# Washington Ground Squirrel Monitoring Report 2013

## And Summary of Monitoring 1999-2013

Boardman Conservation Area

Boardman, Oregon


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## Introduction

The Nature Conservancy (TNC) manages the Boardman Conservation Area (BCA) to protect and restore native plant communities and associated wildlife species (Nelson 2004). The Washington ground squirrel (*Urocitellus washingtoni*; WGS) is one of four conservation target species which inform management activities on the BCA. The WGS is a federal candidate species and state endangered species (U.S. Fish and Wildlife Service (USFWS) 2010; Oregon Department of Fish and Wildlife (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 BCA and the adjacent Naval Weapons Systems Training Facility Boardman (NWSTF) constitutes the largest continuous area of occupied habitat in Oregon and perhaps throughout the entire WGS range (USFWS 2010). Together the BCA and the NWSTF support nearly 90 percent of currently known WGS sites in Oregon and approximately 29% of all known sites within the species' range (USFWS 2010).

Given the importance of the BCA and NWSTF to the WGS, numerous efforts have been made to quantify the relative abundance and distribution of WGS on these lands. The first efforts began in the mid-1990's and continue through the present. In 2003 Threemile Canyon Farm, TNC, Portland General Electric (PGE), USFWS, and ODFW signed a Multi-Species Candidate Conservation Agreement with Assurances (MSCCAA) to provide conservation measures for the WGS and several other species. The MSCCAA provides a formal framework for implementing conservation actions such as habitat management to benefit covered species. In conjunction with these management actions, the MSCCAA also established a monitoring regime to assess how the conservation commitments are affecting long-term change and ecosystem improvements. The MSCCAA dictates two monitoring schemes to assess WGS status. The first, sampling of known squirrel activity sites, must occur every one to three years to document changes in their extent and activity. The second, sampling of available WGS habitat, is to occur every two to five years to track the spatial distribution of activity sites and the creation of new sites over time. The goal of this monitoring scheme, through the combination these two approaches, is to track WGS activity site status, size, and distribution over time.

The objectives of this report are twofold: describe the results of the 2013 WGS monitoring effort and to summarize the results of the WGS monitoring efforts on the BCA from 1999-2013.

### 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**

In 2013 we sampled known WGS activity sites (also referred to as monitoring points) using the following method. We selected a simple random sample of 100 (57%) of the 176 historically occupied activity sites. At all selected sites we determined the status (i.e. occupied vs. unoccupied) and estimated the areal extent (size) of occupied sites. As in previous years, status was determined by tallying evidence: Holes = 1; Droppings = 2; Calls = 4; Visual = 8 (Marr 2004). A site is considered occupied if the total score is ≥ 3 and higher scores equal higher levels of confidence in that determination (Marr 2004). When squirrels were detected we assessed the relative size of occupied sites by estimating the area inhabited by squirrels. To accomplish this we searched the area within a 100m radius of the detection, expanding the search area as needed to capture the full extent of activity. Relative size of occupied sites was determined by measuring the length and width and multiplying them to determine area in square meters. Each site was then assigned to one of three size classes established by Marr (2004; small < 2500 $m^2$, medium ≥ 2500 $m^2$ and < 10,000 $m^2$, and large ≥ 10,000 $m^2$). Additionally, we recorded temperature and wind speed at the end of each visit using a Kestrel 2000 wind/temp meter (Nielsen-Kellerman, Boothwyn, PA). Average wind speed was recorded for 30 seconds at a height of approximately 1.2 m above ground and temperature was recorded simultaneously. Surveys were conducted in spring when squirrel activity and the likelihood of detecting their presence were both high (Morgan and Nugent 1999).

We modified the monitoring point survey protocol used in 2009 (Marr 2009) in an attempt to improve survey efficiency by reducing the search area and modifying the search pattern to improve consistency. Specifically, we reduced the search area from a 400 m radius surrounding the monitoring point to 300 m radius and we replaced bisecting transects with concentric circular transects spaced 60 m apart. We selected a search area of 300 m based on findings from telemetry space-use studies and field observations. Delavan (2008) reported mean home range lengths (the greatest distance between any two fixes within an individual animal's home range) for male Washington ground squirrels were 299 m. Additionally, within-season shifts in core area use by telemetered ground squirrels ranged from 25.5-296 m (Delavan 2008). Finally, Marr (2009) reported 96% of all detections occurred within 300m of monitoring points searched between 2000 and 2009 (a similar relationship is depicted in Fig 1 using data from 2004 - 2009). We used concentric circular transects spaced 60 m apart when initial intensive searches of the monitoring point and surrounding 30 m did not yield evidence of ground squirrel occupation. This protocol modification was implemented to provide uniform search effort over the entire 300 m search area. Circular transects were centered on the monitoring point and spaced 60 m apart using the GOTO function on the GPS unit (Trimble Navigation Ltd., Sunnyvale, CA) to maintain transect spacing. We continued transects until ground squirrels were located or the 300 m interval transect was completed. If a site was unoccupied after completing the initial visit we conducted a second visit ≥ 2 weeks later. If presence was not confirmed after the second visit the site was designated unoccupied.

