WYOMING POCKET GOPHER HABITAT & RADIO TELEMETRY

FINAL PROJECT REPORT, 2010

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INTRODUCTION

The Wyoming pocket gopher (*Thomomys clusius*) is listed as a Sensitive Species by the BLM in Wyoming due to its restricted distribution within the state, its limited ability to disperse, and potential threats from energy development and environmental stochastic events (BLM, 2010). It is also listed as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department. Petitioned in 2007 under the Endangered Species Act, the US Fish and Wildlife Service found that the species was not warranted for listing in April 2010. Primary reasons cited by the Service were a lack of data regarding population trends and the uncertainty surrounding potential impacts from energy development.

Although recent strides have been made in understanding the species' distribution and habitat (Griscom et al., 2010), little is known about the biology and population ecology of *T. clusius*, with much of what is 'known' about these attributes based on studies of *Thomomys talpoides*, a sympatric and ubiquitous species (Beauvais and Dark-Smiley, 2005). Because pocket gophers are fossorial and defend small territories, the young disperse relatively short distances and it is unknown whether they could disperse across soil-compacting barriers such as roads and well pads. An inter-agency meeting held in Laramie, Wyoming in April 2010 identified roads associated with oil and gas development across *T. clusius'* range as the biggest potential threat to population viability due to potential genetic fragmentation.

In order to begin addressing this question and continue the habitat and field coordination work begun by WYNDD in 2009, the BLM funded the project described herein. We set about achieving four primary objectives, as follows:

1. **Dispersal Literature Review:** Conduct a literature review to determine what is known about pocket gopher dispersal in relation to crossing human barriers such as roads.
2. **Radio Telemetry Pilot Study:** Investigate the use of radio telemetry with *T. talpoides* to determine whether the same technology could be used to track *T. clusius* movement and dispersal in the future.

3. **Design Field Diagnostic Tool:** Based on habitat analyses from 2009, develop a tool to predict the probability of *T. clusius* occupation at pocket gopher-active sites in Carbon and Sweetwater Counties using easily-measurable cover variables.
4. **Coordination and Training:** Coordinate with the Rawlins and Rock Springs Field Offices of the BLM to designate 2010 survey sites and train field crews on proper field survey protocols as needed.

DISPERSAL LITERATURE REVIEW

The first objective is to conduct a literature review to determine what is known about pocket gopher dispersal in relation to crossing human barriers such as roads.

In addressing this objective, the question of whether pocket gophers disperse by tunneling underground or crossing the soil surface is of paramount importance. If they disperse only by tunneling, the soil compaction associated with such activities would certainly represent movement barriers serious enough to warrant concern about population extirpations. Although this question has not been studied specifically in *T. clusius*, a comprehensive review of the scientific literature below provides overwhelming evidence that juveniles of several western species disperse across the soil surface. This suggests that soil compacting infrastructure probably does not represent significant barriers between subpopulations of *T. clusius*.

Although they often live in colonial settings, pocket gophers defend individual territories. Once they have claimed a territory (approximate size $150m^2$; Banfield, 1974), they typically occupy and defend it until they die (usually before the age of two; Daly and Patton, 1990). At 6 to 8 weeks of age, juvenile pocket gophers emerge from maternal burrows in search of their own territories (Daly and Patton, 1990). Williams and Cameron (1984) hypothesize that they are tolerated within the maternal burrow system until weaning at which time they are expelled, perhaps through aggressive means. Based on studies of *T. talpoides* in the Rocky Mountain Region, dispersal of *T. clusius* likely takes place in June (Beauvais and Dark-Smiley, 2005) at which time the young disperse in all directions until they find suitable, unoccupied habitat (Vaughan, 1963).

