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# Washington Ground Squirrel Surveys in Adams, Douglas, and Grant Counties, Washington, 2004

by Rich Finger, Gary J. Wiles, Jim Tabor, and Eric Cummins

Washington Department of
FISH AND WILDLIFE
Wildlife Program

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*Cover photos by Jodie Delavan (squirrel) and Rich Finger (background).*

# Washington Ground Squirrel Surveys in Adams, Douglas, and Grant Counties, Washington, 2004

## Final Report

June 2007

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## EXECUTIVE SUMMARY

The Washington ground squirrel (*Spermophilus washingtoni*) occurs in grassland and shrubland habitats of the Columbia Plateau east and south of the Columbia River in Washington and Oregon. Though it is a federal candidate for listing as threatened or endangered under the U.S. Endangered Species Act, relatively little knowledge concerning the species exists for Washington.

In its Heritage database, the Washington Department of Fish and Wildlife (WDFW) maintains a listing of Washington ground squirrel locations in the state dating back to 1941. We surveyed ground squirrel sites identified in this database for Adams, Douglas, and Grant counties, Washington, to (1) confirm species presence, (2) describe the geographic extent of active sites, (3) estimate burrow abundance at active sites, and (4) document predator activity. Our primary goal was to determine the activity status of as many historical Washington ground squirrel sites as possible to update the Heritage database and to prepare for predictive modeling of the species' occurrence using a Geographic Information System.

We surveyed a total of 303 Washington ground squirrel sites from late March to early June 2004 and confirmed occupancy at 218 of 247 (88%) sites that were classified as occupied during surveys conducted from 2001-2003. Occupancy rates for subregions of Washington ground squirrel sites typically exceeded 85%. However, the Seep Lakes Area in Grant County, the Hatton Area in Adams County, and the Foster Coulee Area in Douglas County each showed declines of ≥35% in occupancy rates from 2001-2003 to 2004. The reduction in the Seep Lakes Area exceeded the findings of Dr. Paul Sherman, who observed a 17% decline in active sites in this area from 1999 to 2001. The Black Rock Coulee and Sagebrush Flats Areas in Grant County experienced 15% and 11% declines in active sites from 2001-2003 to 2004, respectively. Nine previously undocumented sites were discovered in 2004.

Most (67.5%, n = 156) active Washington ground squirrel sites in 2004 were characterized by small estimates of burrow numbers (i.e., 1-50 burrows), with 17.7% (n = 41) of sites containing an estimated 51-100 burrows, 14.3% of sites (n = 33) having >100 burrows, and 0.4% (n = 1) of sites having an undetermined number of burrows. Areas predominated by small sites were the Foster Coulee, Duffy Creek, Saddle Mountains, Beezley Hills, and Sagebrush Flats Areas, whereas the Warden, Moses Coulee, Lind, Soap Lake, and Seep Lakes Areas contained relatively more large sites. The Warden Area had by far the largest mean estimate of burrow numbers per site, followed by the Moses Coulee, Soap Lake, and Smyrna Bench Areas. Thirty-one (93.9%) of 33 large sites occurred in Grant County, with the greatest number (n = 10) present in the Moses Coulee Area. Eighty-six (37.2%) of the 231 active sites occurred on federal land, 69 (29.9%) were on private land, 37 (16.0%) were on Nature Conservancy land, 37 (16.0%) were on WDFW and other state land, and 2 (0.9%) were on local school district land.

Biases in counting burrows and documenting sites means that some of our findings should be interpreted with caution. We identified eight areas (Seep Lakes, Hatton, Foster Coulee, Soap Lake, Warden, Ritzville, Lind, and Duffy Creek) where conservation concerns may be greatest for Washington ground squirrels. Recommendations for improved survey methodologies are provided for future work.

## ACKNOWLEDGMENTS

A grant from the Washington State Department of Transportation funded this project. We express our gratitude to the individuals who assisted with this project. We thank Steve Germaine, Harriet Allen, and Derek Stinson for providing comments on previous drafts of the report. We thank Jennifer Brookshier, Raj Deol, Joel Cappello, and Tom Owens (WDFW) for providing data sheets, database support, and/or map support. We thank Randy Hill (U.S. Fish and Wildlife Service), John Musser (Bureau of Land Management), Steve Wetzel (Department of Natural Resources), and Chuck Warner (The Nature Conservancy) for offering information, advice, and property access during surveys. John Cotton (WDFW) assisted with private land contacts. Beau Patterson (WDFW), Neal Hedges (Bureau of Land Management), Pascal Bolduc (Friehe Farms), and Cedar Charnley (Evergreen State College) provided tips on new Washington ground squirrel sites. Paul Sherman (Cornell University), Eric Yensen (Albertson College), Jeff Bernatowicz (WDFW), and Steve Goodman (Arizona Game and Fish Department) shared their knowledge and expertise about behavioral ecology, forage preference, and translocations. We thank Matt Vander Haegen (WDFW) for contributing the Landsat Thematic Mapper image.

## INTRODUCTION

### Description, Range, and Habitat

The Washington ground squirrel (*Spermophilus washingtoni*) is a small ground squirrel occurring in grassland and shrubland habitats of the Columbia Plateau east and south of the Columbia River in Washington and Oregon (Howell 1938, Betts 1990). Oregon populations appear to be limited to Boeing Lease Lands, the Boardman Naval Weapons Systems Training Facility, Bureau of Land Management lands at Horn Butte, and The Nature Conservancy's Lindsay Prairie (Morgan and Nugent 1999, Morgan 2002). Historic locations with populations in Washington occur in Grant (52% of recorded sites), Adams (18%), Douglas (17%), Franklin (7%), Walla Walla (4%), Lincoln (3%), Columbia (1%), and Whitman (<1%) counties (WDFW Heritage database 1941-2003). Recent sites in Washington are primarily concentrated in Adams, Douglas, and Grant counties (Goodman and Cummins 2003).

Washington ground squirrels are most common in shrub-steppe habitats over silty loam soils, particularly Warden (Rickart and Yensen 1991, Greene 1999, Marr 2001) and Sagehill soils (Morgan and Nugent 1999, Marr 2001, Morgan 2002). Vegetation preferences of the species are not fully understood, but other *Spermophilus* are usually food-limited, requiring high quality vegetation and seeds (Yensen and Sherman 2003, Tarifa and Yensen 2004). Recent research on Washington ground squirrels indicates high use of bluegrass (*Poa* sp.) in mid-season followed by a late season diet of forbs (vegetative matter and seeds) and grass seed (Tarifa and Yensen 2004).

### Habitat Loss and Range Contraction

Loss of habitat as a result of conversion of shrub-steppe to cropland may have been the greatest negative factor affecting the Washington ground squirrel population to date (Carlson et al. 1980, Betts 1990, 1999, Yensen and Sherman 2003). The Columbia Basin Irrigation Project, which resulted in the irrigation of about 220,000 ha (550,000 acres) of arid land for crop production (Shepherd 2002), is responsible for much of the habitat loss in the squirrel's range in Washington. Agricultural development has focused on the arable, deep soil communities (Vander Haegen et al. 2001) preferred by Washington ground squirrels (Betts 1990), but the species is unable to persist in soils that are regularly cultivated (i.e., once or twice per year). Betts (1990, 1999) estimated that nearly two-thirds of the species' historic range has been converted to agriculture.

