosted a week in Rifle, Colorado for all the new interns. There, we were able to meet individuals in the conservation field from many different agencies. We also visited natural areas and practiced field research techniques. During the week, I was able to snap a photo of an American Dipper, in Figure 2.

Figure 3. An American badger on the prowl at CPER

Of the many roles that black-tailed prairie dogs play in the prairie environment, their role in the food web is crucial. Prairie dogs are herbivores, and we often observed them feeding on the grasses and forbs that surround their colonies. As a result, prairie dogs often come into conflict with agriculture. Because of their diet, prairie dogs are perceived as taking away potential food for grazing cattle. In reality, cows and other megaherbivores graze more often on prairie dog colonies due to the colonies' abundance of high nutrient plants. (Davidson et al. 2012). This intuitively makes sense, as prairie dogs were far more numerous hundreds of years ago and prairies supported the grazing of enormous populations of bison (*Bison bison*) at the time (Shaw 1995). However, during drought years, prairie dogs may have a small negative effect on cattle growth (Augustine & Derner 2021).

Along with their role as herbivores, black-tailed prairie dogs serve as important prey for other mammals, birds of prey, and reptiles. While in the field, I witnessed the white wings of a ferruginous hawk (*Buteo regalis*) circling above a colony, searching for any unsuspecting prairie dog. We carefully stepped over Prairie rattlesnakes (*Crotalus viridus*) (Figure 4), capable of using their deadly venom to kill and eat prairie dogs, as they waited at the entrance of burrows. We even spotted American badgers (*Taxidea taxa*) (Figure 3) chasing prairie dogs across the landscape, using their long claws to tear at burrows, attempting to uncover any unlucky rodent cowering in its tunnels. One predator that we hoped to spot, but never did, was a black-footed ferret (*Mustela nigriceps*). Because their diets are made up largely of prairie dogs, black-footed ferrets rely closely on prairie dog colonies to sustain themselves (Davidson et al. 2012). Unfortunately, as prairie dogs have declined drastically, so too have the blackfooted ferrets. Declining prairie dog populations, as well as transmission of sylvatic plague from their prey, has caused the black-footed ferret to become highly endangered. Though there are many breeding and reintroduction efforts, the decline and fragmentation of prairie dog colonies across their range has left black-footed ferrets with very little suitable habitat (Davidson et al. 2012) (Livieri et al. 2022).

Figure 4. A prairie rattlesnake sunning itself at SGRC

Figure 5. A burrowing owl perches atop our electric fence

Black-tailed prairie dogs' influence on the plains ecosystem is not limited to their position within the food web. In fact, these rodents are keystone species also due to their large effects on their physical environment. The existence of prairie dog colonies creates unique ecosystems separate from the typical plains ecosystem (Davidson et al. 2012). For one, prairie dogs dig complex networks of tunnels underground, with numerous entrances. When prairie dogs die, or move away from an area, they leave behind unoccupied burrows. These burrows are used by other species, such as burrowing owls (*Athene cunicularia*), named after their reliance on prairie dog burrows as homes to shelter in and rear their young. We often spotted these little owls popping their heads out of burrow entrances to watch us work, such as the individual in Figure 5, and even spotted some juveniles, a first for me. Even when we didn't directly spot the birds, their occupancy of burrows was betrayed by the scattered debris, like down feathers and owl pellets, outside of certain tunnel entrances. We also witnessed additional species utilizing these burrows, including prairie rattlesnakes and other rodents, and countless other species are known to frequent these tunnels (Davidson et al. 2012).

Aside from the subterranean effects on the environment, prairie dogs also greatly alter the surfaces of their colonies. The grasses that are ubiquitous across the Great Plains are greatly reduced on these colonies, due to the normal foraging of prairie dogs, but also due to their habit of "clipping" grass. This deliberate maintenance of plant height in colonies serves to increase visibility, allowing the prairie dogs to spot predators from further away. This attracts other prey species that utilize this increased visibility to detect predators (Davidson et al. 2012). Grass clipping also encourages the growth of forbs, which attract pollinators, like bees