The phenomenon of above-ground dispersal was first described in 1913 by Harold C. Bryant when he described more than fifty, predominantly 'half-grown' pocket gophers (*T. bottae*) that had been trapped by tar next to a street in Berkeley, California. These gophers had presumably been crossing the road at night when they were entrapped by the sticky substance (Bryant, 1913). Daly and Patton (1990) found that 80% of *T. bottae* juveniles captured during a California study were in pitfall traps at the soil surface, not in traps placed underground. In a central Colorado study, Vaughan (1963) discovered that although *T. bottae* and *T. talpoides* adults would shift territories by capitalizing on existing underground tunnel systems, juveniles, by contrast, were caught almost exclusively on the soil surface, presumably during dispersal events. In the most comprehensive multi-year study ever conducted on pocket gophers, Howard and Childs (1959) documented the same trend in California where *T. bottae* juveniles were typically captured in surface pitfall traps in early summer. Williams and Cameron (1984) found similar results when studying *Geomys attwateri* in Texas. There, juveniles were the primary dispersers and were captured in above-ground traps. So although there are some instances when juveniles will disperse underground, in most cases this occurs at night and at ground-level.

The distance that juveniles disperse appears to be highly dependent on the proximity of suitable, unoccupied habitat, which in is often a product of habitat quality and continuity near the natal burrow. This is exhibited in the Vaughn study (1963) where he contrasts the mean dispersal distance of *T. bottae* (60m) to *T. talpoides* (239m) in south-central Colorado. *T. bottae* tends to occupy loamy valley bottoms whereas *T. talpoides* lives in discontinuous, montane habitats. This difference in habitat continuity at least partially explains the need for *T. talpoides* to disperse further. Daly and Patton (1990) found that 73% of *T. bottae* juveniles established territories within 40m of their natal burrow and only 8% traveled more than 100m. Howard and Childs (1959) had higher estimates for *T. bottae* with most juveniles moving approximately 100m. Given the sporadic distribution of *T. clusius* complexes we have observed in the field, it seems likely that *T. clusius* is most like *T. talpoides* and could disperse distances in the 200-400m range, or even further in some instances.

Past researchers tackling the question of pocket gopher dispersal and movement have employed a mark-recapture approach within an intensively monitored study area (Daly and Patton, 1990;

Howard and Childs, 1959; and Vaughan, 1963). Pitfall traps were an especially effective way to capture dispersing juvenile pocket gophers. Knowing where dispersers originated is a major issue hampering the study of juvenile dispersal in relation to roads. Howard and Childs (1959) were unsuccessful at capturing juveniles before they left their maternal dens (presumably because their movements were restricted to a small area within the tunnel system). This fact could make it difficult to determine whether juvenile *T. clusius* are crossing roads, regardless of whether a radio-telemetry or mark-recapture study is carried out. A much more elegant study design would be a genetic approach, where sub-populations on either side of long-standing potential barriers such as state highways could be compared to determine whether there has been genetic crossover between these sub-populations.

The peer-reviewed literature discussed above suggests that juvenile Wyoming pocket gophers probably disperse above ground. This should relieve at least some of the concern regarding genetic isolation and population extirpation brought about by oil and gas activities in south-central Wyoming. However, that not to say that *T. clusius* faces no other threats. For a species with a limited range, and limited habitat within that range, habitat destruction and degradation from energy development should be of concern. Of equal importance is climate change which could shift or degrade *T. clusius* habitat in a relatively short period of time. Future research should address these issues in addition to tracking population trends and answering basic ecological questions about the species.

RADIO TELEMTRY PILOT STUDY

The second objective is to investigate the use of radio telemetry with *T. talpoides* to determine whether the same technology could be used to track *T. clusius* movement and dispersal in the future.

Three radio collars were purchased from AVM Instrument Company in September 2010 and deployed on *T. talpoides* individuals to test the feasibility of using radio-telemetry to track *T. clusius* dispersal. Collars were attached to 2 females and 1 male in October 2010, 15 miles south of Laramie, Wyoming. The AVM *Mini-BT Collars* used in this study are specifically made for small, subterranean animals and have been vetted on tuco-tucos in South America (Izquierdo and

Lacey, 2008). The AVM *Mini-BT Collar* weighs 5 grams and has an estimated battery life of 200 days. The price was $213 per collar and re-batterying costs approximately $100. A R-1000 receiver (Communications Specialists, Inc.) was borrowed from the UW Department of Zoology and Physiology to track the collared pocket gophers for approximately 8 weeks after being deployed.

