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Summary of 2018 Utah Prairie Dog Survival Analysis

Overview

Utah prairie dogs are often translocated to other sites when they create burrow systems in human-used habitats (e.g., playgrounds or golf courses). As a species listed as threatened under the Endangered Species Act, it is important to facilitate translocations that are as effective as possible. In order to assess efficacy of Utah prairie dog (*Cynomys parvidens*) translocations, the Cedar City Field Office of the Utah Bureau of Land Management (BLM) conducted a study to compare survival of translocated Utah prairie dogs between a site with a man-made burrow system (M3) and a site with an abandoned prairie dog-made system (Buckskin). Both sites were dusted with insecticide prior to prairie dog release in order to kill plague (*Yersinia pestis*) carrying fleas, a major threat to prairie dogs and many other species of wildlife in this region. Wildlife cameras were also placed at each translocation site.

There was a total of 124 prairie dogs in the study; 45 prairie dogs were released at Buckskin compared to 79 prairie dogs at M3. Prairie dogs were released at each site in intervals. Each prairie dog was painted with an individual ID and a sample group was fitted with either a VHF or GPS collar. At the Buckskin site, there were 12 prairie dogs with VHF collars and at the M3 site there were 20 prairie dogs with VHF collars and 10 with GPS collars. A BLM technician monitored prairie dog survival by radio telemetry during 08/16/18–12/07/18. At the end of the study, wildlife cameras were collected for analysis.

While a portion of prairie dogs at the M3 site were still alive at the end of the study, all the prairie dogs from the Buckskin site died of the plague by 8/30/19. The plague event prevented further prairie dog release at Buckskin, which explains the discrepancy in number of prairie dogs released at each site. Since this was a study comparing translocation sites and not the plague, the presence of the plague does alter the nature of the study.

In this summary, I will outline the results of my survival analyses from the GPS and VHF collar data as well as some of my findings from the Buckskin camera trap photographs.

VHF/GPS Survival Rates

In order to compare translocated Utah prairie dog survival curves between the Buckskin and M3 sites, I completed a Kaplan-Meier survival analysis. This analysis estimated daily survival during 8/22/18– 12/07/18. Survival of dogs at M3 was 30.6% over the 3-month study while overall survival during 8/22/18–8/31/18 for dogs at Buckskin was 0% (**Figure 1**). It is interesting to note how quickly the plague wiped out the prairie dogs at Buckskin and also how M3 had periods of stability followed by bursts of decline [data was collected every day aside from three days at the

Buckskin site (8/25, 8/26, 8/29) and all days at the M3 site except a 10-day hiatus (11/21–11/30), a 6-day hiatus (11/13–11/18), and a few 1–2-day hiatuses].