Washington ground squirrel population estimates do not exist for Washington, but peripheral range contractions have been reported for every decade since the 1970s (Table 1) and presumably reflect a declining population trend.

### Predators and Disease

In the Seep Lakes area of Grant County, Sherman (1999, 2000, 2001) witnessed northern harriers (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*B. regalis*), prairie falcons (*Falco mexicanus*), badgers (*Taxidea taxus*), and long-tailed weasels (*Mustela frenata*)

Table 1. Peripheral range contractions reported for Washington ground squirrels since 1979.

| | 1979[a] | 1987-1989[b] | 1998[c] | 2002[d] |
|---|---|---|---|---|
| Northern extent | | ✓ | ✓ | |
| Southern extent | ✓ | | ✓ | ✓ |
| Eastern extent | ✓ | | | ✓ |

[a] Carlson et al. (1980)
[b] Betts (1990)
[c] Betts (1999)
[d] Goodman and Cummins (2003)

actively hunting at Washington ground squirrel sites. Other potential predators of Washington ground squirrels include coyotes (*Canis latrans*), mink (*M. vison*), striped skunks (*Mephitis mephitis*), Swainson's hawks (*B. swainsoni*), bald eagles (*Haliaeetus leucocephalus*), great horned owls (*Bubo virginianus*), black-billed magpies (*Pica hudsonia*), common ravens (*Corvus corax*), western rattlesnakes (*Crotalus viridis*), and gopher snakes (*Pituophis melanoleucus*), which feed on other species of ground squirrels (Streubel and Fitzgerald 1978, Michener and Koeppl 1985, Elliot and Flinders 1991).

Little is known about disease in Washington ground squirrels. Sylvatic plague and tularemia have been reported in Piute ground squirrels (*S. mollis*; Rickart 1987) and plague has been reported in Columbian ground squirrels (*S. columbianus*; Elliot and Flinders 1991). These diseases have not been confirmed in Washington ground squirrels, but Sherman (2000, 2001) reported that every ground squirrel he captured during 2000 and 2001 harbored fleas, which are the vector for plague.

Grazing and Agricultural Damage

Though cattle compete with Washington ground squirrels for vegetative food (particularly *Poa* and *Lupinus*), moderate grazing appears to be compatible with Washington ground squirrel occurrence (Greene 1999) if the level of competition for preferred vegetation is not too high (Tarifa and Yensen 2004). In fact, grazing reduces vegetation height, which appears to be beneficial to the squirrels (Tarifa and Yensen 2004). However, management practices that produce bare ground may be detrimental to Washington ground squirrels. Greene (1999) found a significant difference between mean bare ground cover at occupied (3.1%) and unoccupied sites (12.9%).

Washington ground squirrels have been known to cause significant crop damage (Howell 1938) and may compete with cattle for forage. Whisson et al. (1999) observed as much as a 48% lower yield of first-cutting alfalfa from areas used by the somewhat larger Belding's ground squirrel (*S. beldingi*) versus areas where ground squirrels were excluded. Washington ground squirrels have been regarded as a nuisance species by many ranchers and farmers. Prior to state protection in 1997, Washington ground squirrels were commonly killed by ranchers, farmers, and varmint hunters. Goodman and Cummins (2003) reported that an effort to eradicate Washington ground squirrels was authorized by the Washington State Department of Agriculture in 1980.

## Status and Ecological Importance

The Washington ground squirrel became a state candidate species in Washington in the early 1990s and is listed as state endangered in Oregon. It is a candidate for federal listing under the U.S. Endangered Species Act.

Burrowing by Washington ground squirrels probably increases plant productivity by aerating soil, cycling soil nutrients, and improving water infiltration into the soil (Abaturov 1972, Laundre 1998, Vander Haegen et al. 2001). Increased plant productivity and water infiltration may decrease erosion during heavy rainfall (Greene et al. 1994). The species is also important prey for shrub-steppe predators (Schmutz and Hungle 1989, Vander Haegen et al. 2001), including the ferruginous hawk, which is listed as state threatened in Washington.

## WDFW Databases

WDFW manages two databases for Washington ground squirrel data, the Heritage database and the "Colonyprod" database. The Heritage database stores one record of the most recent survey data per documented squirrel site, whereas Colonyprod stores records for the entire Washington ground squirrel survey history and includes multiple records per site. Each record in the Heritage and Colonyprod databases contains coded attributes (e.g., site location, date surveyed, occupancy [Colonyprod only], surveyor, etc.) that are explained in an associated metadata file for each database.

## Surveys

Previous surveys for Washington ground squirrels have been conducted periodically in Washington since 1979 by WDFW, the Bureau of Land Management, The Nature Conservancy, Washington Department of Natural Resources, U.S. Fish and Wildlife Service, and university-affiliated researchers (Table 2). Surveys by Bureau of Land Management and The Nature Conservancy were focused on specific project areas (e.g., Bureau of Land Management- or Nature Conservancy-owned lands). Surveys by the Department of Natural Resources have been conducted in response to management changes (i.e., parcel conversion or grazing lease changes) on department lands. Surveys by WDFW are conducted primarily to monitor trends in site occupancy and to determine status and distribution in the state. The U.S. Fish and Wildlife Service does not conduct regular surveys on national wildlife refuges, but refuge personnel often check known population sites on refuge lands and report newly discovered sites. Research on Washington ground squirrels has been conducted by university personnel (Carlson et al. 1980, Betts 1990, 1999, Sherman 1999, 2000, 2001, Sherman and Shellman Sherman 2005, 2006) and collectively, their findings are responsible for a large proportion of known Washington ground squirrel sites. The expansion of survey work since in the late 1990s is largely related to the squirrel's classification as a state and federal candidate species and to concerns about declining abundance.

Table 2. Surveys of Washington ground squirrels in Washington through 2004. Survey area represents the most specific description possible, but does not imply that the entire area was surveyed; see report cited or contact the principal investigator for a more detailed description.

| Year of survey | Survey area | Primary survey purpose | Principal field investigators | Affiliation | Source[a] |
|---|---|---|---|---|---|
| 1979 | Species' range in Washington | Update range and distribution information | Carlson et al. | Lewis & Clark Col. | 1 |
| 1987-89 | Species' range in Washington | Visit identified locations, search for new sites | B. Betts | East. Oregon Univ. | 2 |
| 1998 | Species' range in Washington | Update occupation status of known sites | B. Betts | East. Oregon Univ. | 3 |
| 1999 | Columbia NWR, Seep Lakes (Grant and Adams counties) | Locate populations | P. Sherman | Cornell Univ. | 4 |
| 2000 | Columbia NWR, Seep Lakes (Grant and Adams counties) | Locate populations, update occupation status | P. Sherman | Cornell Univ. | 5 |
| 2001 | Beverly-Burke Rd (Grant Co.); Duffy Creek, Jameson Lake (Douglas Co.) | Inventory species of special status | J. Musser, N. Hedges, E. Ellis | BLM | - |
| 2001 | Seep Lakes, Columbia NWR (Grant and Adams counties) | Locate populations, update occupation status | P. Sherman | Cornell Univ. | 6 |
| 2002 | Saddle Mt, Beezley Hills, Moses Coulee (Grant Co.); Douglas-Duffy (Douglas Co.) | Inventory species of special status | J. Musser, N. Hedges, E. Ellis | BLM | 7 |
| 2002 | Southern Grant, Adams, Franklin, Walla Walla, Columbia, and Whitman Counties | Update occupation status of known sites | S. Goodman, E. Cummins | WDFW | 8 |
| 2002-03 | Lincoln, Grant, Franklin, Whitman, and Adams counties | Update occupation status of known sites, identify new sites | J. Rosier | BLM | 9 |
| 2003 | Duffy Creek, southern Moses Coulee, Jameson Lake (Douglas Co.); Beezley Hills (Grant Co.) | Inventory species of special status | J. Musser, N. Hedges, E. Ellis | BLM | - |
| 2003 | Douglas and northern Grant counties | Update occupation status of known sites, identify new sites | K. Romain-Bondi, T. McCall | WDFW | 10 |
| 2004 | Jameson Lake, Duffy Creek (Douglas Co.) | Record geographic extent of sites, document site movements | J. Musser, N. Hedges | BLM | - |
| 2004 | Adams, Douglas, and Grant counties | Update occupation status of known sites | R. Finger | WDFW | 11 |