Several monitoring points were less than 300 m apart. When 300 m buffer areas of two adjacent points overlapped significantly (> approximately 40%) we walked the overlapping portion(s) a single time per visit to increase efficiency. When three or more sites were located within 300 m we used linear transects, spaced 60 m apart, to cover the entire amalgamated 300 m buffer area of all the points to increase search efficiency and reduce redundancy.

In an effort to reduce observer bias only two observers completed all site visits. Prior to implementing surveys each observer visited known occupied WGS sites, observed active burrows, scat, and heard squirrel calls to help acquire a search image. Additionally, several surveys were conducted with both observers to ensure they fully understood the survey protocol and field procedures. After this initial training period surveys were conducted independently.

In addition to reporting 2013 survey results we also reviewed results from prior years to provide an overview of WGS status on the BCA. Historic monitoring data (i.e. pre 2013) presented in this report was collected and assembled by Verne Marr for TNC. There have been several changes to field protocols over the life span of the WGS monitoring effort on the BCA (Table 1). Changes include sampling methodology (i.e. selecting a random sample of activity sites verses surveying nearly all sites each year), search area (a 400 m search area was used initially which was reduced to a 300 m search area in 2013) and search pattern (bisecting transects were used initially and concentric circular transects were adopted in 2013). Prior to 2009 nearly all WGS activity sites were visited each year monitoring was conducted (Table 1). During this period many new WGS activity sites were discovered in the course of field surveys. These new sites (all of which were occupied) were often included in the monitoring results for the year they were discovered. While this practice is understandable, it may inflate estimates of occupancy. To account for this potential source of bias we excluded results for sites discovered and included in monitoring results in the same survey season. For example, if a new WGS activity site was discovered in 2004 we excluded it from the 2004 estimates of occupancy to avoid overestimating the proportion of occupied sites as all new sites have a status of "occupied". However, we did not account for the other survey protocol changes and we acknowledge that these changes likely reduce the precision of occupancy estimates and comparability among years. We used JMP (SAS Institute Inc. Cary, NC) to calculate all summary statistics.

## Results

In 2013 we conducted field surveys from February 27$^{th}$ through May 23$^{rd}$. Initial visits (n = 100) were completed between February 27$^{th}$ and May 1$^{st}$. Due to overlapping search areas we surveyed 4 clusters of monitoring points using linear transects, spaced 60m apart, covering the entire amalgamated 300m buffer areas (fig. 2) rather than using concentric circular transects. This increased search efficiency and reduce redundancy. Detections were assigned to the nearest monitoring point. Environmental conditions during initial visits ranged widely, wind 1.4 – 27.7 km/hr and temperature 5 – 26 C. Winds exceeded 20 km/hr during surveys at 5 sites. We detected WGS at 31 sites (31% of sampled sites) during initial visits. Follow-up visits were completed at 69 monitoring points from May 2$^{nd}$ through May 23$^{rd}$ and environmental conditions were less variable; wind speed ranged from 0 – 18 km/hr and temperature ranged from 13 – 34 C, however, temperature and wind were not measured at 29 sites due to the lack of equipment for a second observer. We detected WGS at 9 additional sites during follow-up visits, resulting in 40 total active WGS sites (proportion occupied = 0.40, 95% CI = 0.30 to 0.50; n = 100). WGS detections were distributed throughout the BCA (fig. 2) and throughout the 300 m radius search area (fig. 3; median = 150.5 m, IQR 69.8 – 240 m; n = 40). Most occupied WGS activity sites were small or medium size (i.e. < 2500 m$^2$, ≥ 2500 m$^2$ and < 10,000 m$^2$ respectively, 93%, n = 37; fig. 4) with few large sites (i.e. ≥ 10,000 m$^2$, 7%, n=3). To provide a larger context for these results we reviewed and summarized results of prior monitoring surveys on the BCA.