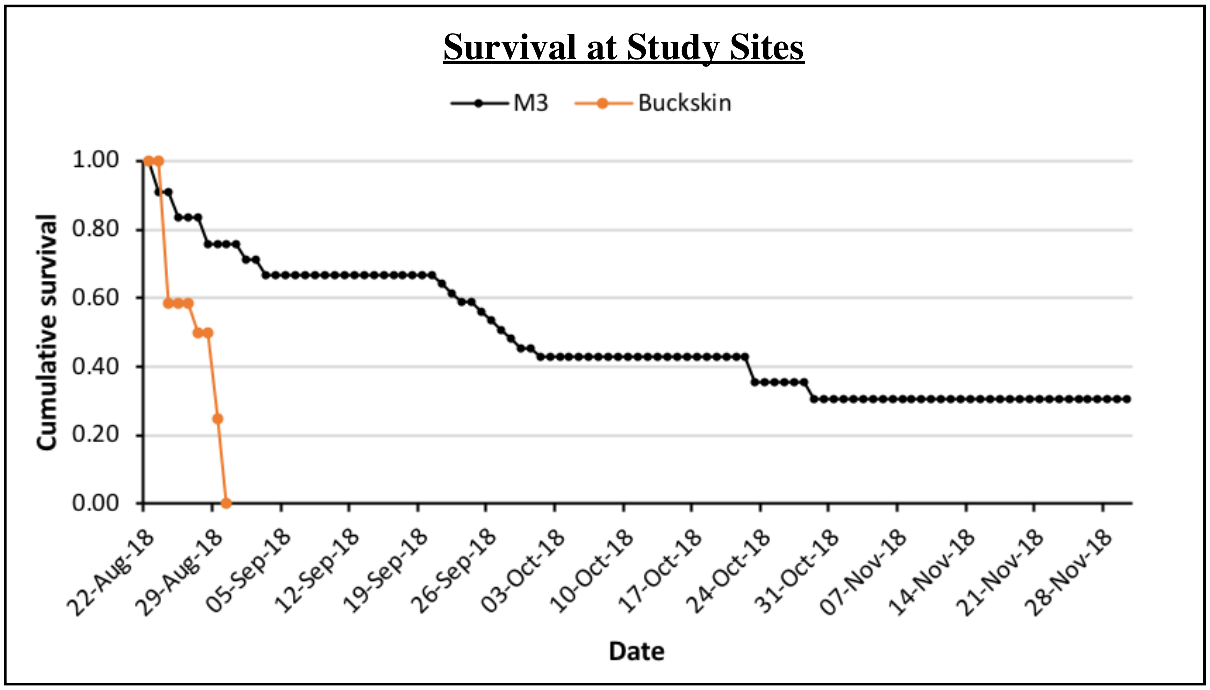


Figure 1: *Kaplan-Meier survival analysis for M3 and Buckskin sites.*

To evaluate variables which might influence survival across the sites, I used the known-fate model with a logit link function in Program MARK (version 7.2). When building the models in the numerical estimation run, I used the default setting for the variation estimation and real parameter estimates from individual covariates (2ndPart and mean individual covariate values). Survival was estimated across a time period of 110 days (there was no change in survival between 11/30-12/7 so I did not include this period in analysis). In the model, I split the time period into 11 10-day time intervals. I modeled survival of translocated Utah prairie dogs as a function of 3 variables (sex, site, mass **Table 1**). A linear time trend (T) was incorporated into half of the models to allow survival for each of the 11, 10-day intervals to vary linearly. The models noted with S. did not have a linear time trend incorporated, so survival was modeled to remain constant for all of the 10-day time intervals.

I constructed 14 biologically relevant models, of which two were substantially supported (ΔAIC_c>2, **Table 2**). The most parsimonious model, model 1, indicated a constant survival across all time intervals (β= -3.170, 95% CI= -5.875 – -0.464) with an additive site effect (β=2.759, 95% CI=1.61 – 3.906) and mass effect (β=.003, 95% CI=0.0002 – 0.006; **Figure 2**). This model had the highest weight, which was only 1.28 times more likely than the second model, but 4.44 times more likely than the third model. The second model did not explain more of the variation in Aug-Nov survival than the best model, which is evident because beta estimates overlapped zero (Sex: β= 0.664, 95% CI= -0.356 – 1.685). According to the MARK analysis, the probability of a prairie dog surviving the duration of the study was 7.2%. The probability of an individual surviving at M3 was 27.8% compared to 0.000007% at Buckskin.

Table 1: *Variables used for MARK analysis*.

Variable	Explanation
Sex	Survival varies between sex (female and male)
Site	Survival varies between release sites Buckskin and M3
Mass	Survival varies with body mass (g) at time of capture
T.	Survival varies linearly through time
S.	Constant survival for each time interval

Table 2: *MARK survival models, ranked in order of AIC_c*.

Model Rank	Model	AIC_c	ΔAIC_c	AIC_c Weight	No. Par.	Deviance
1	S. Site, Mass	119.5770	0.0000	0.42761	3	113.4137
2	S. Sex, Site, Mass	120.0820	0.5050	0.33219	4	111.8080
3	S. Site	122.5588	2.9818	0.09629	2	118.4777
4	T. Site	123.8862	4.3092	0.04958	2	119.8051
5	S. Sex, Site	124.6174	5.0404	0.03440	3	118.4541
6	T. Sex, Site	125.1954	5.6184	0.02576	3	119.0321
7	T. Site, Mass	125.2515	5.6745	0.02505	3	119.0883
8	T. Sex, Site, Mass	127.2894	7.7124	0.00904	4	119.0154
9	T. Mass	137.6969	18.1199	0.00005	2	133.6158
10	S. Sex, Mass	141.6337	22.0567	0.00001	3	135.4704
11	T. Sex, Mass	141.8076	22.2306	0.00001	3	135.6444
12	S. Mass	142.0112	22.4342	0.00001	2	137.9301
13	S. Sex	145.6325	26.0555	0.00000	2	141.5514
14	T. Sex	148.7992	29.2222	0.00000	2	144.7181

It is unsurprising that the best survival model contained an additive effect of site (given all of the prairie dogs died at Buckskin– likely due to plague), but it is interesting to note that the additive effect of body mass at time of capture is present in the best survival model. The model suggests that heavier prairie dogs have a higher survival rate than lighter prairie dogs (**Figure 2**).

