Washington Ground Squirrel Translocation Monitoring Report 2013

Boardman Conservation Area,

Boardman, Oregon

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Introduction

In February 2013 the Oregon Department of Fish and Wildlife (ODFW) and the US Fish and Wildlife Service (FWS) translocated Washington ground squirrels (*Urocitellus washingtoni*; WGS) from property managed by Three Mile Canyon Farm to the Boardman Conservation Area (BCA) and the Bureau of Land Management Horn Butte property in Morrow County, OR (Henderson 2013). The WGS is a federal candidate species and state endangered species (ODFW 2012) that has experienced population declines and breeding range reductions due to habitat conversion and increases in human disturbance (Csuti et al. 1997). The Nature Conservancy (TNC) staff and volunteers assisted with this effort by developing release site criteria, constructing and placing release enclosures, and monitoring radio collared WGS. This report is intended to complement Henderson (2013) by providing additional information gleaned from radio collared WGS released on the BCA. Specifically we will address the following objectives to assist with and inform future decisions about WGS translocation efforts.

1) Estimate radio collared WGS survival.
2) Evaluate factors influencing the fate of an animal such as capture weight, sex, and post-release movement. We chose these factors based on prior WGS telemetry studies (Delavan 2008, Klien 2005) which demonstrated differences in movement and survival among sex and age classes.
3) Assess space-use of collared animals to better understand patterns of WGS following translocation.

Study Area

The 22,642-acre BCA is located southwest of Boardman, in northern Morrow County, Oregon, on properties owned by Threemile Canyon Farms. It is located within the Columbia Basin Section of the Columbia Plateau Ecoregion and is drained by two small tributaries, Willow Creek and Sixmile Creek, to the mainstem Columbia River. The climate in the Columbia Basin is semi-arid with hot, low precipitation summers and relatively cold winters. Average annual precipitation on the BCA ranges from approximately 9-11 inches. Southwesterly winds prevail throughout most of the year.

The BCA is part of a large block of native dominated shrub steppe and grassland habitat which has been identified as significant for conservation. Further, the BCA contains some of the best remaining grassland and shrub-steppe in the ecoregion. The BCA has high-quality occurrences of bitterbrush (*Purshia tridentata*) shrub steppe, big sagebrush (*Artemisia tridentata*) steppe, bluebunch wheatgrass (*Pseudoroegneria spicata*) grasslands and needle-and-thread (*Hesperostipa comata*) grasslands.

Methods

TNC staff, in conjunction with project partners, developed several criteria for selecting WGS release sites. These included distance from the capture site, number of potential WGS burrows present, history of WGS occupancy, and accessibility for monitoring. In order to reduce the likelihood of WGS returning to capture sites we selected release sites > 3.5 km from the nearest capture location. This distance was selected based on the maximum dispersal distances observed by Klien (2005) and as recommended by Van Vuren et al. (1997). We reviewed historic monitoring point data and selected sites with multiple years of occupancy and confirmed through field visits that release sites had > 10 suitable burrows. All selected release sites were located near access roads (primitive two-track roads) to facilitate release and monitoring efforts.

WGS were captured using live traps, weighed, sexed, aged, and outfitted with 3.7 g necklace radio collars (model M1530; Advanced Telemetry Systems, Isanti, MN) then released into pre-constructed wire enclosures containing wooden nest boxes for cover. The enclosures were intended to temporarily restrict WGS movement away from the release sites to provide an acclimation period (Finger 2012). See Henderson (2013) for an in-depth description of capture, tagging, and release methods.

Following release radio collared WGS were monitored intensively for one to two weeks in an effort to capture potential long distance dispersal events and to detect early mortalities. Following this initial period animals were located at least once per week until they were recaptured to remove collars. We searched for radio collared animals using a portable receiver (Communications Specialist, Orange CA; model R1000) and a hand-held Yagi three element antenna. To locate collared animals we started at or nearby release sites and scanned for all active collars. If a signal was heard the observer navigated to the site and attempted to observe the collared animal or signs of activity (i.e. active burrows and fresh scat). The location of the collared animal was then recorded with a hand held GPS unit (multiple brands and models were used such as Trimble Juno, (Trimble Navigation Ltd, Sunnyvale, CA) and Garmin eTrex (Garmin International, Inc. Olathe, KS)). If an animal was not detected we went to the last known location and walked circular transects spaced approximately 100 m apart while scanning for the missing animal. Transects were continued to 400 m if the animal was not detected. To detect long distance movements we also searched areas approximately 1 km^2 surrounding release sites by walking linear transects spaced approximately 100 m apart on several occasions. Additionally, we searched for missing collared animals while driving roads surrounding the release sites.