Spatial precision was very good with these collars. Using a 3-element Yagi antenna, collared animals could be detected from up to 300 meters away while in their burrows. By subsequently using the receiver without the antenna, the location of the gopher could be determined to within 20cm. Nevertheless, there are some significant setbacks in the deployment of these collars. The collar design is bulky and cumbersome and attachment involved an inordinate amount of fitting and adjusting leading to excessive stress on the animal. In addition, the transmitter hangs around the gopher's neck which may hamper gopher movement and feeding, including the use of cheek pouches.


AVM Mini-BT Collar deployed on *T. talpoides* female, Oct. 14, 2010.

The first collared animal died a few hours after being released into its burrow system on October 14, 2010. Showing signs of stress before and after collaring, we believe that a combination of thermal strain from being in the trap overnight, handling stress, and the constraints of the collar led to its death. Captured on the same day, the second collared gopher was released in better condition. That gopher has been monitored approximately every week since its release and has stayed within a 2 meter area since then. We believe that this gopher has also died and we have plans to retrieve the collar soon. While collaring the third individual, the collar itself broke, rendering it unusable and highlighting an additional weakness in the design of the AVM *Mini-BT Collar*.

Overall we are encouraged by the technological advances allowing the monitoring of subterranean animals with radio-telemetry, however we have serious concerns about the design of the AVM *Mini-BT Collar* and the potential negative impacts of its deployment on pocket gopher behavior and survival. Unfortunately it appears that AVM may be the only company making collars for subterranean animals as Telonics (another major radio-telemetry distributor) was contacted but they do not have anything that will work for such research. In discussing these issues with AVM recently, they suggested that their *CT Collar with 393 battery* might work better than the *Mini-BT Collar*. The battery would be smaller and the collar would be a nylon zip-tie instead of a copper bolt. The drawback of this product is that the battery would only last 100 days and the transmitter would only have a 100m range, which may make it difficult to track dispersed pocket gophers given the assumed 200-400m dispersal distances discussed above. If a radio-telemetry project is undertaken in the future, it would be worth exploring the use of AVM's *CT Collar*.

FIELD DIAGNOSTIC TOOL

The third objective is to design a diagnostic tool that BLM biologists can implement using easily measureable field variables to assess whether sites are occupied by *T. clusius* or the more common *T. talpoides.*

We constructed this tool based on several significant differences between cover variables recorded at *T. clusius* sites when compared to control sites (i.e., non-gopher sites) and *T. talpoides* sites (Griscom et al. 2010). Generally speaking, *T. clusius* sites were characterized by salty, clay soils with abundant bare ground and little rock, litter, and grass cover. In many cases, Gardner's saltbush was the dominant or co-dominant shrub species and big sagebrush, if present, was subdominant.

To create a quantitative model from this descriptive model, we used Principle Components Analysis (PCA) to account for autocorrelation and to pull out the variables that explained the most variation in the data and could essentially ‘stand in’ for the rest. ‘Percent bare soil’, ‘percent rocks’, and ‘percent big sagebrush’ were the most explanatory variables resulting from the PCA analysis, and ‘tunnel width’ was added as it was found to be a good predictor of which species occupied a site but could not be included in the PCA analysis (Griscom et al., 2010). Every possible model incorporating these 4 variables was compared using Akaike Information Criterion (AIC) and the final best-fit model included ‘percent bare soil’, ‘percent big sagebrush’ (ARTR), and ‘tunnel width’ (in mm). The resulting logistic equation (Box 1) can be used to calculate the probability that a gopher complex is occupied by *T. clusius* (as opposed to *T. talpoides*) based on measurements of those three variables. An example of how to use this equation is provided in Box 2.

Box 1: Logistic equation giving the probability of *T. clusius* occurrence based on measured habitat variables.

Y = Probability of *T. clusius* occurrence = $(e^{\wedge F})/(e^{\wedge F} + 1)$

where F = (**0.0827***% bare soil) - (**0.264***%ARTR) - (**0.112***tunnel width) + 2.989

Box 2: Example of use of the *T. clusius* probability equation.