Efforts to identify the distribution of WGS on the BCA began with extensive transect surveys in 1999 and 2001 (Table 1). From these initial surveys WGS activity sites were identified and used as the basis for subsequent occupancy monitoring efforts. Five systematic occupancy surveys were completed, occurring every 1-4 years, following the 2001 completion of distribution surveys. A pilot study to assess the efficacy of a Distance sampling strategy to assess WGS distribution outside of known activity sites was also conducted in 2009. Sampling and field methods used to assess occupancy were changed in two significant ways since surveys were initiated. In 2009 the sampling protocol was changed from a complete census (or nearly so) of WGS activity sites to a random sample of sites (a random sample was also used in 2013; Table 1). In 2013 we modified the search pattern and search area radius from a bisecting transect pattern and a 400m search radius to a concentric circular transect pattern with a 300m search radius. We implemented these changes based on recommendations from prior surveys and to increase search consistency and efficiency. These changes may increase estimate variability among surveys. Occupancy estimates ranged from a low of 0.29 (29%, 95% CI 0.21 – 0.37, n = 117) in 2009 to a high of 0.88 (88%, n = 139) in 2006 (fig. 5). Size of WGS activity sites changed dramatically throughout this time period as well (figs. 4 and 6). The proportion of occupied WGS sites and the proportion within each size category are closely associated. For example, the proportion of large activity sites increased as occupancy increased and conversely, the proportion of small sites declined as occupancy increased (fig. 6).

WGS detections are based on three factors – burrows with scat, calls, and visual observations. We used the scoring system devised by Marr (2004) to estimate the number of detections which were based on the observation of scat and burrows (final score = 3), call detections (scores 4-7), and visual detections (scores 8-15; fig. 7). A total of 468 WGS detections occurred during occupancy surveys (2004-2006, 2009, and 2013). Most of these detections were based on observation of scat and burrows (48.7%, n = 228) and call detections (31.4 %, n = 147) with relatively few visual observations (19.9%, n = 93). However, this relationship was somewhat variable across years (fig. 7).

Finally, the 2009 pilot study to assess the use of Distance sampling techniques to detect “new” WGS sites produced limited results. They tested two methods, point counts and transects. Point counts produced no new detections and transects produced only 7 detections (100.3 km of transect, 0.07 detections / km).

## Discussion

The results of WGS activity site monitoring surveys conducted on the BCA between 2004 -2013 indicate high occupancy (and numerous “large” WGS sites) during the initial 3 years of surveys. This was followed by a dramatic decline in occupancy (and a corresponding decline in the number of “large” sites) in 2009 and continued low levels in 2013. Unfortunately, the cause of the decline is unknown and potentially attributable to a number of factors, or combinations of factors, including environmental conditions, predation, dispersal and movement, and stochastic events. One danger of using a sampling scheme based on visiting historic sites, particularly in a large contiguous grassland with few apparent barriers to dispersal, is that it does not account for animal movements and it is therefore likely to result in the appearance of a decline because animal movement is confounded with demographic changes. Surveys of areas outside of monitoring points are necessary to more accurately assess population changes and patterns of landscape level use. The pilot study conducted in 2009 to search for WGS outside of known sites produced few detections. These results suggest, in the context of low occupancy estimates from known activity site visits and few “large” activity sites, that WGS abundance on the BCA was low (Marr 2009). This trend continued in 2013, however, we did not search for WGS outside of known sites.

Given the close association between occupancy rate and activity site size, these measures may be indicative of WGS relative abundance when used in combination. Site size is thought to be indicative of the number of animals at each site and occupancy is assumed to be representative of the number of active sites on the BCA. However, these assumptions have not been tested so conclusions based on these assumptions are speculative and potentially deceptive. For instance, Van Horne et al. (1997), investigating the relationship between burrow counts and abundance of Townsend's ground squirrels (*Urocitellus townsendii*) determined that burrow counts were poor indicators of squirrel numbers. Additionally, assessing the size of an occupied monitoring point is complicated by the cryptic nature of WGS and by the propensity of these animals to move about and among activity centers within a season (Delavan 2008). Further, the size classes used have little or no biological basis. Individual animals often use several core areas within their home range and home range sizes often exceed 10,000 $m^2$ (Delavan 2008), the criteria for the largest size category. Therefore a thorough evaluation of the relationships between site size and the number of squirrels occupying a site is warranted and may shed light on the utility of this measure.

Other aspects of the field method which merit scrutiny are detection type and probability. Burrows with scat, calls, and visual observations of animals are the three accepted factors used to confirm the presence of WGS. Burrow and scat detections made up nearly half of all detections and, importantly, call detections made up only approximately 30% of detections for all survey years combined. This is significant because field survey methods, such as transect spacing and environmental condition requirements necessary to complete surveys, are based on the ability to detect audio calls (Greene 1999, Morgan and Nugent 1999). Our data indicate that although call detections are clearly important, they are not the primary method of detecting WGS on the BCA. Revising survey protocols to reflect this information may increase detection probabilities; however, surveys based on burrow and scat detection are also likely to increase survey effort. One limitation of the scoring method used to assign detections to type (i.e. scat, calls, and visual) is that they are not necessarily indicative of the initial detection type. For instance, an observer may find a burrow with scat then subsequently hear a call and finally see the animal. In this example the detection would be classified as a visual observation – the highest level of evidence to support occupancy. Therefore, using this classification scheme to estimate the relative importance of a detection type likely overestimates the number of detections based on both calls and visual observations while underestimating the number of detections based on burrows and scat. We intend to record initial detection types (i.e., scat, audio, visual) and habitat types (i.e., annual grass, bunch grass, and shrub) in future monitoring efforts. Further, we also intend to implement a pilot study in the spring of 2014 to assess the utility and effectiveness of trained scent-dogs in locating WGS scat.