Figure 6. A male pronghorn that wandered into our trapping plot

and butterflies, and ungulates such as pronghorn (*Antilocapra americana*) (Buehler 2019). Constant clipping also allows for greater nitrogen cycling, increasing the nutrients of plants within the colony. This further serves to attract grazing animals to prairie dog colonies, who can then take advantage of the more nutritious flora (Davidson et al. 2012). In fact, we observed pronghorn antelope, bison, and domestic cattle grazing within the colonies. Though the plants associated with prairie dog colonies attract some of the largest animals in the ecosystem, they also attract some of the smallest. Hardwick 2006 observed greater pollinator richness and diversity within colonies than off in Pawnee National Grassland, suggesting that the flora allowed to flourish within these colonies attract a plethora of arthropod species essential for the prairie ecosystem's flowering plants. I didn't necessarily observe a large population of pollinators within colonies, but witnessed large numbers of arthropods around burrow entrances, such as black widow spiders (*Latrodectus hesperus*) and darkling beetles (*Eleodes suturalis*).

Figure 7. A long exposure photo of a lightning storm rolling through Pawnee National Grassland

For most of the summer, we worked in Pawnee National Grassland. This expansive range of prairie sits in Northeastern Colorado, near the border of Wyoming. The grassland is a combination of private and public lands, and we often worked on plots of land adjacent to private property. In particular, we worked on the Central Plains Experimental

Range (CPER), which is owned and managed by the USDA Agricultural Research Service an is used largely to conduct agriculture-related research. The area that falls under CPER is around 15,500 acres, (6,280 hectares) and is made up of fenced off plots, most hosting a cohort of young male cattle (USDA). Apart from cattle, the range exemplified just about the full extent of a pristine shortgrass prairie ecosystem, allowing me to witness animals I had never seen before, such as prairie rattlesnakes and American badgers. CPER also hosts a number of prairie dog colonies, and even just driving down the dirt roads, we witnessed an abundance of the little rodents. While working on CPER, our crew stayed at Colorado State University's Semi-arid Grasslands Research Center (SGRC), which was host to multiple field houses, as well as a main building where we did most of the prairie dog processing.

The area was an endless sea of grass, dirt roads, barbed wire fences, and tumbleweeds. Growing up in the Great Plains of Texas, the flat expanse was all too familiar, but Pawnee still felt completely unique. Someone just passing through the region may dismiss it as unremarkable, a whole lot of nothing, but after spending a summer there, this couldn't be further from the truth. The plains are truly a beautiful ecosystem. The subtle change in colors on the landscape from different communities of plants, the sparse seas of prickly pear cacti, the roving pronghorn galloping across the plains at high speeds, the horned larks and lark buntings that flushed with the approach of humans. So many instances of beauty, just below the surface. As the author Suzanne Winckler put it, "…the joy of prairie lies in its subtlety. It is so easy—too

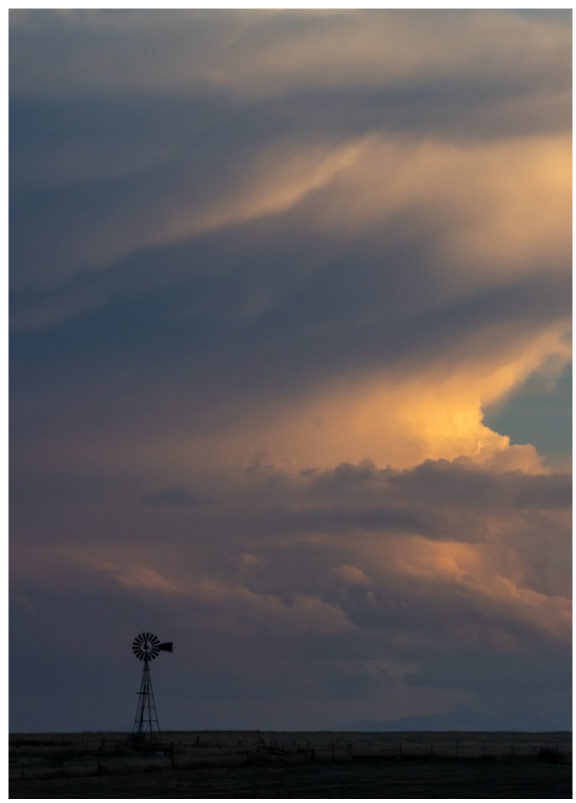

Figure 8. A windmill at sunset at CPER

easy—to be swept away by mountain and ocean vistas. A prairie, on the other hand, requests the favor of your closer attention. It does not divulge itself to mere passersby." (Winckler 2004)

Figure 9. A young steer that somehow managed to get stuck in a plot, surrounded by prairie dog burrows and traps (CPER)