[a] References: 1, Carlson et al. (1980); 2, Betts (1990); 3, Betts (1999); 4, Sherman (1999); 5, Sherman (2000); 6, Sherman (2001); 7, Musser at al. (2002); 8, Goodman and Cummins (2003); 9, Rosier (2003); 10, Romain-Bondi (2003); and 11, this study.

## METHODS

### Survey Objectives

Our primary objective was to survey as many historical Washington ground squirrel sites as possible for continued occupation by squirrels. Secondary objectives were to estimate burrow abundance and document predator activity at all sites surveyed.

### Data Collection

We surveyed historical Washington ground squirrel sites using a survey protocol developed by Goodman (2003). Surveys occurred from 29 March to 3 June 2004 in Adams, Douglas, and Grant counties. Because we expected the species to aestivate at a later date at higher latitudes, we began surveys at southernmost sites early in the survey period and proceeded northward. At each active site, we estimated burrow abundance and described geographic extent. Predator activity was recorded at all sites, regardless of occupancy status.

We did not have adequate time to survey all known Washington ground squirrel sites ($n$ = 501) in the state, therefore we focused on 322 sites in Adams, Douglas, and Grant counties that were found to be occupied during surveys in 2001-2003 to increase the likelihood of documenting active sites. Some sites were not visited because the landowner did not grant us access. We surveyed 45 additional sites that were not visited during 2001-2003 or were inactive or unconfirmed during 2001-2003. These sites were surveyed only when convenient and data from them were not used for comparative analyses.

Washington ground squirrels were usually most easily detected by their high-pitched whistle or alarm call. The high frequency of the alarm call is difficult for some people to hear; therefore surveyors were required to pass a "True Tone" hearing test prior to surveying. Surveys were postponed during rain or winds reaching or exceeding 40 km per hour (Table 3).

Surveys were conducted at historically active Washington ground squirrel sites identified in the Heritage database and to a lesser degree from verbal reports by agency biologists and the public. Sites were located on the ground by using a Garmin GPS eTrex (Universal Transverse Mercator, North American Datum of 1927). Once located, the area within 30 m of the site coordinate was searched thoroughly for squirrel sign, including visual confirmation of animals, alarm calls, and fresh droppings, to assess activity at the site (Goodman 2003). At active sites, we used alarm calls and/or active burrows to estimate the outer boundaries of sites. To describe the spatial extent of sites, we recorded a UTM center point for each "pocket of activity" (see Appendix A for definitions) encountered until we felt that we had located all or most pockets of activity (Goodman 2003). For nearly all locations, we estimated burrow abundance at sites by range-of-values categories (i.e., 1-25, 26-50, 51-75, 76-100, 100+; Goodman 2003). When burrow abundance estimates exceeded 100, we still attempted to categorize burrow estimates within a range, but selected the range conservatively (e.g., 151-300). For a few sites where burrow abundance was difficult to estimate, we made broader estimates (e.g., 1-50). In making burrow estimates, only burrows thought to have been used in 2004 were counted. Burrows that appeared

Table 3. Inclement weather conditions for Washington ground squirrel surveys based on the Beaufort Scale. Surveys should be postponed if wind force categories exceed 5 (beneath dotted line).

| Force category | Wind Speed | | | Name | Conditions on land |
|---|---|---|---|---|---|
| | Knots | Km/h | Mi/h | | |
| 0 | <1 | <2 | <1 | Calm | Smoke rises vertically |
| 1 | 1-3 | 1-5 | 1-4 | Light air | Smoke drifts and leaves rustle |
| 2 | 4-6 | 6-11 | 5-7 | Light breeze | Wind felt on face |
| 3 | 7-10 | 12-19 | 8-11 | Gentle breeze | Flags extended, leaves move |
| 4 | 11-16 | 20-29 | 12-18 | Moderate breeze | Dust and small branches move |
| 5 | 17-21 | 30-39 | 19-24 | Fresh breeze | Small trees begin to sway |
| 6 | 22-27 | 40-50 | 25-31 | Strong breeze | Large branches move, wires whistle, umbrellas are difficult to control |
| 7 | 28-33 | 51-61 | 32-38 | Near gale | Whole trees in motion, inconvenience in walking |
| 8 | 34-40 | 62-74 | 39-46 | Gale | Difficult to walk against wind, twigs and small branches blown off trees |
| 9 | 41-47 | 76-87 | 47-54 | Strong gale | Minor structural damage may occur (shingles blown off roofs) |
| 10 | 48-55 | 88-102 | 55-63 | Storm | Trees uprooted, structural damage likely |
| 11 | 56-63 | 103-118 | 64-73 | Violent storm | Widespread damage to structures |
| 12 | 64+ | 119+ | 74+ | Hurricane | Severe structural damage to buildings, wide spread devastation |

in good condition (i.e., tunnel was intact and clear of vegetation), but showed no sign of recent activity, were tallied if they occurred within 30 m of any detected squirrel activity. All surveys in 2004 were performed by a single surveyor (R. Finger), which eliminated problems with inter-observer variability in interpreting field sign and estimating burrow abundance.

If the initial search within 30 m of a site coordinate revealed no evidence of ground squirrel activity, we made radial transects at 60 m, 90 m, 120 m, and 150 m (Goodman 2003). Radial transects were conducted by circling the site coordinate while using a GPS to maintain a specific distance from the coordinate using the "Go To" function of the unit. If evidence of activity was discovered during these transects, we immediately switched to the methodology described above for active sites (i.e., described geographic extent and estimated burrow abundance) starting from the center of newly discovered activity. The location of the center of newly discovered activity was recorded and entered in the Heritage database. If Washington ground squirrel activity was not discovered after completion of all transects, the site was recorded as "inactive." A site was recorded as "unconfirmed" if we found one or more Washington ground squirrel-sized burrows that appeared used (i.e., disturbed soil at the burrow entrance) but failed to detect additional evidence of occupancy such as scat, a confirmed sighting, or vocalizations.

Number of badger burrows and sightings of other potential ground squirrel predators were recorded for all sites. At active sites, badger burrows and predator sightings were documented if they occurred within 30 m of any "significant pocket of activity", including the original site

location. For inactive sites, predator activity was documented during the thorough search between the GPS coordinate and the 30-m transect and along the 60-m and 90-m transects.