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Van Horne, B., R.L. Schooley, S.T. Knick, G.S. Olson, and K.P. Burnham. 1997. Use of burrow entrances to indicate densities of Townsend's ground squirrels. Journal of Wildlife Management 61:92-101.

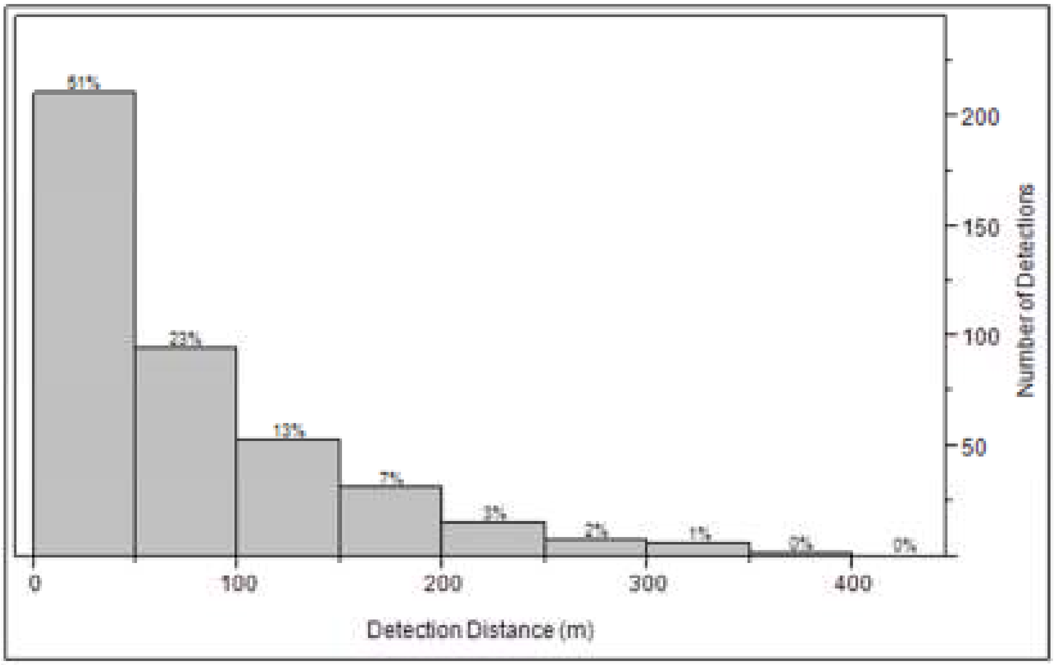


Figure 1. WGS detections diminished rapidly with increasing distance from the monitoring point. This figure includes data from the BCA for the years 2004, 2005, 2006, and 2009 as reported by Marr in a comprehensive database assembled for TNC. The median detection distance was 49 m from the monitoring point (IQR 17 – 103 m; n = 415).