The first step in the process of our fieldwork was determining the location to set out traps and catch prairie dogs. This was a process that involved learning from others that were familiar with the area of CPER and knew where prairie dog colonies were located. After we had obtained the location of a potential colony, we drove out to scout the location. From a distance that would prevent the prairie dogs from spooking and diving into their burrows, we used binoculars to scope out the activity in a colony. If the colony was active, we would see prairie dogs going about their normal business, running from one burrow entrance to another, standing up to scan for predators, and doing the adorable behavior of hopping up and making a jump-yip sound. After a preliminary examination, we would then go onto the colony to see how many burrows were active. We could determine if a burrow was actively inhabited by prairie dogs from indicators around the burrow, such as fresh dirt dug up from the tunnels, fresh scat, and clipped grass.

After determining that a colony was active and suitable for trapping, we set to work constructing our plot. It varied from colony to colony, but we restricted our plots to about 1 hectare in size. We marked the plot boundaries with plastic fence posts temporarily driven into the ground. Around these fence posts, we spooled two strands of electric fence wire - one just above waist height, and one at knee height. As many of the colonies we worked on were also used by cattle, electric fencing was necessary to prevent cattle from eating the prairie dogs' bait, trampling the traps and trap markers in the process. This fear was not unfounded, as even with electric fencing, we found that cattle had an affinity for kicking over traps and making our day harder. Setting up an effective electric fence was a process of trial and error. For a long time, we were unable to get the fence to deliver anything more than what felt like a mild static shock. This proved to be ineffective in deterring cattle, who would just knock over the fencing. We even once found a cow trapped inside our plot, who had somehow gotten inside the intact fence, but had no idea how to get out. We eventually corralled the black cow out of the fence, pictured in Figure 9. After a lot of trial and error, as well as some amateur electrical engineering, the fence delivered an effective, yet mild, electric shock, and deterred cattle without a problem.

While setting up the outside perimeter of the plot, we also altered the landscape within the plot, setting out traps along with their corresponding markers. At each burrow entrance that showed activity, we staked down a trap, the opening of which faced the entrance. Depending on the size of the colony, we set out up to 100 traps on a plot. To keep track of such a huge number of traps, each was labeled with either orange or yellow neon tape and marked with a number. Since we would be taking away the trap from its burrow if it caught a prairie dog, we needed a way to mark the burrows as well. This was accomplished using large wooden yard stakes, which were taped and labeled corresponding to each trap. After each trap and stake were set out, the coordinates of the traps were marked using a GPS. Now that the stage was set, we could begin trapping.

Figure 10. Three juvenile prairie dogs caught in a trap

The process of trapping these rodents was tedious yet rewarding. Before any traps could be primed and ready to catch a prairie dog (or three), the traps had to be “pre-baited.” After setting out the traps at the corresponding burrow entrances, our team baited the traps with horse feed and oats, and forced the doors of the trap to stay open using small carabiners. The purpose of this was straightforward: attract prairie dogs to the traps and allow them to become familiarized with the objects so close to their homes. The prairie dogs would then be more likely to enter the trap to feed when the traps were actually set, thereby increasing the chances of capture. It took some trial and error to determine how far in advance we had to pre-bait and allow prairie dogs to adjust to the altered landscape and become comfortable with feeding inside the traps. Eventually, we found that a time span of around a week was the sweet spot for pre-baiting. Knowing this allowed our team to set up plots and pre-bait them while actively trapping other plots, making for a more efficient rotation of trapping on our study plots.

After the traps had been sufficiently pre-baited, then came the time to set the traps. This process involved our crew heading out to the plots in the early morning, beginning around 4 am. Trap-setting had to be done at this early hour, much to the chagrin of my sleep cycle, in order to ready the traps before the prairie dogs wake up and begin foraging for food, which occurs around sunrise. The whole process could take up to a few hours, depending on how many traps needed to be set. In the darkness of the early morning, with only our headlamps to guide us, we moved from trap to trap, quickly removing the multi-colored mini-carabiners that kept the doors of the trap open. We then set the trap to trigger, the plate in the middle raised, ready to slam the doors of the cage shut when any unsuspecting prairie dog came along to feed on the bait. New bait was added for every morning we trapped, consisting of the feed used in pre-baiting, as well as cut-up slices of carrot to entice the little rodents. As we attempted to set all traps as quickly and accurately as possible, the often-unseen nocturnal world the prairie hosted was alive with activity. The aptly named kangaroo rats, with their long legs, hopped around our feet as we trudged through each colony, the faint shine of spider eyes littering the landscape. The yipping and howling of packs of roaming coyotes soundtracked the night, accented with the beeps and wooshes of nighthawks showing off for potential mates. One night even included a close encounter with a juvenile pronghorn hunkered down for the night, blending in with the prairie landscape, and no doubt terrified by the large creatures with bright lights who stumbled upon it.