Let us suppose that a resource manager at the BLM is assessing the potential impacts of a proposed pipeline to *T. clusius*. There is an active pocket gopher complex directly in the path of the proposed pipeline, but the manager does not have the time or resources to trap the site and determine whether *T. clusius* or *T. talpoides* occupies the site. If the manager sends out a crew to measure percent cover of bare soil, big sagebrush, and tunnel width according to the protocol in Appendix A, he/she can estimate the probability that the site is occupied by *T. clusius*. For this example, let us assume that these were the measurements:

% Bare Soil = 81.25%

% Artemesia tridentata = 8.75%

Average Tunnel Width = 50mm

The probability of *T. clusius* occupancy at the site would then be calculated as follows:

$Y = (e^{\wedge F})/(e^{\wedge F} + 1)$

$Y = (e^{\wedge ((0.0827 * 81.25) + (-0.264 * 8.75) + (-0.112*50) + 2.98975)}) / (e^{\wedge ((0.0827 * 81.25) + (-0.264 * 8.75) + (-0.112*50) + 2.989)} + 1)$

Y = (21.3097/22.3097) = **0.955**

Therefore, in this example there is a 95.5% probability that *T. clusius* occupies the site and an inverse 4.5% probability that *T. talpoides* occupies the site.

Once the logistic equation (Box 1) is used to calculate the probability of *T. clusius* occurrence, managers must still decide if the calculated probability is sufficient to classify a site as Wyoming pocket gopher habitat. This is fairly straightforward when the probability is very high, as in Box 2. This decision is less clear at lower probabilities. In order to address this question, receiver operating characteristic (ROC) curve calculations were used to determine the best cut-off between predicted probability of *T. clusius* and *T. talpoides*, where 'best' is defined as the probability threshold resulting in the lowest miss-classification of *T. clusius* sites. A threshold of 30% performed the best, which means that sites with 30% probability or greater were most likely occupied by *T. clusius* and sites less than 30% were most likely occupied by *T. talpoides.* Table 1 shows the performance of the tool on the same data that were used to create it. The 30% threshold was found to perform better than others based on its overall accuracy (91% sites correctly predicted), Euclidian distance (0.099), and Kappa statistic (0.76) which suggests 'good' to 'excellent' agreement (Landis and Koch, 1977). Despite this good performance, the diagnostic tool should be used with caution as it is based on relatively few measurements (i.e., only 21 *T. clusius* and 42 *T. talpoides* sites) and probably does not represent the full natural variability of cover types occupied by either species throughout Carbon and Sweetwater Counties.

A caveat regarding this model is that, due to the scarcity of *T. clusius* data, we were forced to use all available sites to build the model, leaving no sites for independent validation. To partially address this, we assessed model performance using habitat data collected in 2010 at 7 sites by Rawlins BLM and LWR Consultants where either *T. clusius* or *T. talpoides* were captured. Ideally, a validation dataset would be larger, but additional *T. clusius* sites are currently not available. Table 2 displays these results. Using the 30% threshold discussed above, the tool correctly predicted which species occupied the site in 4 of the 7 cases. These results suggest only moderate performance at 57% accuracy. In other words, this independent dataset indicates that the tool only has a 57% probability of correctly predicting which species occupies a site. With additional data, the tool can be strengthened in coming years. For now, however, managers should use the tool with an understanding of its limitations and the knowledge that the only definitive way to determine whether *T. clusius* occupies a particular site is through trapping and correct field identification.

COORDINATION & TRAINING

Four field training and coordination efforts were completed by WYNDD under this project:

1. Site assessment and field training session led by Hannah Griscom with LWR Consultants in the Rawlins Field Office in August 2010. The purpose of the session was to assess habitat in the project area and train the field crew in systematic searching and identification of pocket gopher activity, trapping, and habitat data collection (LWR went on to capture 9 *T. clusius* individuals at that site).
2. A similar training session was held in September in the Rock Springs Field Office with representatives of the BLM and SWCA Environmental Consultants.
3. Site assessment and trapping was conducted by WYNDD staff in the vicinity of Oregon Buttes and Bear Creek in the Rock Springs Field Office in early October. This is an area predicted to have Wyoming pocket gopher habitat, but where none have been captured. We failed to capture *T. clusius*, but suitable habitat and tunnel widths of the correct range do occur in the area warranting additional trapping efforts in the future.
4. We also worked with the Rawlins Field Office of the BLM to delineate *T. clusius* survey sites for BLM staff to survey in 2010.