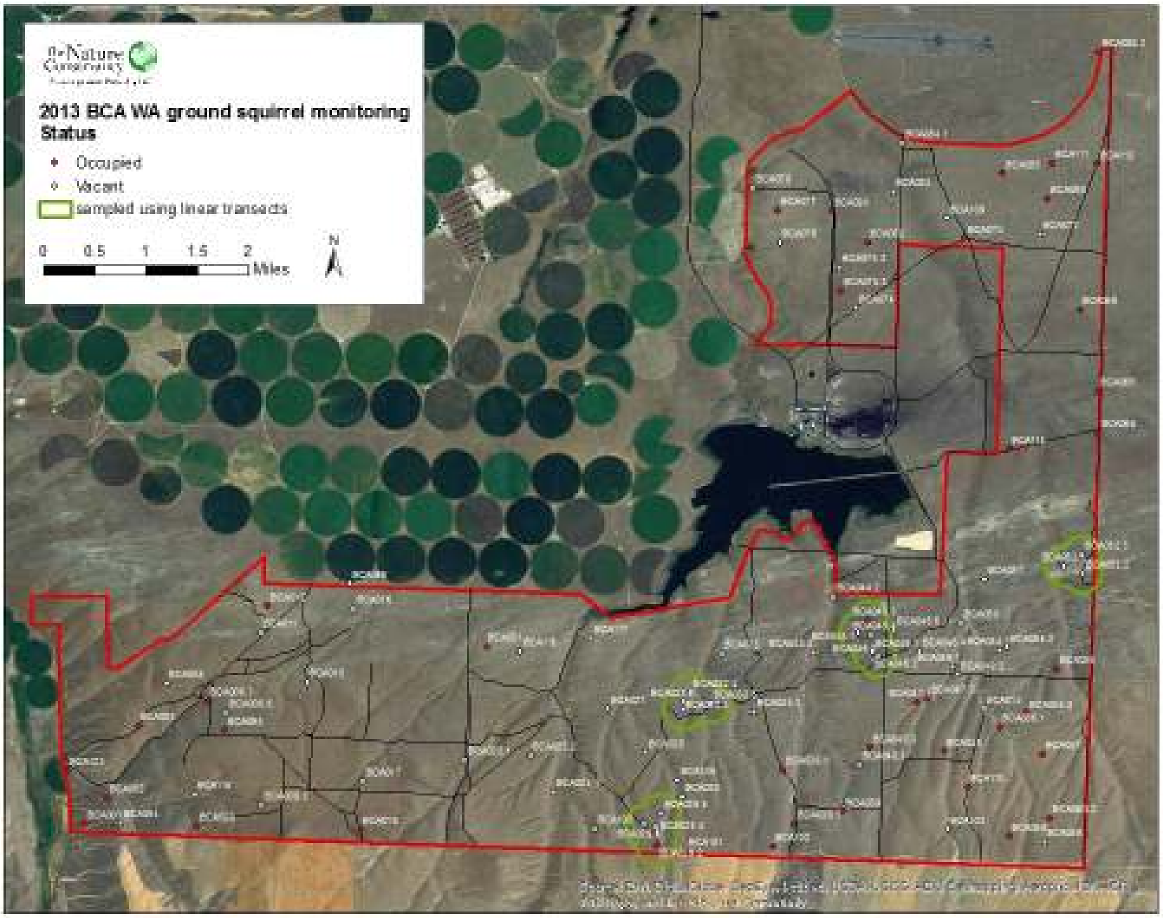


Figure 2. Randomly selected WGS monitoring sites by status (i.e. occupied / unoccupied) 2013. The green lines encircling four clusters of points represent the amalgamated outlines of overlapping 300 m buffers. To increase search efficiency and to reduce redundancy we used linear rather than circular transects at these locations.

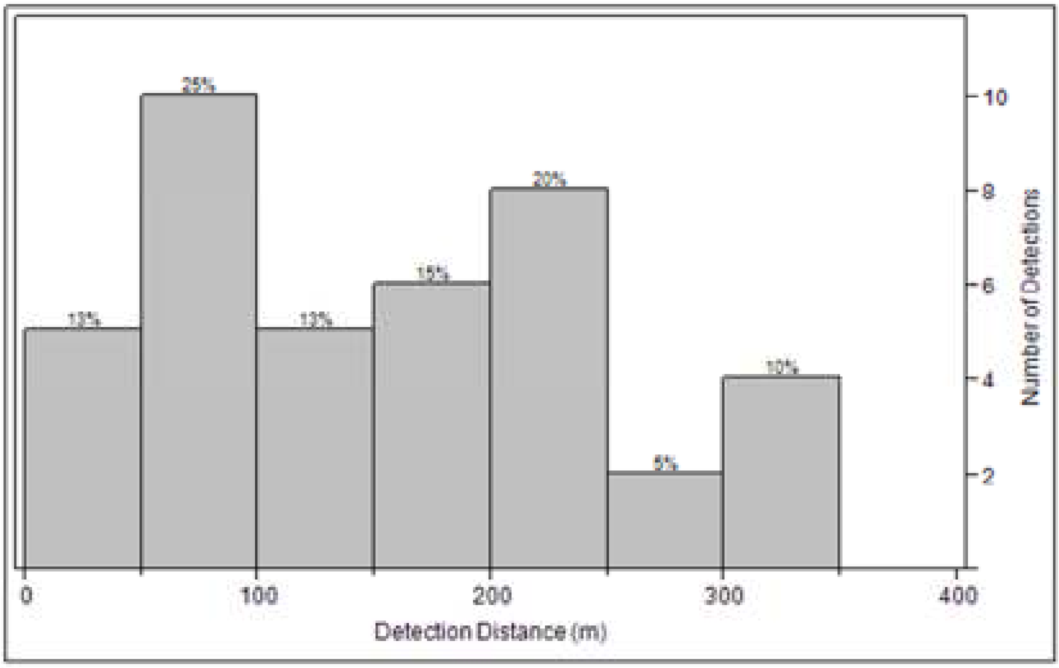


Figure 3. In 2013 we detected squirrels throughout the 300 m radius search area (median = 150.5 m, IQR 69.8 – 240 m; n = 40).