Figure 11. Successful traps in the shade, waiting to be processed

Thankfully, after the traps were set and the crew made it back to our beds around 5-6 a.m., we were afforded a few precious hours of sleep as the prairie dogs woke up, ate the tasty bait laid out for them, and hopefully, got trapped. At around 9 a.m., we would head out to see the day's yield. As we arrived at the plot, we were often greeted by a portion of the traps closed, inhabited by prairie dogs. Each occupied trap was a different experience. Prairie dogs varied significantly in personality, some cowering in the furthest corner of the trap, others angry that we dared to trap them, and loudly voicing their opinion on the matter. What also varied was the number of prairie dogs in the trap. Most only contained a single animal, but it was not uncommon for two to three prairie dogs to occupy a single trap, and rarer for four to five animals (Figure 10). These multianimal traps often included one or more juveniles, such as the trio in the photograph above. As we collected the successful traps, we enclosed them in a pillowcase, which simulates the darkness of a burrow and keeps prairie dogs calm during transportation (Figure 11). We had to work quickly, as we wanted to minimize the time that the traps sat exposed to the sun and to predators, who could harass the captive rodents. Only on a few occasions did unintended targets, like cottontail rabbits (*Sylvilagus floridanus*) or mourning doves (*Zenaida macroura*), get caught in our traps. Most days, we could expect to trap around ten to twenty individuals, with some days catching only a few, and some very long days where up to forty were captured.

Figure 12. Brooke drawing blood from a prairie dog in Conata Basin

After collecting the trapped prairie dogs, we transported them to a processing station. The location of the station varied, but was often in the conference room next to our field house at CPER, or at a foldout table covered by a shade canopy situated right next to the colony we trapped (Figure 12). Because we were dealing with animals that may carry deadly diseases, we geared up with protective equipment, including nitrile gloves and n95 masks. We also applied DEET to our arms and legs, in case any flea jumped off the prairie dog onto us. This equipment not only protected us from any prairie dog or flea-borne pathogens, but also protected the prairie dogs from any exposure to human-borne pathogens. As many of these rodents were large and had the possibility of biting, we anesthetized each animal to protect ourselves from being bitten and to reduce the impact and stress of our handling on the animals. We used a combination of isoflurane, a general anesthetic commonly used in the veterinary field, and oxygen, which were fed through a regulator into an anesthesia chamber (in the form of an airtight plastic tub) in which the pillowcase-cloaked individuals were placed. The process of anesthetizing a prairie dog depended on its body size, but it usually took from two to three minutes for the animal to fall asleep. At that point, we transferred the prairie dog out of the chamber and kept them under by feeding the anesthesia through a cone loosely situated around the animal's muzzle. It was at this point that we began collecting data.


Figure 13. The table with all our supplies for processing

Following anesthesia, we shaved fur from an area between the shoulder blades, as well as the inside of the thigh. From the thigh, we extracted a blood sample, which was then applied to a strip of absorbent paper, called a Nobuto Strip, to later be analyzed for the presence of plague. Next, we attached an ear tag on one ear, which displayed a number to be used in identification if the animal was trapped again. On the other ear, a cut was made to the tip, which provided a DNA sample to be analyzed in the lab later. Then, in the shaved area on the animal's back, we applied a PIT tag. PIT tags are small, pill-shaped devices that are inserted subcutaneously, and serve as another form of identification; more reliable than the ear tags, which are prone to fall off. Each PIT tag corresponds with a 15-digit number, which can be read on a PIT tag reader by waving the wand above the site of the tag. After that, we took physical data from the animals, including weight (in grams), total length (in millimeters), and hind foot length (also in millimeters). As animal welfare was our highest priority, many precautions were taken to ensure the prairie dogs' safety. Since we were working on hot summer days, and the prairie dogs were sometimes waiting a while for their turn to be processed, we injected the animals with lactated Ringer's solution (LRS), a fluid that provides hydration and electrolytes. We also applied a hydrating ointment to the prairie dogs' eyes to prevent them from drying out. Finally, using black hair dye, we painted a unique symbol on each individual’s back. This would allow us to observe and identify individuals while they were in their natural habitat after release. Throughout the process, we were also on the lookout for any fleas that may have been stunned by the anesthesia, or that were crawling through the prairie dogs’ fur. We plucked any flea we spotted and placed it in a tube filled with ethanol. It was a challenge to pick up the wily little insects with tweezers, especially while wondering if the flea was harboring a disease that wiped out half of Europe.