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TABLES

Table 1. Field diagnostic tool performance with the same input data used to create it. At a gopher-active site, the tool calculates the probability that site is occupied by T. clusius. Using 30% probability as the cutoff, the tool is correct in 91% of the cases. THTA = *Thomomys talpoides*; THCL = *Thomomys clusius*. Green = correctly predicted; Red = incorrectly predicted.

species captured	probability of *T. clusius* occupancy	% soil	tunnel width (mm)	% ARTR
THCL	0.993	84.375	45	0
THCL	0.985	84.375	50	0.6375
THCL	0.984	75	45	0
THCL	0.98	65.625	40	0.2125
THCL	0.97	81.25	55.4	0
THCL	0.963	78.125	55	0
THCL	0.955	68.75	50	0
THCL	0.922	60.3	49	0
THCL	0.914	87.5	70	0
THCL	0.907	59.4	50	0
THCL	0.902	84.4	69	0
THCL	0.856	81.3	50	8.8
THTA	0.85	81.3	70	0.4
THCL	0.843	50.9	45	1.8
THCL	0.835	50	49	0
THCL	0.695	59.4	63	0
THTA	0.692	41.6	50	0
THCL	0.635	65.6	70	0
THCL	0.607	81.3	50	13.9
THTA	0.533	59.4	60	3.9
THTA	0.532	49.7	60	0.9
THCL	0.52	59.1	50	8.3
THCL	0.367	50	60	3.5
THTA	0.263	56.3	69.5	3.3
THTA	0.229	46.9	50	9.3
THTA	0.225	65.6	70	6.8
THTA	0.19	62.5	60	10.9
THTA	0.153	69.7	60	14.1
THTA	0.15	56.3	60	10
THTA	0.125	60.3	40	20.6
THTA	0.122	68.8	70	10.5
THTA	0.118	42.5	53	9.7
THTA	0.118	43.4	70	2.8
THTA	0.108	56.3	80	2.9
THTA	0.094	56.3	70	7.7
THTA	0.09	31	70	0
THCL	0.078	44.7	60	9.2
THTA	0.074	29.5	70	0.3
THTA	0.07	35	75	0.2
THTA	0.064	71.9	90	5.7
THCL	0.05	47.8	88	0
THTA	0.039	49.7	74	7.6
THTA	0.034	18.4	70	0
THTA	0.019	71.9	100	6.1
THTA	0.019	63.4	80	12.1
THTA	0.017	42.5	82	5.1
THTA	0.017	68.8	100	5.7
THTA	0.015	46.9	80	7.9
THTA	0.014	40.3	70	10.2
THTA	0.013	48.8	75	11.2
THTA	0.013	44.4	90	3.4
THTA	0.011	36.3	50	18.3
THTA	0.009	30.4	65	11
THTA	0.008	0.5	60	4
THTA	0.004	68.8	100	11.3
THTA	0.003	34.1	70	14.1
THTA	0.001	27.2	100	3.7
THTA	0.001	44.7	70	23.7
THTA	0	49.8	100	13.5
THTA	0	68.8	140	7.6
THTA	0	54.1	120	12.2
THTA	0	15.9	80	35.1
THTA	0	32.6	130	21.9

Table 2. Field diagnostic tool performance with new input data from 2010 surveys. Using 30% probability as the cutoff, overall tool accuracy was 57%. THTA = *Thomomys talpoides*; THCL = *Thomomys clusius*. Green = correctly predicted; Red = incorrectly predicted.

Complex Name	Organization	Species Captured	% soil	tunnel width (mm)	% ARTR	probability of THCL occupancy
229108SW_2	BLM	THCL	53.1	50	1.7	0.79
229108SW_6	BLM	THCL	59.4	55	4.2	0.65
C30	LWR	THCL	57.2	58	3.1	0.60
C4	LWR	THCL	48.8	45	6.1	0.60
2208732NE_3	BLM	THTA	30.0	50	0.0	0.46
C17	LWR	THCL	56.3	48	12.3	0.27
229030SE_3	BLM	THCL	30.5	50	6.5	0.14

APPENDIX A : How to collect input variables for the *T. clusius* field diagnostic tool.