Statistical analysis

The fate of radio collared animals is not always definitive as collars can fail, be removed by the animal, or removed during a predation event. For the following analyses we assumed that all recovered collars, including those found with definitive sign, such as animal remains, bite marks, and predator scat, and those lacking such substantiation were a product of WGS mortality. However, to acknowledge this uncertainty we defined two classes of fate: live and recovered. A “live” designation indicates the radio transmitter was located and the animal displayed signs of life (i.e. movement, fresh sign, calls, visual observation, etc.). This designation was retained until a radio collar, with or without definitive signs of mortality, was located at which point the animal was reclassified as “recovered”. Please note that Henderson (2013) treated recovered collars in a different manner.

To address Objective 1 (survival) we used the Kaplan-Meier survival estimator (Kaplan and Meier 1958) in JMP (SAS Institute Inc. Cary, NC) to generate survival estimates for the study period. This method is advantageous when transmitters fail or animals are “lost” (i.e. censored) prior to the conclusion of the study (White and Garrott 1990).

To address Objective 2 (factors influencing fate) we used simple descriptive statistics and tests comparing among groups, such as the one-way Wilcoxon/Kruskal-Wallis test (rank sums), to depict the study results. We used nonparametric tests where the assumption of normality was not met. We used two measures of animal movement to evaluate the relationship between animal movement and fate. The first measure, maximum distance moved from the release site, is the linear distance from the release site to the most distant observation of the animal. The second measure, mean distance moved between weeks, depicts animal movements between observations. To calculate mean distance per week we first averaged distance moved by animal per week then we averaged all animal movements per week together. We used mean distance to account for the unequal sampling effort over the course of the study (i.e. more observations in weeks 1 and 2 than in 3-10). All statistical tests for Objective 2 were calculated using JMP 10.0.0 (SAS Institute Inc. Cary, NC), and movement calculations were performed using Geospatial Modelling Environment (Beyer 2012) and ArcGIS 10.1 (ESRI, Redlands CA).

To assess space-use of collared animals we calculated home range using the Minimum Convex Polygon (MCP) estimator. We chose the MCP for simplicity and because of the number of observations per animal was low. We acknowledge that the results of the MCP estimator are strongly influenced by the number of observations per animal (White and Garrott 1990) and therefore may produce biased home range estimates; however, it is a simple and effective method for illustrating areas of use by collared WGS. MCP was calculated using Geospatial Modeling Environment (Beyer 2012).

Results

Between February 11-21, 2013 ODFW and FWS staff and volunteers captured, collared, and translocated 20 WGS (9 female, 11 male) to three release sites on the BCA (figs.1 and 2). Distance between release sites ranged from 169 - 947 m (median = 908 m) and mass of collared animals ranged from 22-172 g (median = 130 g, IQR = 76.5-143.5, n = 20). Observation of collared animals began February 11, 2013 and concluded when WGS were recaptured to remove collars on April 25, 2013. FWS staff and volunteers conducted frequent searches for radio collared animals during weeks 1 and 2 post release resulting in 1-4 observations per animal for that period. TNC staff and volunteers in conjunction with FWS staff conducted less frequent searches in subsequent weeks resulting in 1-2 observations per animal per week. Two collared WGS were censored early in the study. Animal 78 was censored immediately after release and was never located in the field (this animal was therefore excluded from all movement analyses) and animal 3637 was located the week of release but was not located subsequently.