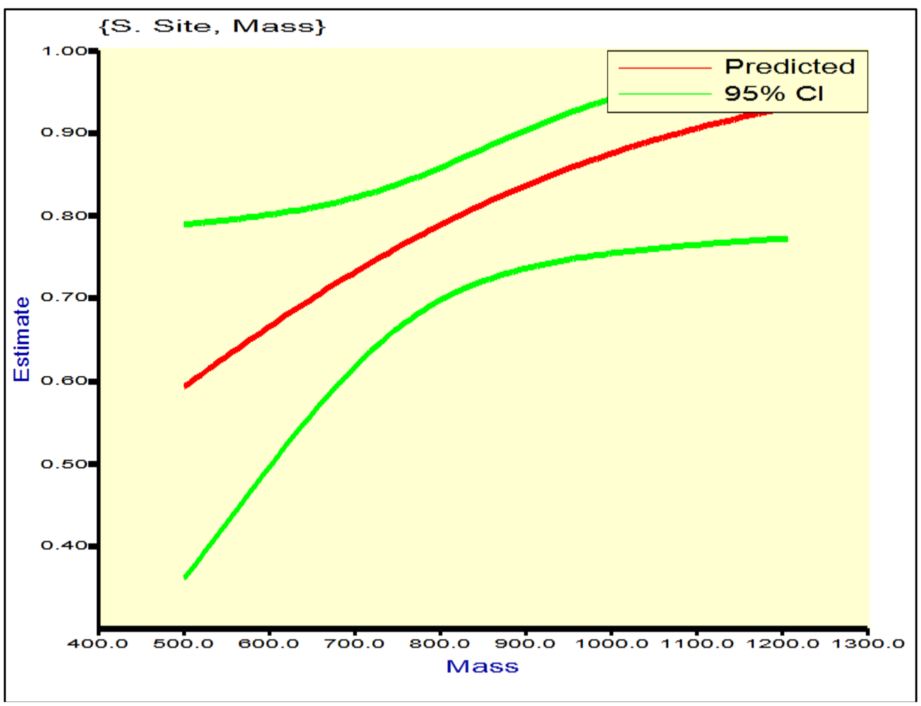


Figure 2: *Independent covariate plot of most parsimonious model for any given time interval of 10 days. This curve just shows survival over a 10-day interval, but in the S. model all 10-day intervals have the same survival.*

On average, prairie dogs translocated in this study weighed 797.62g at time of capture. The average mass of prairie dogs that survived the entire study was 883.33g, while the average mass of prairie dogs that died was 773.21g. This finding is supported by a number of studies focused on different prairie dog species. Over an 8-year mark and recapture study of Canadian black-tailed prairie dogs, Stephens et al. (2017) found that mass had a positive correlation with survival. Additionally, Eads and Hoogland (2016) recorded that adult black-tailed prairie dogs with lower mass were more likely to be parasitized by fleas. Hoogland et al. (2006) observed that emaciated Utah prairie dogs were not more likely to preyed upon, but all died nonetheless. All of these studies indicate that mass may indeed be an important factor in prairie dog survival rates.

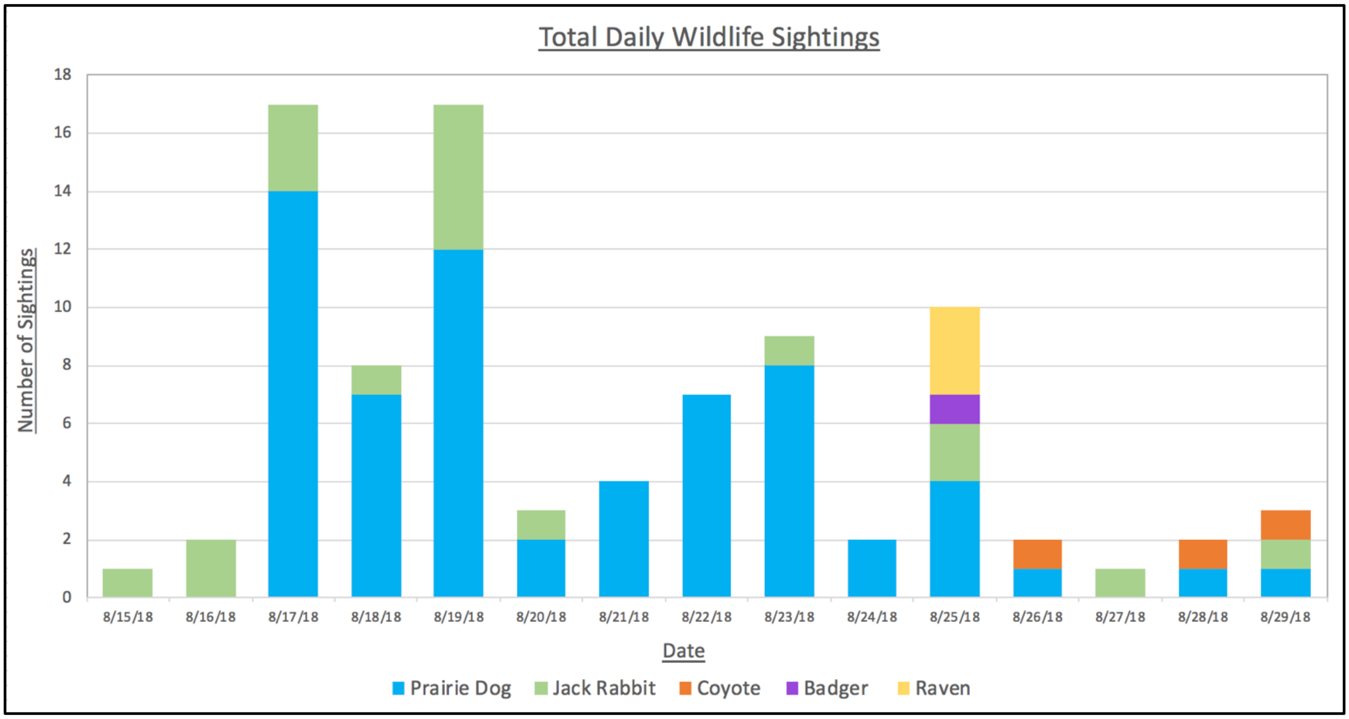
Since mass may have some effect on survival, I wanted to see whether there was a relationship between mass and whether prairie dogs were killed by predation. As larger prairie dogs tended to have a higher survival rate, I hypothesized that they might be less likely to be predated. I used a binary logistic regression to look at the correlation between mass and general predation. This relationship appears to be insignificant (P=0.333). I also ran a similar model for avian predation with an insignificant result (P=0.955). Although these models proved insignificant, this may be due to the small sample size. It could be helpful to look into these trends in future studies.