Area Delineation

To describe trends in Washington ground squirrel site occupancy by geographic subregion, we arbitrarily delineated boundaries for 15 "areas" around groupings of known sites (Figures 1 and 2; Appendix B). Areas typically held one or more clusters of ground squirrel sites in which individual sites were located in fairly close proximity (usually <5 km) to one another. Solitary sites were sometimes also present and were included within the appropriate area. Area boundaries were digitized using features such as roads, streams, county lines, and powerlines or by digitizing a straight line between specific locations such as crossroads, as represented in a DeLorme Washington State Atlas and Gazetteer™. Area boundaries are considerably larger than the actual locations known to be occupied by Washington ground squirrels.

Data Analysis

Mean number and standard error of active Washington ground squirrel burrows, badger burrows, and pockets of activity were calculated for each area. We limited our analyses to surveys from 2001-2003 and 2004 to assess recent changes in occupancy patterns. Occupancy rate was the ratio of the number of active sites during 2004 to the number of active sites during surveys made in 2001-2003. Sites with an activity status of "unconfirmed" were excluded from the analysis.

Mean number and standard error of active squirrel burrows counted per site were calculated for each area using the midpoint value for each site (i.e., 26-50 = 38). We averaged the number of pockets of activity counted per site within areas as an index to the geographic extent (i.e., the more pockets of activity, the greater the colony extent) of sites in each area.

Survey Assumptions

The survey protocol makes several assumptions that should be reviewed before interpreting the data presented in the results.

***Assumption 1:*** **The protocol accurately determines occupancy status of all Washington ground squirrel sites**. Transect intervals are spaced 30 m apart and thus small patches of activity (<5 burrows) could be missed, resulting in active sites being recorded as inactive.

***Assumption 2:*** **Burrow abundance estimates are accurate and meaningful.** Difficulties in detecting burrows, determining occupancy, and accurately identifying site boundaries may mean that some burrow abundance estimates are inaccurate. Research on Piute ground squirrels in southwestern Idaho found that trained observers were inconsistent in assigning activity status to burrow entrances (Van Horne et al. 1997). Also, burrow abundance typically increases after pups emerge and mature (S. Germaine, pers. comm.), thereby possibly biasing our estimates of numbers of active burrows and pockets of activity toward higher counts as the study progressed.

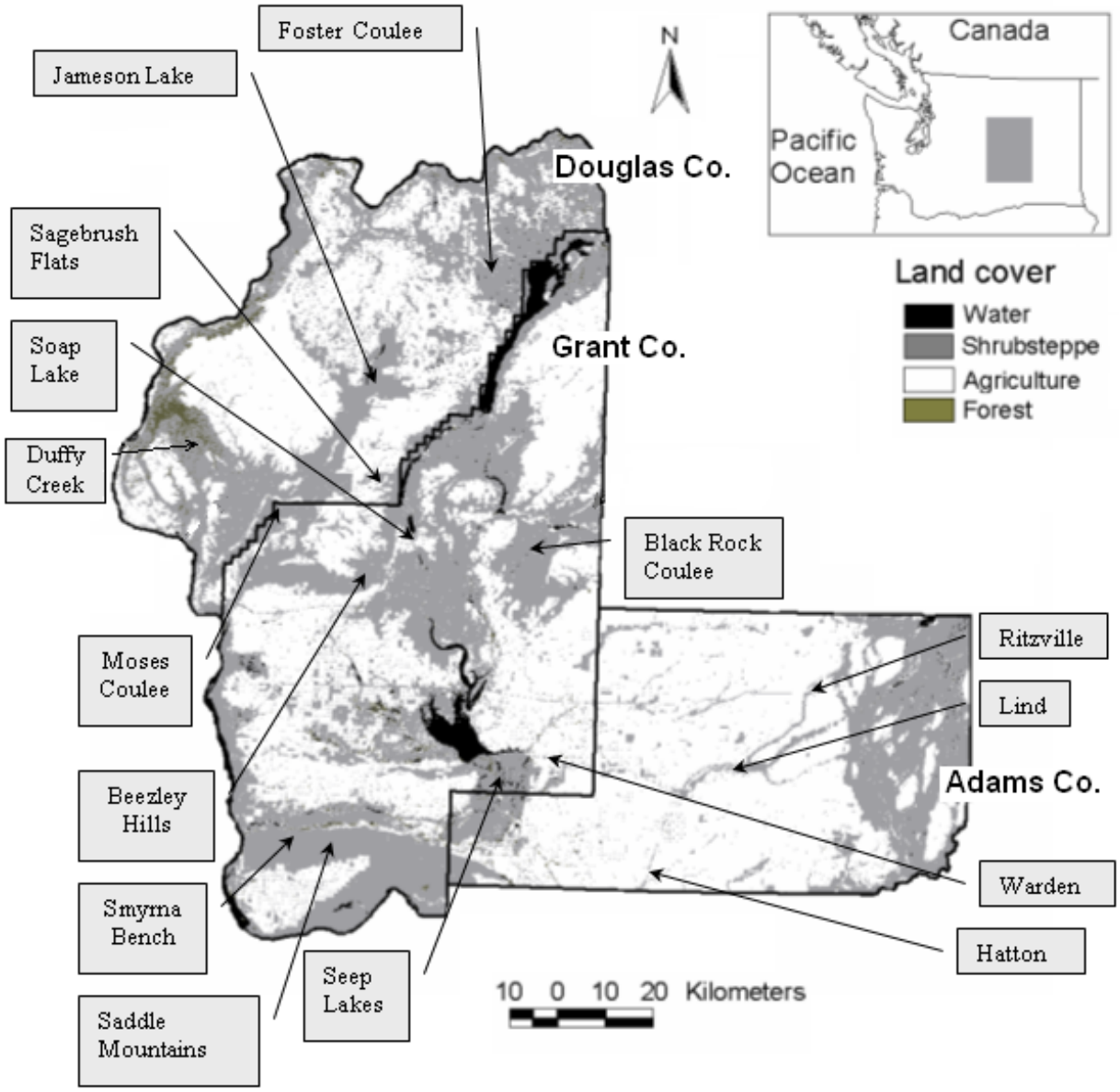


Figure 1. Approximate locations of 15 Washington ground squirrel areas surveyed during 2004 in relation to landcover types in Adams, Douglas, and Grant counties, Washington. The landcover class map was derived from Landsat Thematic Mapper data and was contributed by M. Vander Haegen (WDFW).