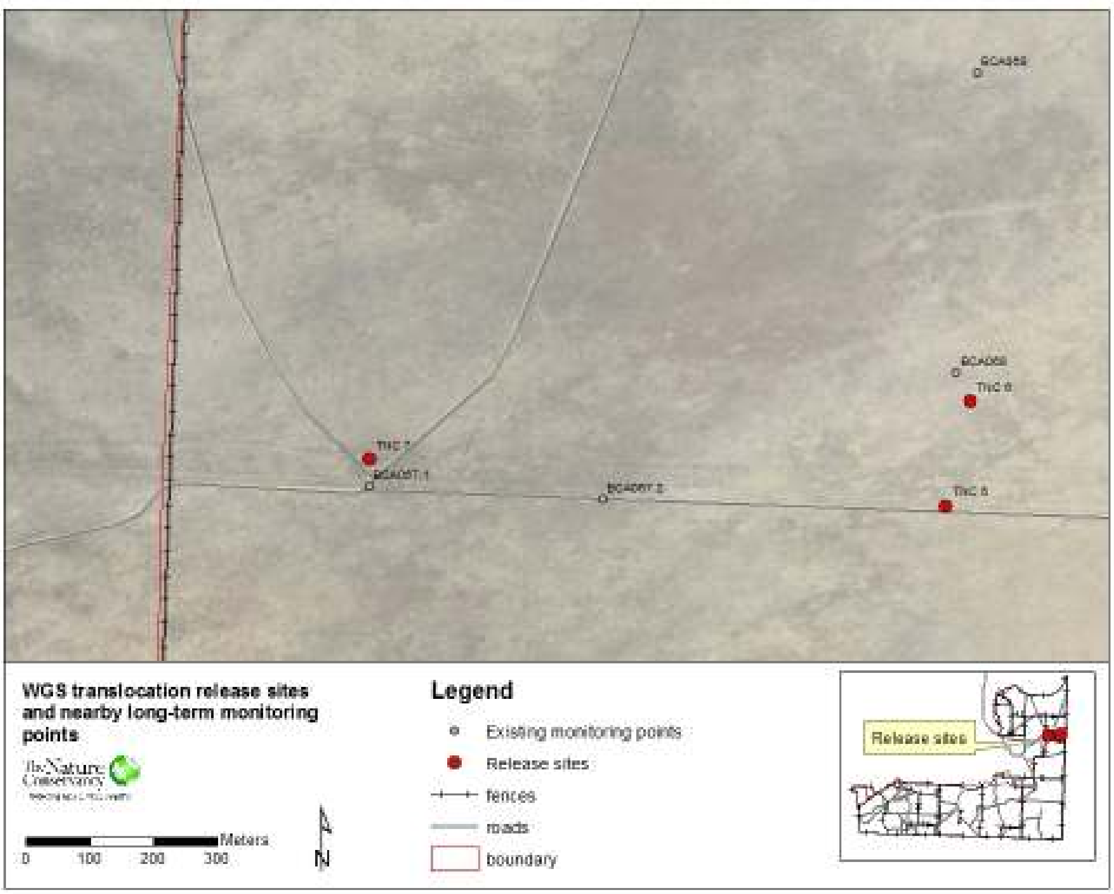

Figure 1. WGS translocation release sites on the Boardman Conservation Area, February 2013.

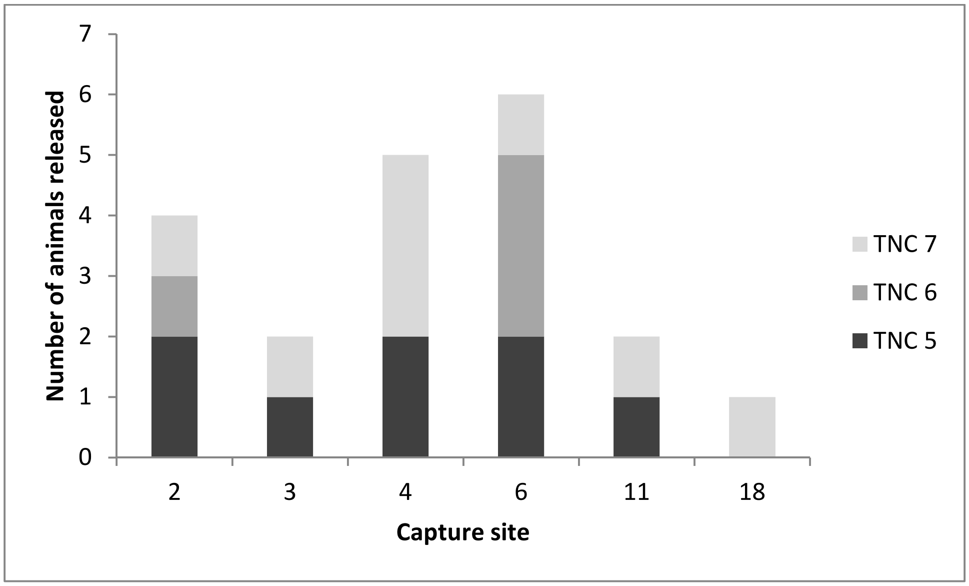

Figure 2. WGS were captured at six locations on the Radar Range (i.e. capture sites 2, 3, 4, 6, 11, and 18) and released at three locations on the BCA (i.e. TNC 5, TNC 6, and TNC 7).