I was fortunate to have the opportunity to conduct all of the processing steps, but for much of the time, Charlize and I focused on monitoring the breathing of the prairie dog and adjusting the anesthesia accordingly, scribing data, and prepping and cleaning equipment such as vials, syringes, and other tools. By the end of the summer, our team was a well-oiled machine that was able to process prairie dogs quickly and accurately.

After each individual was processed fully, they were placed back into the trap to wake up, and were often given a piece of carrot as a snack and compensation for participating in our study. On most days, once all the individuals were processed, they were transported back to their colony and released at the same burrow that they were caught at. On extremely hot days, or days when a large number of individuals were caught, groups of processed prairie dogs were transported back to their burrows periodically throughout the day.

Figure 14. A bison trudges across the badlands

Around halfway through the summer, in late June, our team was informed that two sites north of us were experiencing the start of sylvatic plague outbreaks in their colonies. These two sites were Thunder Basin National Grassland in Northeastern Wyoming, and Conata Basin, situated between Buffalo Gap National Grassland and Badlands National Park in South Dakota. At this point, we packed up our gear and headed North to catch prairie dogs in these two areas, to help us capture genetic samples of animals that were present during the plague outbreak, with special interest in tissue samples from any survivors. The project aims to return to these same sites to sample prairie dogs, post-plague to help capture genomic signatures of plague resistance. We spent two weeks in the two states, from July 9th to the 20th, driving back down to Colorado over the weekend between. The first week consisted of scouting for sites and setting up plots, and then pre-baiting so that the next week we could trap and process prairie dogs.

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Figure 15. A map with the three sites we trapped over the summer

During the first week, we started by traveling to Thunder Basin, where we scouted and set up two plots. One plot was established in a colony not known to be affected by plague, which was apparent from observation. This colony had many individuals running from burrow to burrow and foraging. There was also a relatively high number of burrowing owls in and around the colony, perhaps suggesting that this colony had experienced some recent die-off, leaving burrows empty and available for use by other species. The second plot on the other hand was largely bare, having just experienced a plague outbreak. The burrows didn't have many signs of activity, grass cover was relatively high, and only a few prairie dogs were spotted in the colony. We thought that even though this colony may not yield a high number of captures, the prairie dogs that were still surviving may exhibit some resistance to the plague that wiped out most of their colony-mates.

Figure 16. Two juvenile burrowing owls in Thunder Basin National Grassland

After setting up those traps and leaving bait with other teams in the area to pre-bait for us, we headed Northeast into South Dakota. Though Thunder Basin's landscape differed in subtle ways from Pawnee's, the terrain that made up Conata Basin was completely foreign to me. As we searched for suitable locations to trap, we were surrounded by striated buttes arising from the plains landscape, showcasing millions of years of history contained in each colored layer. All the while, herds of bison roamed across this otherworldly environment. We were fortunate enough to secure a camping site within Badlands National Park, allowing us to witness breathtaking views of the skyline of sedimented strata. The process of choosing colonies was similar to the process at Thunder Basin. One very active colony was set to be trapped, as well as a plaguedevastated colony with very little activity. We were unable to find someone to pre-bait the colonies while we were away, so we heavily baited each trap and prayed that they would be ready by the time we returned. One important thing to note is that these plots were not guarded by electric fences, so we also were up to the mercy of any large animal that might want to take advantage of the easy meal.