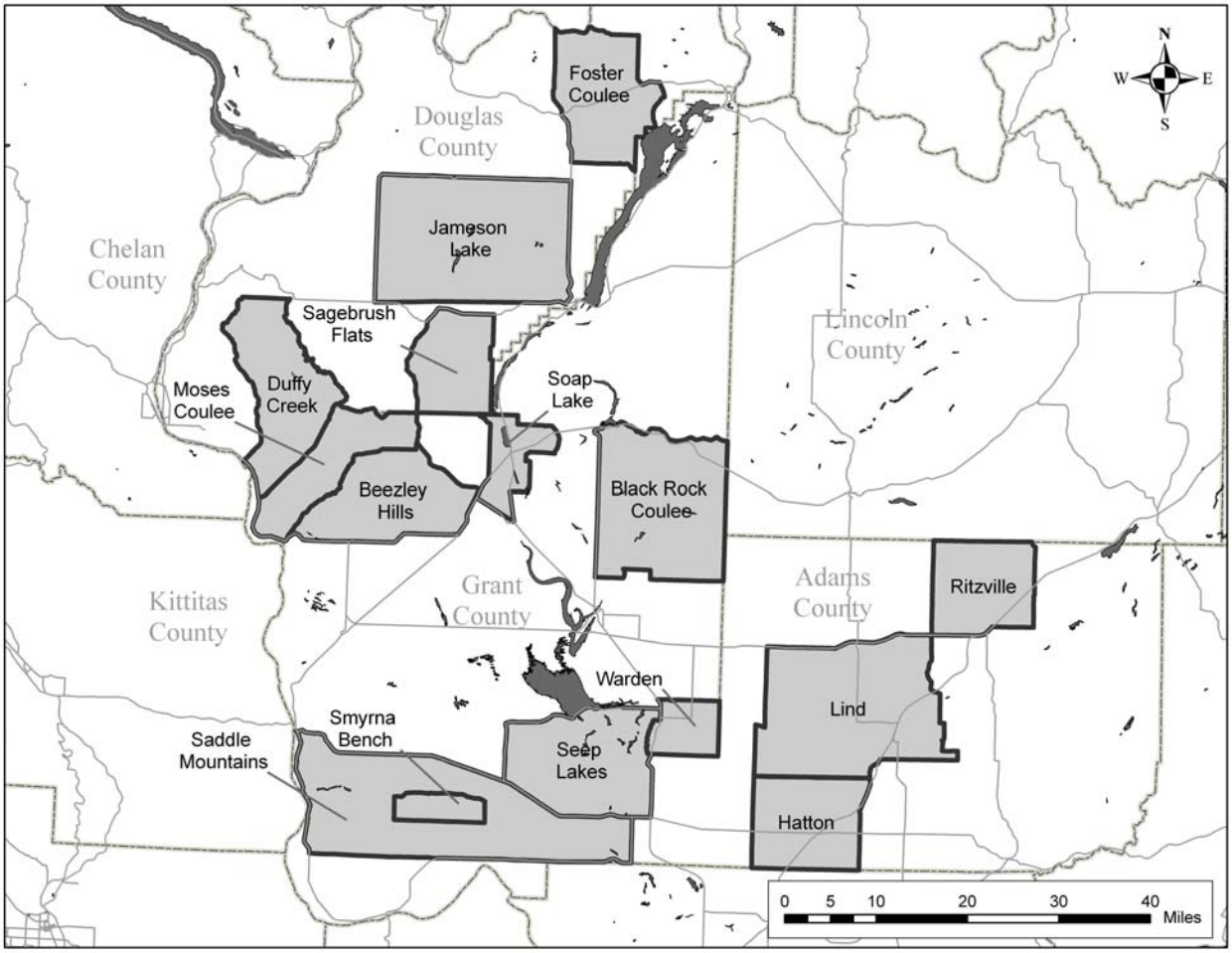


Figure 2. Locations of 15 delineated Washington ground squirrel areas in Grant, Douglas, and Adams counties, Washington.

## RESULTS

Site Occupancy Trends and Sizes

A total of 303 Washington ground squirrel sites were surveyed in 2004, with 231 (76.2%) found to be active, 13 (4.3%) judged as unconfirmed, and 59 (19.5%) inactive (Table 4; Figures 3-5; Appendix C). Grant County held most (68.4%) active sites, with smaller numbers in Douglas (20.3%) and Adams (11.3%) counties (Table 4). Site occupancy was highest in Douglas County and lowest in Adams County (Table 4).

Of the 247 sites active during 2001-2003, 218 (88%) remained active in 2004 (Table 5; Figures 3-5). The Seep Lakes, Foster Coulee, and Hatton Areas exhibited the greatest proportion of site vacancy from 2001-2003 to 2004 (Table 5). Losses in the Seep Lakes Area were especially severe near Long Lake, Windmill Lake, and Heart Lake, where activity continued at only 1 of 11

(9%) surveyed sites (Figure 6). Additionally, 10 sites considered inactive in 2001-2003 were reoccupied in 2004 (Appendix C). Eight of these were estimated to hold ≤25 burrows, while the other two had ≤75 burrows, and four occurred in the Seep Lakes Area. Two sites of uncertain status in 2001-2003 were also active in 2004, as well as one site not checked in 2001-2003.

About two-thirds of active Washington ground squirrel sites in 2004 were characterized by small estimates of burrow numbers, with 118 sites (51.1%) containing an estimated 1-25 burrows and 38 sites (16.5%) having 26-50 burrows (Table 6). Additionally, 30 sites (13.0%) held an

Table 4. Overall numbers of active, unconfirmed, and unoccupied Washington ground squirrel sites visited in Adams, Douglas, and Grant counties, Washington, in 2004.

| County | No. of active sites[a] | No. of unconfirmed sites[a] | No. of inactive sites[a] | Total |
|---|---|---|---|---|
| Adams | 26 (70.3) | 1 (2.7) | 10 (27.0) | 37 |
| Douglas | 47 (85.5) | 0 (0) | 8 (14.5) | 55 |
| Grant | 158 (74.9) | 12 (5.7) | 41 (19.4) | 211 |
| Total | 231 (76.2) | 13 (4.3) | 59 (19.5) | 303 |

[a] Percent of total sites for each county appears in parentheses.

Table 5. Total numbers of Washington ground squirrel sites surveyed in 2004 and differences in occupancy rates from 2001-2003 to 2004 for 15 areas of Adams, Douglas, and Grant counties, Washington.

| County(ies) | Area[a] | Total no. of sites surveyed in 2004 | Site occupancy rate[b] |
|---|---|---|---|
| Adams | Hatton | 5 | 1:2 (50%) |
| Adams | Lind | 7 | 4:4 (100%) |
| Adams | Ritzville | 4 | 4:4 (100%) |
| Douglas | Duffy Creek | 22 | 21:22 (95%) |
| Douglas | Foster Coulee | 9 | 3:5 (60%) |
| Douglas | Jameson Lake | 13 | 12:12 (100%) |
| Douglas | Sagebrush Flats | 11 | 8:9 (89%) |
| Grant | Beezley Hills | 56 | 43:46 (93%) |
| Grant | Black Rock Coulee | 22 | 17:20 (85%) |
| Grant | Smyrna Bench | 22 | 18:18 (100%) |
| Grant | Soap Lake | 4 | 3:3 (100%) |
| Grant | Warden | 11 | 11:11 (100%) |
| Grant, Adams | Saddle Mountains | 16 | 13:14 (93%) |
| Grant, Adams | Seep Lakes | 70 | 30:46 (65%) |
| Grant, Douglas | Moses Coulee | 31 | 30:31 (97%) |
| | Total | 303 | 218:247 (88%) |

[a] Area boundaries are depicted in Figure 2.
[b] The ratio of the number of active Washington ground squirrel sites during the 2004 survey to the number of active sites during the 2001-2003 surveys for each area, followed by the percent of active sites remaining in 2004 (in parentheses).