Camera Trap Trends

In analyzing the camera trap data, I recorded each prairie dog sighting I was able to uniquely identify. If dogs were too far to identify or the picture did not capture their ID, I recorded prairie dogs in 10-minute intervals. If there were multiple prairie dogs in the same photo I made note of this as well. Similarly, I recorded other wildlife species sighted in 10-minute intervals. The reason for this is that the camera is often triggered multiple times by a single animal and I did not want to over-record sightings per individual appearance.

The camera trap data may help identify a number of trends around Utah prairie dog survival. For the most comprehensive data trends, M3 and Buckskin data should be compared to one another. At this point, I have only completed the Buckskin analysis. This camera trap data can help us identify trends between other wildlife present and prairie dog sightings (**Figure 3**), understand which species most heavily prey upon prairie dogs, and potentially theorize which species may spread plague between prairie dog colonies. I noted that the Buckskin site had a large number of cattle moving through it (this all took place after the plague had wiped out the prairie dogs and is therefore not portrayed in **Figure 3**). It would be interesting to note whether this is also the case at M3. In general, it would be beneficial to compare wildlife sightings between the two sites and infer whether a high frequency of one species may have been likely to bring plague into Buckskin. If this is the case, sites that have high frequencies of that particular species could be avoided for future translocations.

Figure 3: *This stacked bar graph shows the total number of wildlife sightings for each day broken down into five species (Utah prairie dog, jack rabbit, coyote, badger, raven). Total sightings are shown for each day that the Buckskin prairie dog group was alive according to VHF collars.*



Conclusion

The fact that Buckskin prairie dogs contracted plague even with insecticide dusting may suggest that fleas were brought onto the site by larger, more mobile mammals after the start of the study. While fleas could have been brought in by predators such as coyote or badger, the high frequency of cattle at the site should also be considered as potential plague vector (cattle were only seen on camera after the prairie dogs had all died, but their presence at that time indicates that they may also have been present at earlier times as well– potentially between dusting and prairie dog release). Correlation between cattle presence and prairie dog plague mortality could be looked into further in future studies. It might also be beneficial to test cattle for fleas and see whether these fleas are carrying *Cynomys parvidens*– as it seems that cattle themselves do not contract the plague.

While there was indeed survival at the M3 site, it was still low (30.6%). A 2001 review by Truett et al. found that survival rates of translocated prairie dogs ranged between 0-40% months after release. However, more recent translocations have often had greater success. A study by Dullum et al. (2010) on black-tailed prairie dog colonies estimated survival between 79-67% over the first three months. This study found that larger colonies were often more successful immediately after translocation, which may be helpful for future iterations of this study. Shier (2006) concluded that prairie dogs translocated with their families were five times more likely to survive than those translocated with random individuals. Taking such studies into account when creating plans for future translocations may help improve survival rates.

With all this in mind, conducting further years of testing at a larger number of sites will portray a more accurate survival rate of prairie dogs at translocated sites (as well as which variables influence this survival). While the data from this first study provides useful information– and can help shape future years of Utah prairie dog translocation research– its results should be viewed in a larger context. As such, additional years of research will be crucial in identifying patterns for translocation success.

Sources

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