Figure 17. A landscape in Badlands National Park

Before we left, we met with a team of people working for various conservation groups and government agencies, such as the National Parks service and the US Forest Service, who were in the area to combat the plague outbreak. This was largely because Conata Basin is home to the only place in the world where the population of black-footed ferrets are self-sustaining. (Cain et al. 2011) In every other place where these ferrets are found, new individuals need to be introduced by humans to keep population numbers up. This team knew that they had to work fast and effectively to minimize the losses to the ferret population, as well as the prairie dogs. We saw large fleets of ATVs, being used by this team to quickly move across colonies from burrow to burrow, spraying flea powder around the entrances. Dusting burrows with flea powder is a highly effective way to control for and prevent the spread of plague in prairie dog colonies (Eads & Biggins 2019). It was inspiring to see so many people, from many different places and agencies, working together to save wildlife.

After taking that weekend off to recharge, we returned to Thunder Basin to begin trapping. From the very active colony, the first day of trapping yielded twenty individuals, which was a huge success. We were able to collaborate with another team from the Forest Service who were mapping prairie dog colonies in the area, showing the team our process of trapping and data collection. The less inhabited colony only yielded four unique individuals, but, presumably, these prairie dogs were survivors from the plague outbreak and may harbor the resistant alleles our team was searching to uncover. After a few days of trapping, we were able to obtain 24 genetic samples in total. We then packed our traps and gear we had used in the National Grassland and headed once again to South Dakota.

Figure 18. A photo of the moon taken the night of our bison close encounter

Unfortunately, upon our return to Conata Basin, we were greeted with an unfortunate site. We arrived at our colonies around 9 p.m. in order to check their status and bait them for trapping the following morning, and our headlamps found a disaster scene. Almost every trap was knocked over, with markers missing. Some traps were even crushed beyond repair, and I had the pleasure of recovering a trap that was caked in a large patty of bison dung. Sometime during the week, maybe even multiple times, herds of curious bison had rummaged through our traps to score a meal that was meant for the prairie dogs, uprooting and crushing our hard work with their massive bodies. By the time we had finished salvaging what we could of the plots, around 12 p.m., we were too tired to drive all the way to our planned campsite, choosing instead to set up camp next to one of the colonies. Half an hour after falling asleep, I was awoken by Galen whisper-shouting "*Matthew, Matthew!*" As I opened my eyes, I realized that I heard a deep *huff, huff*, a foot from where my head was resting. I quickly realized that a herd of bison had happened upon our camp and were surrounding my tent! One in particular had taken an interest in my tent and was pushing its snout against the canvas. I sat up in my tiny single-person tent, unsure of what to do. On one hand I was terrified that the big, clumsy ungulate might crush me accidentally, while at the same time enamored at being so close to one of my favorite animals. I just laughed at the absurdity of the situation as I waited for the bison to get bored. Eventually, the huge mammals moved on to graze somewhere else.

After the close encounter with bison, the rest of our time in South Dakota focused on trapping. The results of this trapping were similar to that of Wyoming, where a large number of individuals were caught at the active site, while at the less populated site, zero prairie dogs were caught. We figured that this was due to the bison's trampling of the plot, leaving the colony with no time to adjust to the traps. However, our team walked away with 23 prairie dog genetic samples, so trapping in South Dakota was still a success. We finally packed up our gear and headed back down to Colorado, where we would continue trapping on CPER for the rest of the season.

Figure 19. A prairie dog peeking out of its burrow at CPER

Data

Not all prairie dogs caught went through the entire trapping process. For recaptured prairie dogs, we had already collected data on these individuals earlier in the summer, meaning that the process was much simpler. Usually, it involved reapplying anything that had come off, whether that be the ear tag, or often, the dyed symbol. We also collected weight, which I noticed varied between different individuals. I was curious what the growth rates were of the individual pups we trapped between the two trapping periods, and whether there was any difference in the growth rates between sexes. I observed a difference in sizes between sexes, with the largest individuals often being male. Males have previously been observed to have larger average body masses than females, displaying sexual dimorphism (Hoogland 2003).

We had collected body mass data from 20 prairie dogs who were captured first at the start of the summer as pups, (late May to early June) and recaptured later in the summer (early August). During both trapping periods, the juveniles' body masses were recorded, showing the growth that a prairie dog experiences during their first months of foraging. First, I visualized the juveniles' growth over time in Figure 20. Next, I determined the average daily growth (ADG) of each individual by dividing their gain in mass by the amount of days in between captures, and calculated averages of those rates (Table 1). I also calculated the average growth between sexes, which was an average of 72.57% increase in females, and a 82.22% increase in males. I visualized the averages, along with their corresponding standard deviations in Figure 21. I then ran a twotailed t-test to determine any sexual dimorphism in growth rates of juveniles, which resulted in a p-value of 0.434, suggesting no significant difference in growth rate between sexes (Table 1). With Hoogland's conclusion that black-tailed prairie dogs exhibit sexual dimorphism in weights (Hoogland 2003), it could be hypothesized that both sexes grow at similar rates, but males may have a longer growing period. However, a sample size of n=20 is relatively small, and further analysis with more individuals may yield alternate results.