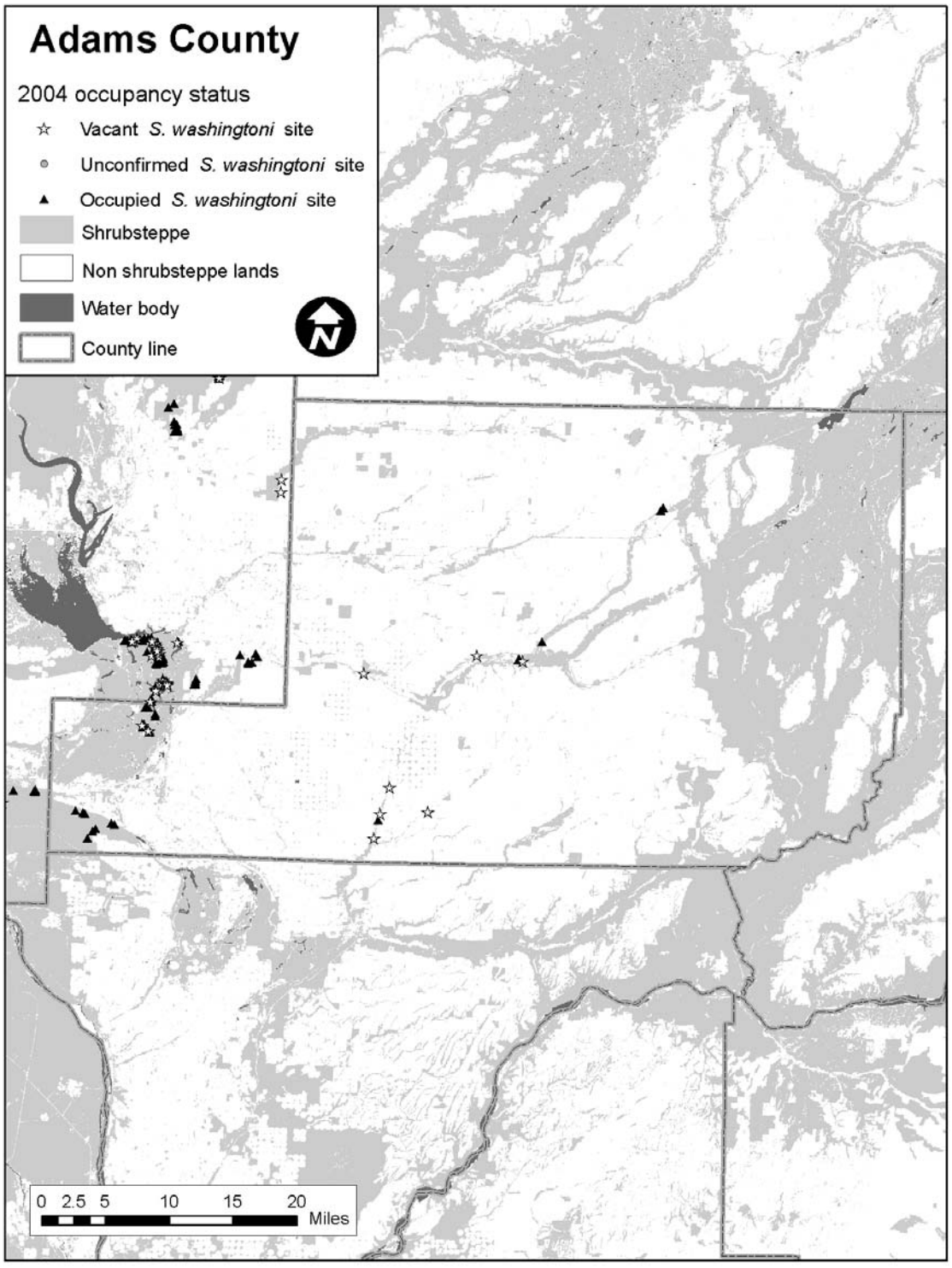


Figure 3. Occupancy status of 37 Washington ground squirrel sites surveyed in Adams County, Washington, in 2004.

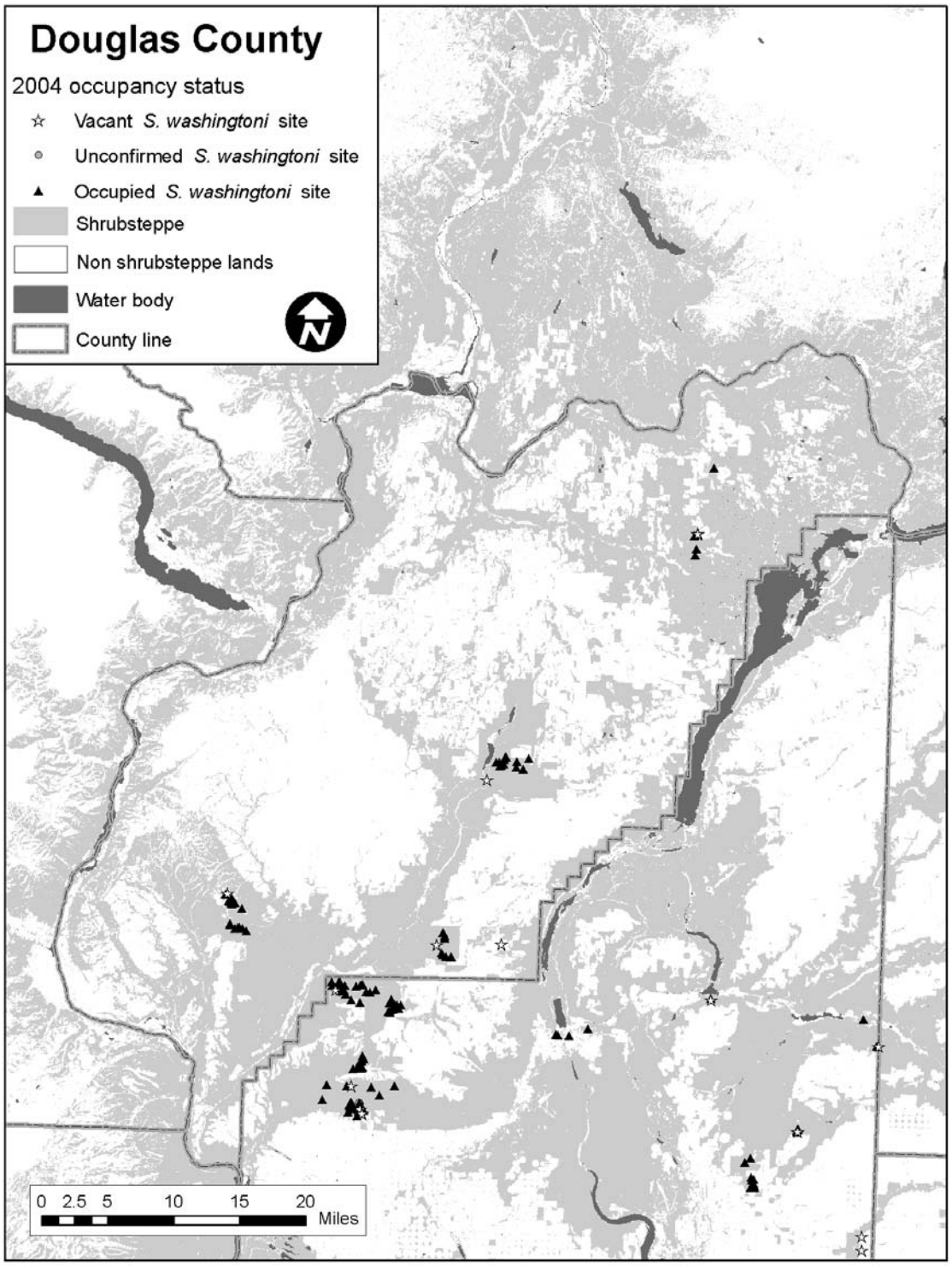


Figure 4. Occupancy status of 55 Washington ground squirrel sites surveyed in Douglas County, Washington, in 2004.