Objective 1: Survival

Translocated WGS survival was low, 10 of 20 collars (50%; 3 female, 7 male) were recovered. All collar recoveries occurred early in the study (fig. 3). Survival estimates, which account for censored animals, produced similar results (44.7%, n = 20; females = 66.7% n = 9; males = 22.2% n = 11) for the study period. Survival estimates for males were lower than females, however; the low precision of the estimates, indicated by large overlapping confidence intervals, demonstrate the relationship between sex and survival is uncertain (fig. 4).

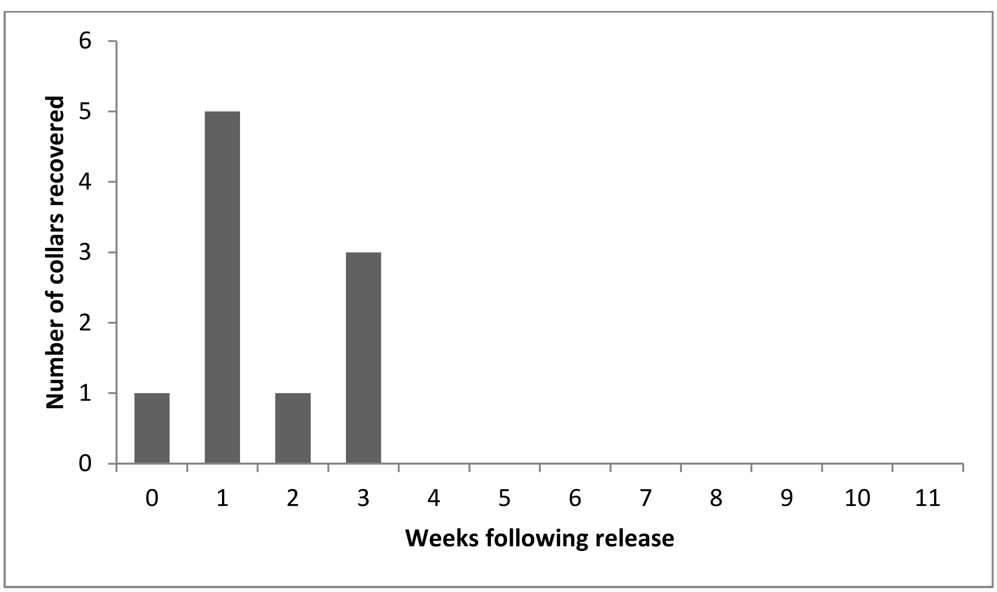

Figure 3. WGS collar recoveries occurred early in the study.

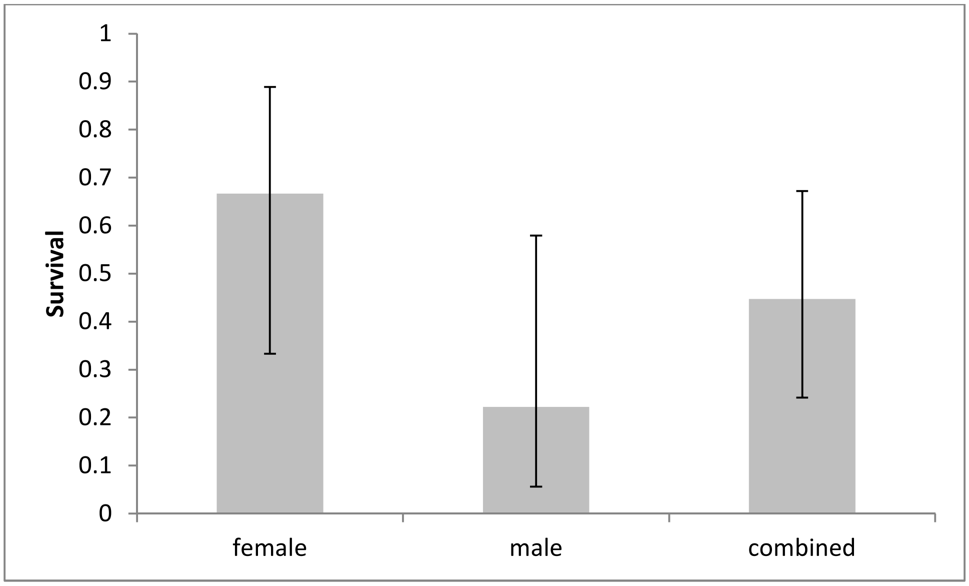

Figure 4. Survival estimates varied by sex, however, estimate precision was low and the relationship between sex and survival is uncertain (error bars represent 95% CI).