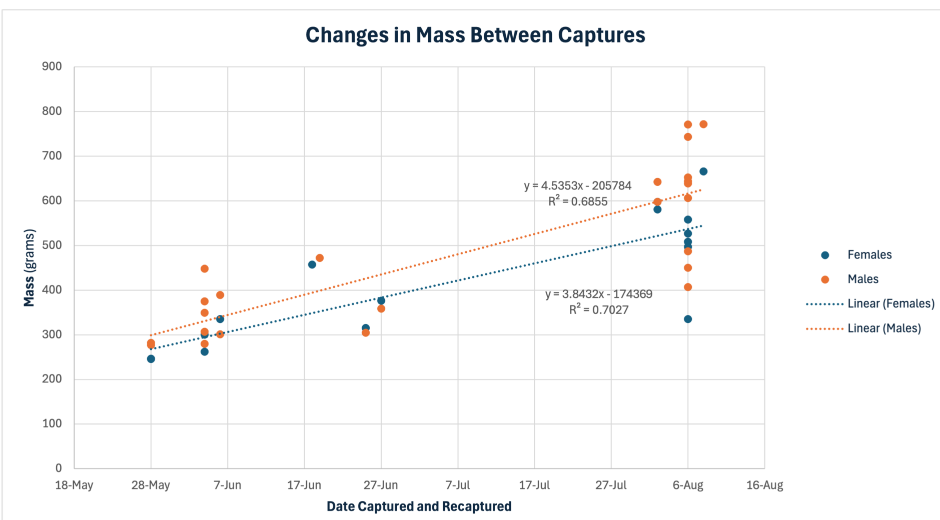

Figure 20. A chart that shows the general changes in mass between the prairie dogs' first captures, on the left, and their recaptures, on the right

Average Daily Growth Descriptive Statistics						
Total ADG (Averge Daily Growth) Average	Female ADG Average	Male ADG Average	Total ADG Standard Deviation	Female ADG Standard Deviation	Male ADG Standard Deviation	ADG T-test
4.570889142	4.107447513	4.879850228	2.094925709	1.942909904	2.217647401	0.434086562

Table 1. A table providing statistics relating to calculated average daily growth (ADG)

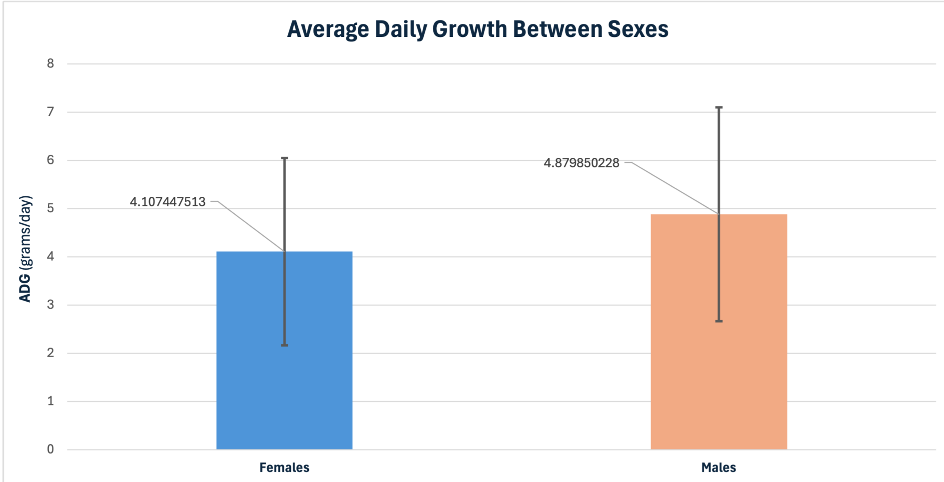

Figure 21. A chart comparing the ADG averages between female and male prairie dogs, including the standard deviation

Although the sample size is low, it is still evident that the change in mass varies from individual to individual. Most prairie dogs' masses were measured between a period of around 60 days, yet the mass gained during that time varied across a whole order of magnitude, from around 40 to around 400 grams (Figure 22). This could be due to differences in foraging efficacy, genetic differences, or perhaps variations in stages of development between individuals. A larger sample size, as well as more frequent mass measurements may produce a more conclusive pattern of growth.