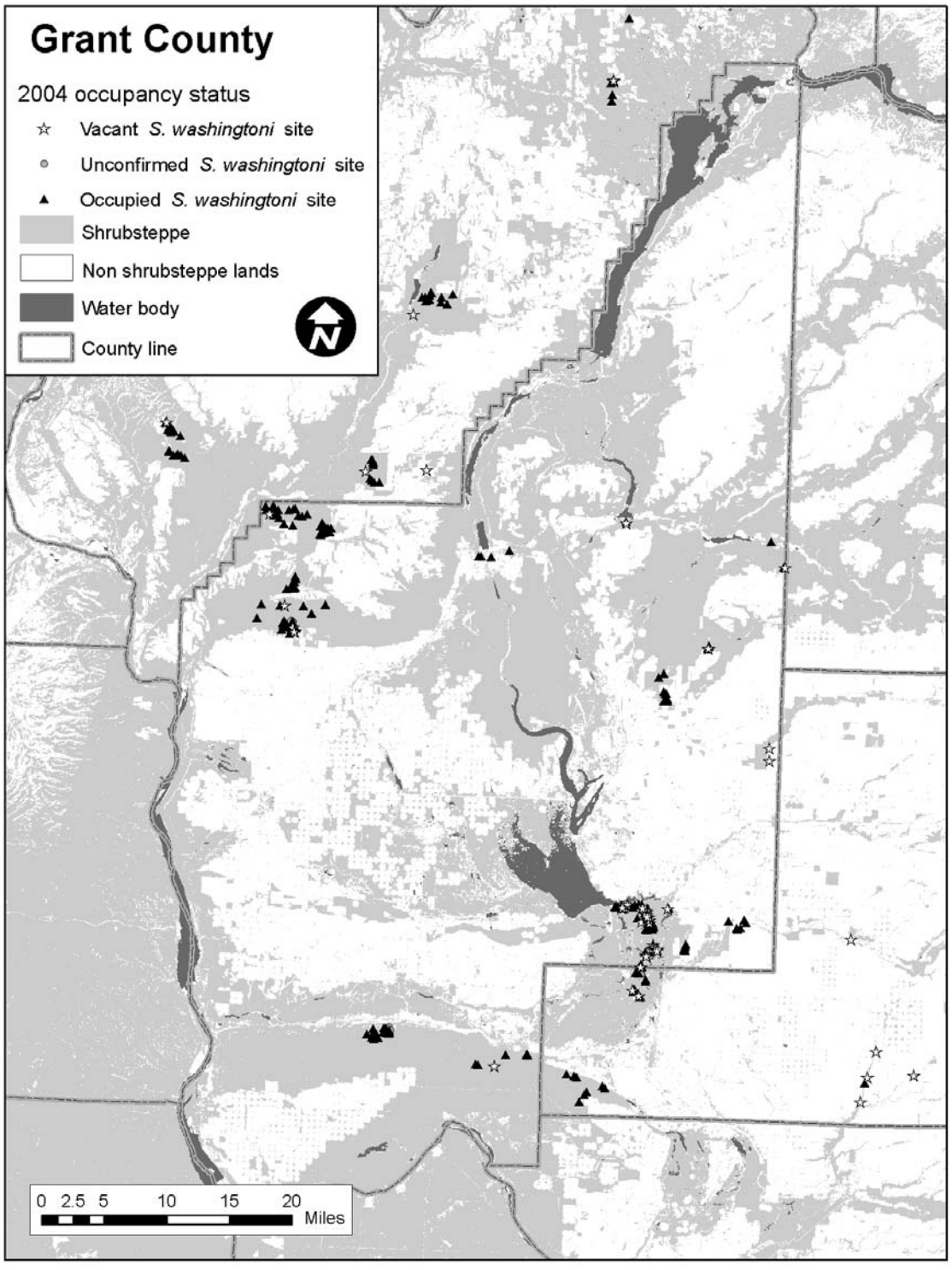


Figure 5. Occupancy status of 211 Washington ground squirrel sites surveyed in Grant County, Washington, in 2004.