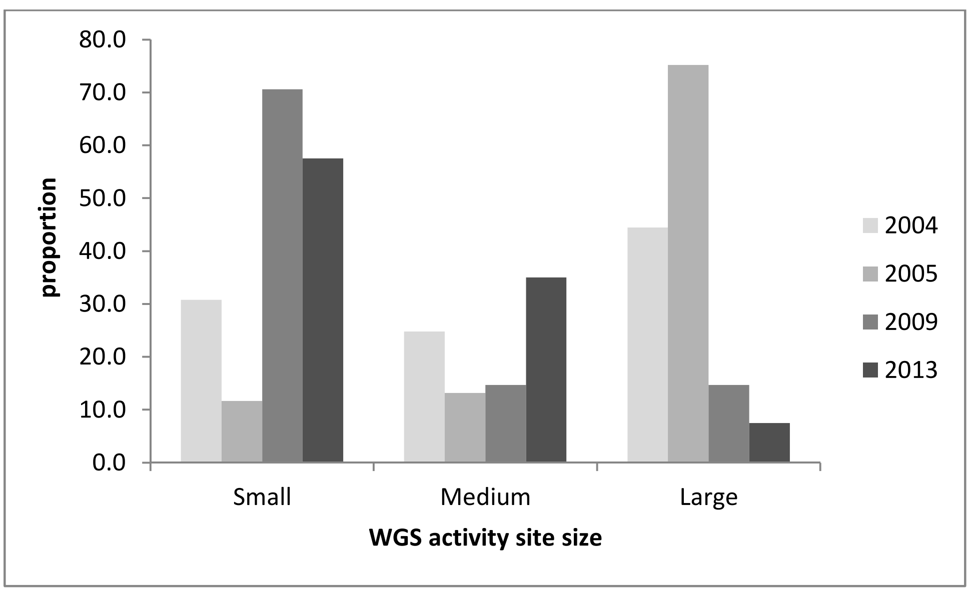


Figure 4. Size of WGS activity sites varied widely among surveys on the BCA with the proportion of small sites increasing through time and the proportion of large sites decreasing. Note: size was not determined for most sites in 2006 and therefore excluded from this figure.

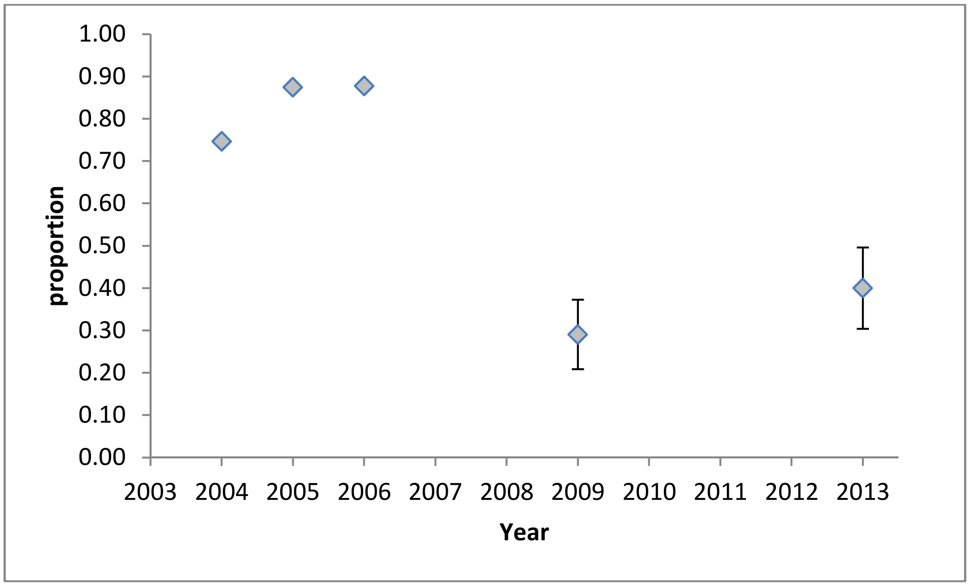


Figure 5. Washington ground squirrel monitoring point occupancy estimates generated from systematic surveys on the BCA varied widely from 2004-2013. Estimates from 2004-2006 were generated by visiting nearly all sites (i.e. censuses) whereas estimates for 2009 and 2013 were random samples (we report 95% CI for samples only).