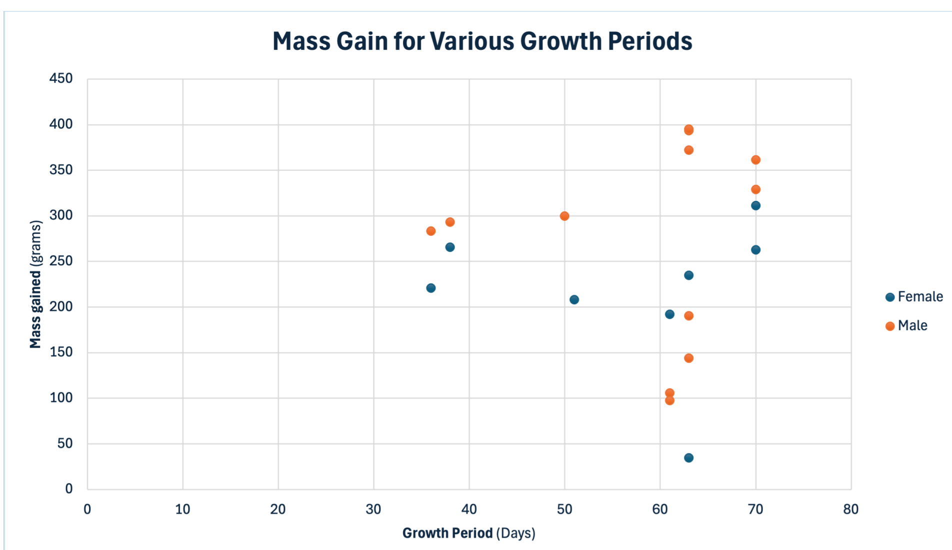

Figure 22. A chart visualizing the mass gained by each individual compared to that individual's growth period

As the internship was only over one summer, it is difficult to draw conclusions from the data collected. However, continued data collection of growth rates in juvenile prairie dogs over multiple years could inform how growth rates change under different conditions, when related to short-term weather patterns and longer-term climate change. Because of the highly variable nature of prairie dog colonies (post-introduction of plague), they experience “boom and bust” cycles, spurred by many conditions, including outbreaks of sylvatic plague or climate conditions (Davidson et al. 2022). As climate change causes more drastic and frequent variations in weather conditions across the Great Plains, this may lead to limitations on the availability of food, as well as making colonies more susceptible to plague outbreaks (Eads & Biggins 2017). Monitoring the growth rates of juveniles during development over multiple years alongside climate conditions may help us predict the future effects to the health of prairie dog colonies. The accuracy could be improved by collecting weights at multiple fixed times throughout the season, as well as monitoring external variables such as meteorological data, food availability, and presence of plague. The data collected from this summer can serve as a baseline for further experimentation.

Conclusion

Throughout this experience, I was able to better myself as a scientist and person. I learned valuable skills that will help me as I pursue a career in ecology and biological research. From field skills such as learning how, when, and where to set traps, to learning to perform anesthesia and draw blood, the tangible experiences will help me to better perform science in the future. Even further, as this was the first year of the study, I was able to witness first-hand how field experiments are planned, and I learned how to adapt when one or more of the many uncontrollable variables interfere with those aforementioned plans. I was also able to improve my photography skills, being able to spot subjects faster, and producing some of my favorite photos I’ve ever taken. Aside from these skills, I was able to meet so many amazing people and colleagues, presenting many possible paths that I could take to study and conserve wildlife. It was inspiring learning from and talking with these experts who have devoted their lives to understanding and protecting species crucial to the wellbeing of ecosystems.

On a personal level, I was able to gain a deeper understanding and appreciation for prairie dog biology and ecology, and for the prairie ecosystem as a whole. The memories that I made spotting golden eagles soaring across the landscape, stumbling upon prairie rattlesnakes, watching the evening thunderstorms roll through, and countless others will stick with me for a long time, and solidified in my mind the crucial need to protect this natural beauty.

Figure 23. Starry skies show the Milky Way over Pawnee National Grassland

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