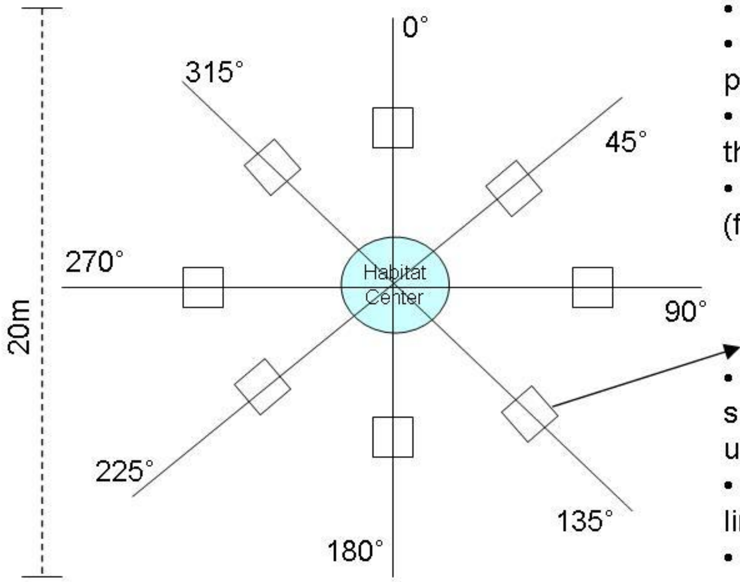
Tunnel width: Rebar or some sort of stake should be used in the vicinity of active gopher mounds in order to locate tunnels. Measurements should be taken from **at least 3 tunnels** throughout the gopher complex (usually less than 20m x 20m) and averaged for the final input width. Once a tunnel is located, use a shovel to dig a vertical cross-section to below the tunnel and, using a ruler or meter stick, measure the distance from the bottom to the top of the hole in millimeters.

% *Artemesia tridentata* cover: Four (4) line-intercept transects should be used to measure big sagebrush cover at the plot (it is not necessary to distinguish between *Artemesia tridentata* subspecies). A metric tape-measure should be used to measure 4, 20-meter-long transects that run through the habitat center in predefined directions (see diagram below). For these purposes, the 'habitat center' is the center of the freshest-looking pocket gopher mounds in the complex. Starting at either end of the transect, each *Artemesia tridentata* shrub that falls beneath the right edge of tape measure should be recorded by the number of centimeters it covers. Continue along each 20m transect until all the big sagebrush shrubs have been recorded (see below for how to deal with confusing situations). Add up all line-intercept measurements and divide by 8000 (20m x 100cm/m x 4 transects) to calculate percent *Artemesia tridentata* cover for at the site.

% bare soil cover: Bare soil is measured using 1m x 1m Daubenmire plots. In the past, we have found that 4, 1m sections of collapsible PVC pipe (with 4 joints) work well in terms of price and portability). While conducting each line-intercept transect, 2 Daubenmire plots should placed at the 5m-meter mark and the 15m-mark (see diagram below). Within the Daubenmire frame, estimate the percent cover of bare soil (excluding rocks over 1cm, litter, and all other vegetative cover). Average the percent cover between the 8 Daubenmire plots to calculate % bare soil cover for the site.

2009 WYNDD Pocket Gopher Surveys

Vegetation Plots



LINE TRANSECTS

- 4 line intercept transects
- Each is placed 45° from previous.
- Each is 20 m long, centered at the capture location.
- Only shrub cover is measured (forbs and grasses ignored).

DAUBENMIRE PLOTS

- 8, 1 m x 1 m Daubenmire subplots are used to measure understory and shrub cover.
- Placed at 5m and 15m along line intercept transects.
- Shrub, forb, grass, bare ground, mound, and rock cover (classes) are measured.

Guidelines for measuring Artemesia tridentata cover