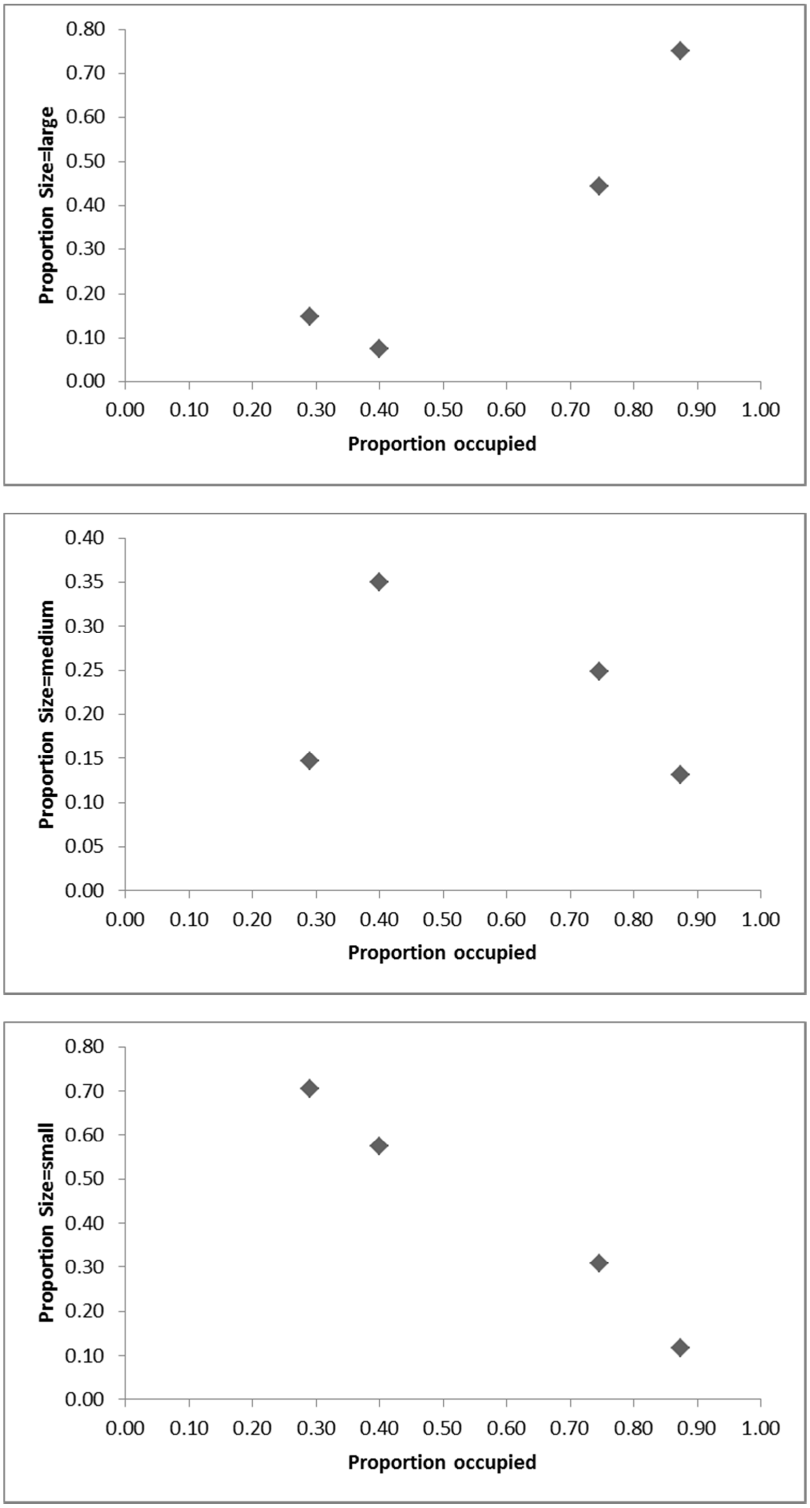


Figure 6. WGS activity site occupancy and size appear to be closely associated. For example, the proportion of large sites increased with occupancy rates. This figure represents data from four years of monitoring surveys, 2004, 2005, 2009, and 2013. Activity site size was not reported for most sites visited in 2006 and therefore excluded.