Objective 2: Fate and capture weight, sex, movement

We evaluated the relationship between ultimate fate (whether an animal was “live” or “recovered” at the end of the study) capture weight, sex and movement to better understand factors influencing translocated WGS survival.

Body mass is often used as an indicator of fitness; however, the capture weight of animals with collars which were recovered ($median_{(recovered)}$ = 126 g, IQR = 71-142.5 g, n = 10) and those alive ($median_{(live)}$ = 136 g, IQR = 110-164 g, n = 9) at the end of the study were similar (Wilcoxon/Krusjal-Wallis test H = 1.71, df = 1, P = 0.19, n = 19). Further, the fate of animals with collars which were > 5% of capture body mass (n = 5) and those with collars < 5% of body mass were also similar (n = 14; Fisher’s exact test df = 1, P = 0.58, n=19).

We evaluated the relationship between fate and movement using two measures of movement: maximum distance from release sites and mean distance moved per week. Maximum distance moved from release site was relatively low (median = 241.3 m; range 44.6-862.0 m) for all WGS (fig. 5) and similar for both sexes ($median_{(female)}$ = 241.3 m, IQR 56-380.3 m, n = 9; $median_{(male)}$ = 239.5 m, IQR = 144.8-407.3 m, n = 10; H = 0.54, df = 1, P = 0.462). The maximum observed distance moved was 862.0 m by a male WGS. Animals with recovered collars ($median_{(recovered)}$ = 154.2 m, IQR = 80.5-237.392 m, n = 10) moved shorter distances from the release site than live animals ($median_{(live)}$ = 306.9 m, IQR = 245.3-455.9 m, n = 9; H = 4.166, df = 1, P = 0.04, n = 19). Overall mean distance moved per week was small ($median_{(mean\ distance)}$ 83.1 m, IQR = 17.5-169.3 m, n = 86). However, males moved longer distances ($median_{(male)}$= 150.5 m, IQR = 58.4-242.2 m, n = 26), than females ($median_{(female)}$= 48.5 m, IQR = 15.2-144.4 m, n = 60; H = 4.8, df = 1, P = 0.0271). Additionally, animals with recovered collars ($median_{(recovered)}$= 159.7 m, IQR = 87.5-311.8 m, n = 11) moved further than live animals ($median_{(live)}$= 76.1 m, IQR = 1.37-155.9 m, n = 75; H = 6.9, df = 1, P=0.0082; fig.6)

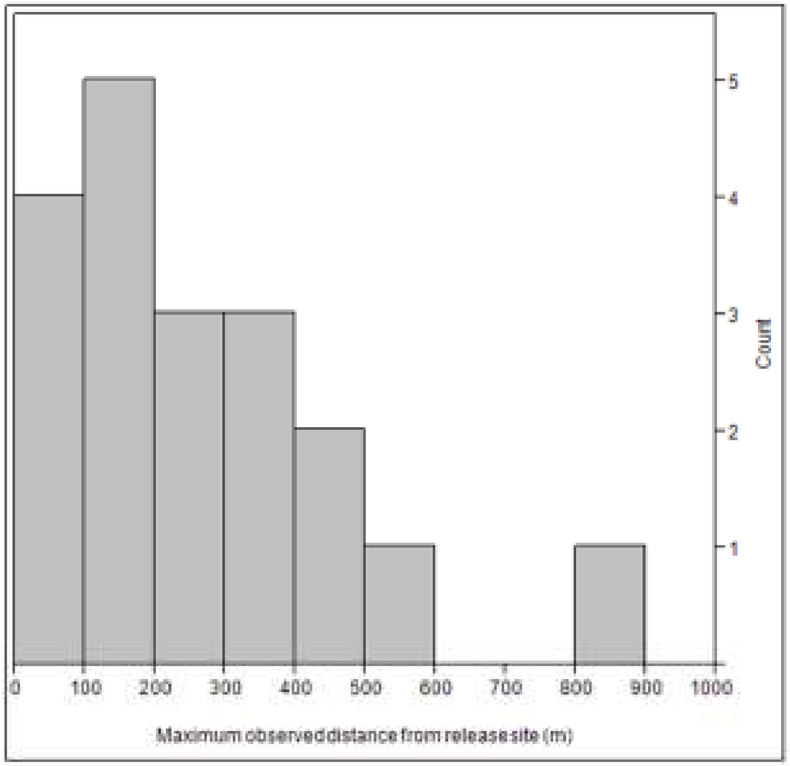

Figure 5. The maximum observed distance from release site was relatively low with most WGS moving <300 m from the release site (median = 241.3 m).