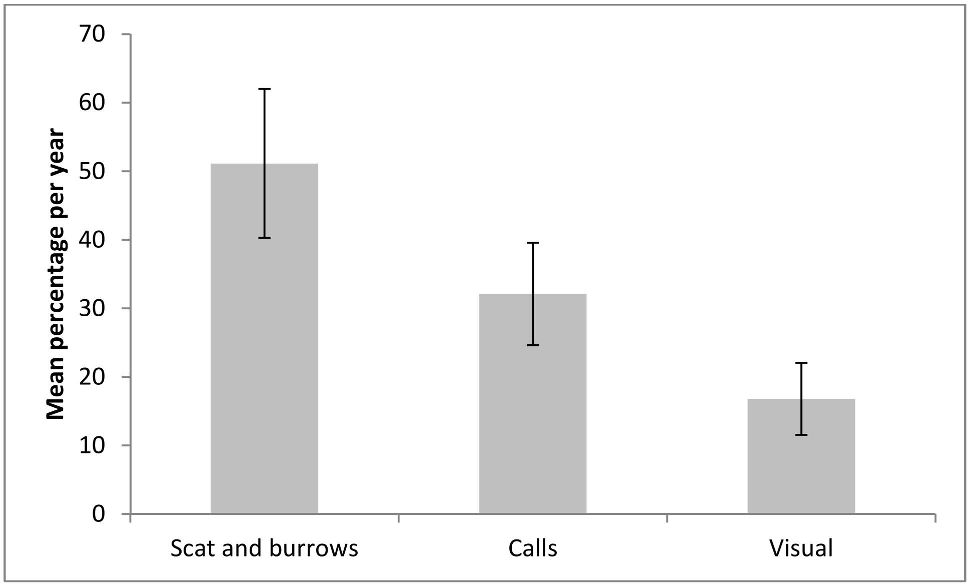


Figure 7. Most WGS detections on the BCA were based on observation of scat and burrows or audible calls while visual observations were relatively infrequent (mean detections by category per year +/- SE, n = 5 years).

Table 1. Summary of WGS monitoring conducted on the BCA from 1999 - 2013.

| Year | Survey dates | Purpose | Method | Sites visited | Established sites | Occupancy(%) excluding sites found year of survey | Reference |
|---|---|---|---|---|---|---|---|
| 1999 | 4/12/1999 - 6/11/1999 | Map the distribution of squirrel sites in the southern tier of the BCA (south of reservoir) | Initial surveys to located squirrel sites - quarter section search areas, linear transects spaced 60m apart, 2 visits for unoccupied quarter sections | 104 | 104 | NA | Morgan, R. L., and M. Nugent. 1999. Status and habitat use of the Washington ground squirrel Spermophilus washingtoni on State of Oregon lands, South Boeing, Oregon in 1999. Oregon Department of Fish and Wildlife. |
| 2001 | 3/5/2001 - 5/30/2001 | Map the distribution of squirrel sites in the northeastern portion of the BCA (Railroad, North and South Boeing pastures) | Initial surveys to located squirrel sites - quarter section search areas, linear transects spaced 60m apart, 2 visits for unoccupied quarter sections | 25 | 129 | NA | reported in dataset provided by Vern Marr |
| 2003 | 2/19/2003 - 6/3/2003 | Incidental observations | Incidental observations -no established protocol | 23 | 141 | NA | reported in dataset provided by Vern Marr |
| 2004 | 2/4/2004 - 4/17/2004 | Monitor established squirrel sites | Survey of established monitoring points, 400 m bisecting transects, 2 visits for unoccupied sites | 155 | 158 | 75 | Marr, V., 2004. Washington ground squirrel monitoring Boardman Conservation Area 2004. The Nature Conservancy. |
| 2005 | 3/25/2005 - 5/27/2005 | Monitor established squirrel sites | Survey of established monitoring points, 400 m bisecting transects, 2 visits for unoccupied sites | 160 | 167 | 87 | Marr, V., and D. Stumbaugh. 2005. Washington ground squirrel monitoring Boardman Conservation Area and NWSTF, Morrow County Oregon 2005. The Nature Conservancy. |
| 2006 | 2/7/2006 - 5/5/2006 | Monitor established squirrel sites | Survey of established monitoring points, 400 m bisecting transects, 2 visits for unoccupied sites | 148 | 176 | 88 | reported in dataset provided by Vern Marr |
| 2009 | 3/12/2009 - 5/10/2009 | Sample distribution of squirrel sites outside of established monitoring points and monitor established sites | Point and transect distance sampling for new sites; stratified random sample for established monitoring points - 400m radius bisecting transects, 2 visits for unoccupied sites | 117 | 176 | 29 | Marr, V., 2009. Washington ground squirrel monitoring, Boardman Conservation Area 2009: Distance sampling pilot project and monitoring point sampling. The Nature Conservancy. |
| 2013 | 2/27/2013 - 5/23/2013 | Monitor established squirrel sites | Simple random sample of established monitoring points - concentric circular transects spaces 60m apart out to 300m, 2 visits for unoccupied sites | 100 | 176 | 40 | Rosier, J. 2013. Washington ground squirrel monitoring, Boardman Conservation Area 2013. The Nature Conservancy. |