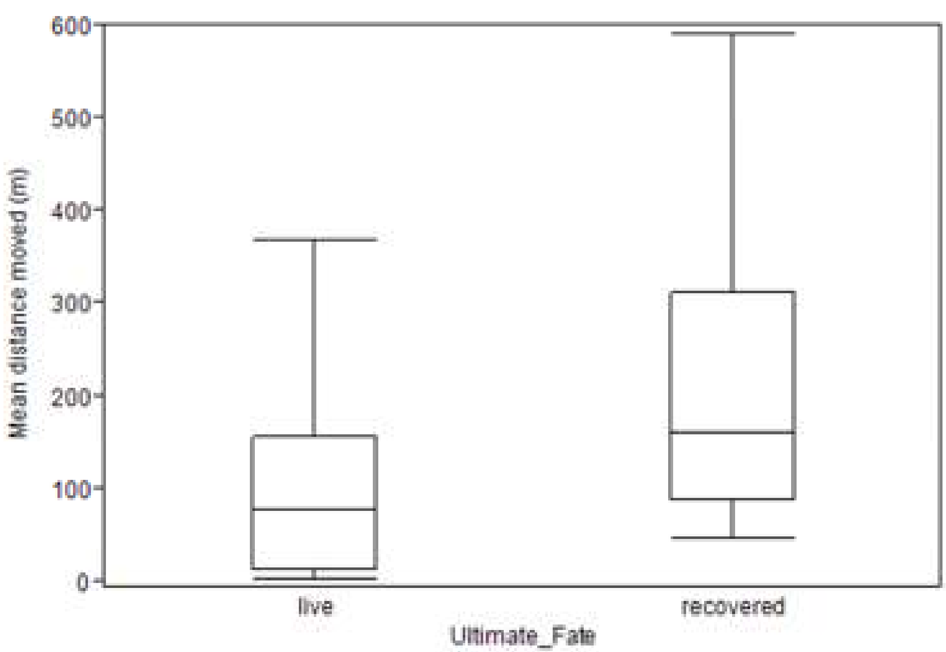

Figure 6. Boxplot representing the relationship between mean distance moved per week and the fate of WGS. (Center bar = median, edges of box = 25 and 75% quartiles, whiskers = min and max).

Objective 3: Space use by translocated WGS

To evaluate space use by tranlocated WGS we used the MCP estimator. MCP was calculated for all animals with 9 or more telemetry locations throughout the observation period (n=8 animals; table 1). We excluded release locations from home range estimates because WGS often established a home range which did not overlap the original release site. All of these animals were considered alive at the end of the observation period (i.e. none were collar recoveries). MCP varied widely from 20 m^2 to 8.8 ha (0.005 ac to 21.8 ac) and displayed a bimodal distribution with 5 animals with home ranges < 2 ha in size and 3 animals with MCP > 6 ha ($median_{(MCP)}$ = 1.1 ha, IQR = 0.16-6.99 ha).

Two animals (tag numbers 1112 and 2324) had extraordinarily small ranges (both 0.002 ha). All telemetry locations for these animals from 3/7-4/16 were obtained while the animal was in the burrow, that is, there was no visual confirmation that these animals were alive. Therefore it is unknown whether the animals were alive, dead, or collars lost underground. However, animal 1617 also had a relatively small home range (0.6 ha) and this animal was also found in the burrow during all telemetry checks from 3/7-4/16 and yet it was recaptured on 4/24 showing signs of reproduction. Further, space-use of translocated squirrels overlapped to a large degree (fig. 7). For example, the home range of animal 1112 (male) was entirely within that of animal 3133 (female) and the home ranges of animals 910 (male), 2122, 2526, and 5455 (all three female) overlapped to a large degree. All of these animals were originally captured at different trap sites which ranged from 710-3096 m apart (median = 2633 m).

Table 1. Area use ranged widely for the collared squirrels. The minimum convex polygon home range was calculated for all animals with 9 or more telemetry locations throughout the study period.

Tag Number	SEX	Telemetry Locations	MCP (ha)	MCP (ac)
910	male	17	8.8	21.8
1112	male	9	0.002	0.005
1617	female	13	0.6	1.6
2122	female	16	7.2	17.7
2324	female	15	0.002	0.005
2526	female	15	1.2	2.9
3133	female	12	1.1	2.6
5455	female	16	6.5	16.1

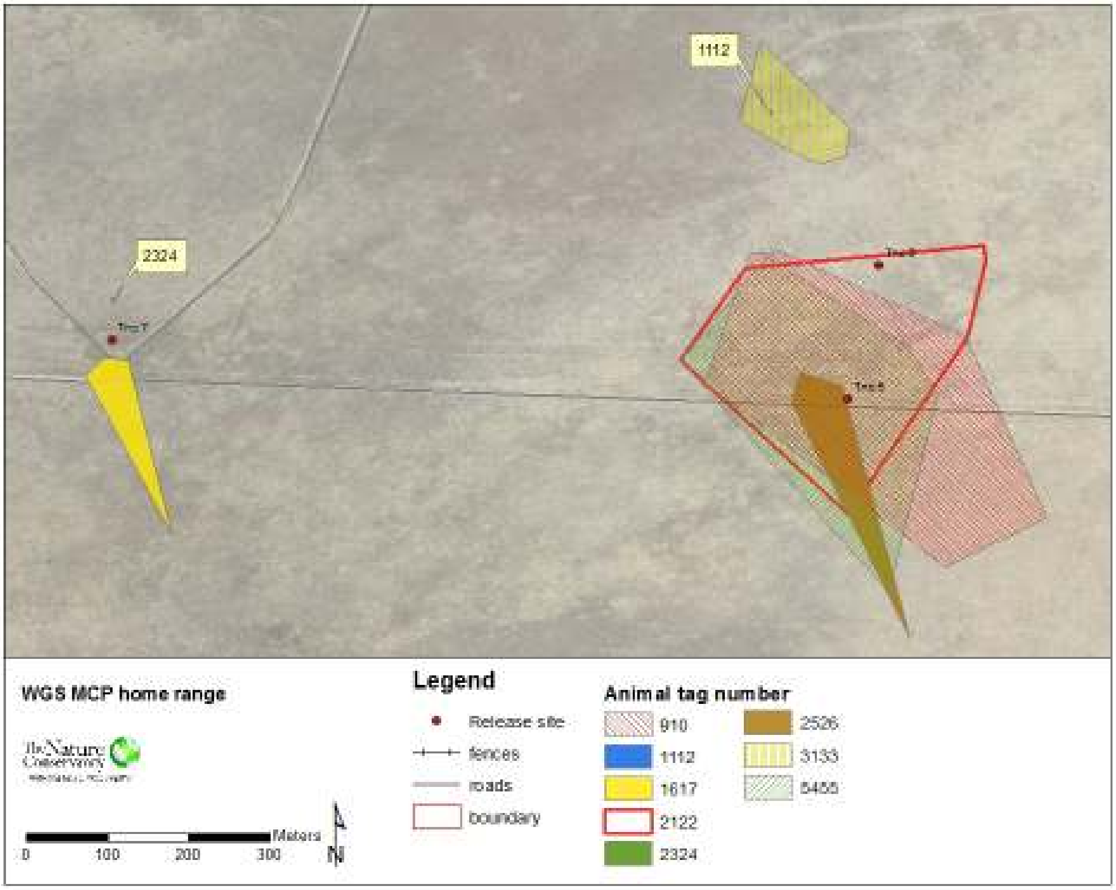

Figure 7. Minimum convex polygon home range estimates for WGS varied widely in size yet space-use often overlapped.

Discussion

The success of wildlife translocation efforts are influenced by numerous factors such as elevated stress levels in translocated animals, agonistic interactions with conspecifics, weather, habitat, and disease, which, in combination, often results in low survival rates for translocated animals (Davis 1995, Griffith et al. 1999). Survival estimates observed from this WGS translocation effort were low but comparable to estimates for other ground squirrel translocation attempts, for example, Busscher (2009) reported 44% survival for tranlocated Idaho ground squirrels (*Urocitellus brunneus*). Also, the distribution of collar recoveries through time, with most mortality occurring shortly after release, is consistent with results from California ground squirrel (*Spermophilus beecheyi*) translocation efforts (Van Vuren et al. 1997). Interestingly, survival estimates for translocated animals in this study were similar to those reported for juvenile WGS on the BCA by Klein (2005; range = 0.20 (95% CI = 0.09-0.39) - 0.56 (95% CI = 0.38 to 0.72)). Further, Klein (2005) estimated that only 36% of radio collared juvenile animals survived to hibernation. Although most mortality occurred early in this study, the short duration of the monitoring effort represents only a brief window of the WGS annual activity period. We recommend extending field observations of radio collared animals to capture the full annual activity period in future efforts.

Elevated stress levels potentially influence survival rates of translocated animals therefore minimizing stress associated with capture, handling, collaring, and release is paramount. Radio collars can adversely affect survival by decreasing animal mobility, increasing visibility, or influencing animal behavior (White and Garrott 1990, Whitney et al. 2001). Two very small WGS (22 and 30 g) were collared in this study and the collars represented 17 and 12% of body mass respectively. High radio tag weight relative to animal body mass may adversely influence animal behavior (White and Garrott 1990, Whitney et al. 2001). While this relationship is variable among taxa, general guidelines recommend transmitter weight should represent < 5–10% of the individual's body mass (Sikes et al. 2011). Most researchers strive for collar weights <5% of body mass for ground squirrels (e.g. Delavan 2008, Klien 2005, Olson and Van Horne 1998) to minimize the potential for confounding radio collar effects with natural sources of mortality. Interestingly, the 30 g animal (tag number 910) was recaptured at the end of the study weighing 179 g. However, the radio collar of the 22 g animal (tag 12) was recovered in week three of the study. Although results of this study did not show a relationship between capture weight and fate we recommend following the < 5% guideline in future radio telemetry efforts to minimize potential adverse effects.

Wildlife translocations can induce dispersal-like movements which can reduce survival in several ways including increased exposure to predation and agonistic behavior from conspecifics. In this study, movement away from the release site was low and similar to movements observed for resident animals in other studies (Delavan 2008). Including the two censored animals, which may in fact represent our inability to detect long distance movements, at least 17 of 20 animals moved <600 m from the release site. This was somewhat unexpected given the long distance movements exhibited during juvenile dispersal events (Klien 2005) and long distance movements observed in other ground squirrel translocation efforts (Van Vuren et al. 1997). Further, in contrast with predictions of dispersal-like movements reducing survival, we observed that recovered collars were found closer to release sites than animals which survived throughout the study. This may indicate focused depredation near the release sites. These observations when combined with observations of weekly movements (i.e. mean distance moved per week was greater for recovered WGS than for live animals) suggest that surviving animals moved away from the release site then moved relatively short distances per week thereafter. Van Vuren et al (1997) reported a similar pattern in translocated California ground squirrels; most surviving squirrels established home ranges and settled away from the release site. Additionally, Klien

(2005) observed higher survival rates for dispersing juvenile WGS than non-dispersers with the difference attributed to increased badger depredation at natal sites.

Animal space use can be influenced by numerous biotic and abiotic factors such as topography, climate, habitat, animal behavior, and inter and intraspecific interactions. The limited observations of this study preclude evaluation of most of these factors, yet our observations do indicate a large degree of overlap in space use and dramatic variation in home range size among individuals. The overlapping home ranges, and implied social interactions, observed in this study are consistent with observations from non-translocated populations (Delavan 2008, Sherman and Shellman Sherman 2010). Sherman and Shellman Sherman (2010) have observed female WGS cooperatively excavate and maintain burrow systems, raise pups, defend territories and warn of approaching predators. They use the term “reproductive coalitions” to describe this cooperative behavior. Retaining these coalitions among tranlocated animals by releasing them at the same location could enhance translocation success. We suggest incorporating animal “relatedness”, using proximity of capture as a surrogate, into the design and implementation of future translocation efforts.

Finally, we recommend using an experimental framework for future translocation efforts. White and Garrott (1990) summarize the rationale for using an experimental approach succinctly “cause and effect relationships can only be determined through manipulative experiments” and “wildlife tracking techniques lend themselves particularly well to manipulative experiments…” Clearly and succinctly defining translocation objectives, assumptions, and measures of success could further our knowledge of WGS biology and help refine future conservation efforts. Several factors, such as “relatedness”, release cage design (or lack of cage), survival of translocated and resident WGS, and the presence of established conspecifics at release sites, among others, could be evaluated using an experimental framework with little additional effort.

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