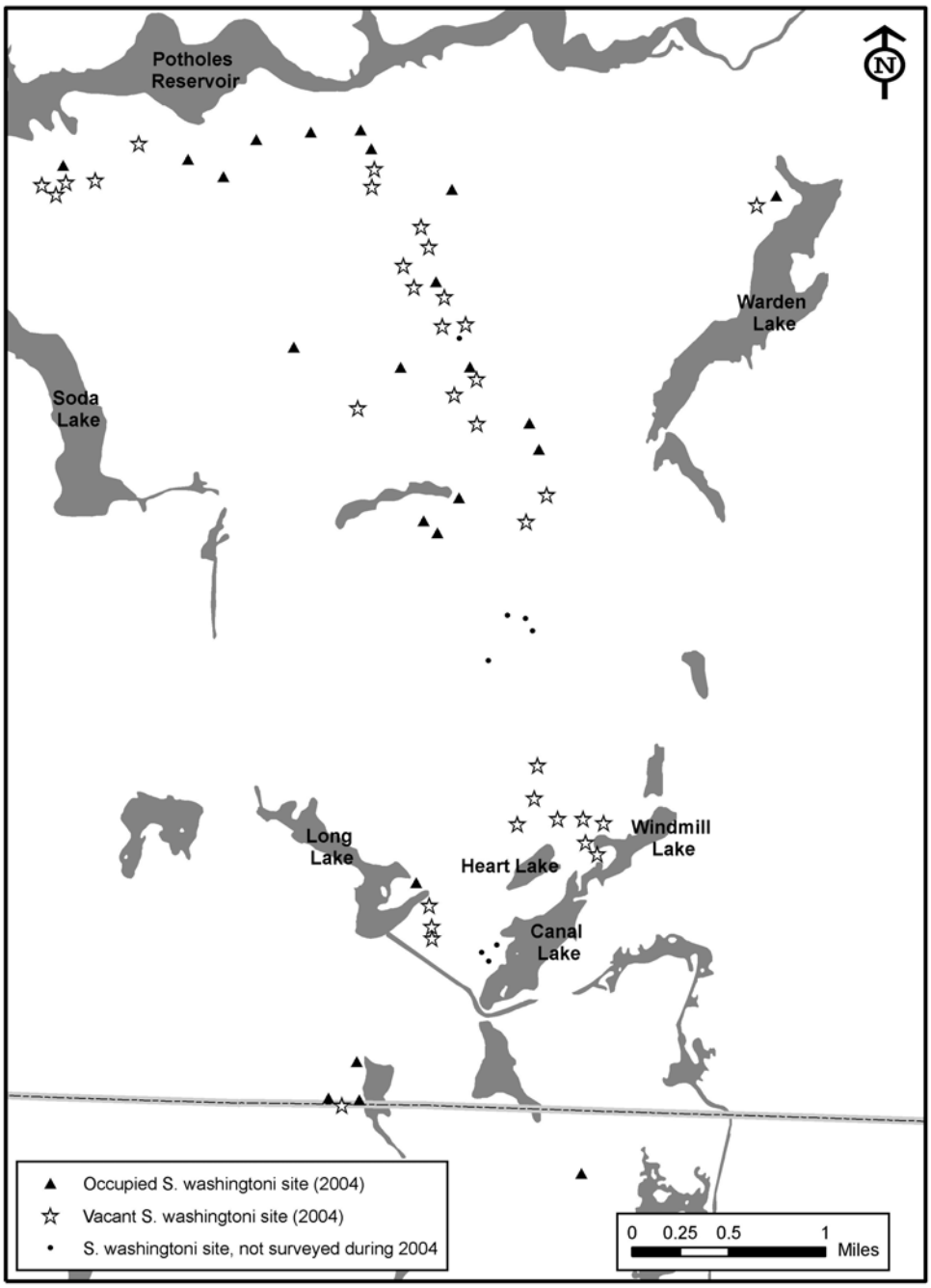


Figure 6. Occupancy status of 64 Washington ground squirrel sites in the main portion of the Seep Lakes Area, Grant and Adams counties, Washington, in 2004.

Table 6. Estimated numbers of burrows for Washington ground squirrels and badgers at active squirrel sites in 15 areas of Adams, Douglas, and Grant counties, Washington, in 2004.

| County(ies) | Area[a] | No. of sites per category of estimated burrows[b,c] | | | | | | | Mean no. of burrows estimated per active site (SE) | No. of burrows at largest active site[d] | Mean no. of pockets of activity per active site (SE) | Mean no. of badger burrows per active squirrel site (SE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1-25 | 26-50 | 51-75 | 76-100 | 101-200 | >200 | Total | | | | |
| Adams | Hatton | 1 | - | - | - | - | - | 1 | 13.0 (-) | 1-25 | 1.0 (-) | 0 |
| Adams | Lind | 1 | 1 | 1 | - | 1 | - | 4 | 59.9 (20.7) | 101-125 | 2.5 (0.6) | 3.3 (1.0) |
| Adams | Ritzville | 3 | - | - | 1 | - | - | 4 | 31.8 (18.8) | 76-100 | 2.0 (1.0) | 3.5 (2.9) |
| Douglas | Duffy Creek | 17 | 3 | 1 | - | - | - | 21 | 20.1 (3.5) | 51-75 | 2.1 (0.3) | 0.7 (0.2) |
| Douglas | Foster Coulee | 5 | - | - | - | - | - | 5 | 13.0 (0) | 1-25 | 2.0 (0.4) | 2.0 (0.7) |
| Douglas | Jameson Lake | 8 | - | 3 | 1 | - | - | 12 | 31.8 (8.2) | 76-100 | 3.7 (0.8) | 2.2 (0.7) |
| Douglas | Sagebrush Flats | 6 | 2 | - | 1 | - | - | 9 | 28.2 (8.8) | 76-100 | 2.6 (0.4) | 2.4 (0.5) |
| Grant | Beezley Hills | 28 | 8 | 3 | 1 | 4 | - | 45[e] | 35.2 (6.3) | 176-200 | 2.7 (0.4) | 1.9 (0.5) |
| Grant | Black Rock Coulee | 10 | 2 | 3 | - | 2 | - | 17 | 40.9 (10.2) | 151-175 | 2.8 (0.5) | 2.1 (0.6) |
| Grant | Smyrna Bench | 6 | 2 | 6 | 2 | 1 | 1 | 18 | 68.6 (16.6) | 201-400 | 2.8 (0.4) | 2.3 (0.7) |
| Grant | Soap Lake | 2 | - | 1 | - | - | 1 | 4 | 72.5 (44.4) | 201+ | 3.3 (2.3) | 2.0 (2.0) |
| Grant | Warden | - | 2 | 2 | 1 | 4 | 2 | 11 | 164.2 (52.1) | 551-700 | 6.3 (1.5) | 10.7 (6.2) |
| Grant, Adams | Saddle Mountains | 9 | 4 | 1 | - | 1 | - | 15 | 31.3 (7.2) | 101-125 | 1.8 (0.3) | 2.4 (0.8) |
| Grant, Adams | Seep Lakes | 14 | 7 | 5 | 2 | 5 | 1 | 35 | 57.3 (9.3) | 201-300 | 2.9 (0.4) | 8.9 (2.0) |
| Grant, Douglas | Moses Coulee | 8 | 7 | 4 | 1 | 7 | 3 | 30 | 83.8 (14.3) | 276-300 | 5.6 (0.7) | 6.1 (1.5) |
| | Total | 118 | 38 | 30 | 11 | 25 | 8 | 231[e] | 52.5 (4.5) | 551-700 | 3.2 (0.2) | 4.0 (0.5) |

[a] Area boundaries are depicted in Figure 2.
[b] Includes active sites only.
[c] For 17 sites where the estimated number of burrows was spread over more than one size category, the site was placed in the smallest size category of the estimate. Thus, for an estimate of 26-75 burrows, the site was listed under the category of 26-50 burrows.
[d] The largest estimated number of burrows at any active Washington ground squirrel site in the area.
[e] Total includes one site that lacked a burrow estimate because the entire site could not be surveyed.

estimated 51-75 burrows, 11 sites (4.8%) held 76-100 burrows, 25 sites (10.8%) held 101-200 burrows, eight sites (3.5%) held >200 burrows, and one site (0.4%) held an undetermined number of burrows. As a percent of total active sites present, small sites (i.e., those with 1-50 burrows estimated) were especially prevalent in the Foster Coulee (100%), Duffy Creek (95.2%), Saddle Mountains (86.7%), Beezley Hills (81.8%), and Sagebrush Flats (88.9%) Areas (Table 6). The Hatton and Foster Coulee Areas had the smallest mean burrow estimates per site. By comparison, large sites (i.e., those with >100 burrows estimated) were most represented in the Warden (54.5%), Moses Coulee (33.3%), Lind (25.0%), Soap Lake (25.0%), and Seep Lakes (17.1%) Areas (Table 6).

The Warden Area had by far the largest mean estimate of burrow numbers per site, followed by the Moses Coulee, Soap Lake, and Smyrna Bench Areas (Table 6). Thirty-one of 33 large sites occurred in Grant County (Appendix C), with the greatest number (n = 10) present in the Moses Coulee Area (Table 6). Eight sites spread among five areas had >200 burrows. A site at the Sage Hills Golf Course in southeastern Grant County was the largest single site visited in the survey, with an estimated 551-700 burrows recorded.

We documented 740 pockets of activity (including the 231 original site locations) during the survey. Because of concerns that pockets of activity were not recorded consistently among survey years, these data are only used as a guide to site size and to document burrow distribution at sites. Mean numbers of pockets of activity per active site were greatest in the Warden and Moses Coulee Areas, whereas the smallest estimates occurred in the Hatton and Saddle Mountains Areas (Table 6). One pocket of activity (30-m radius) is equal to about 0.28 ha (0.7 acres).

Survey time varied from 10 to 105 minutes per Washington ground squirrel site, depending on activity status, size, and slope of the site. Small active sites usually required <30 minutes to complete, inactive sites required about 60 minutes, and large active sites required about 90 minutes. Accurate estimates of the numbers of active burrows were often hardest to obtain and most time consuming at sites exceeding 2 ha in size, especially when on steep slopes >45°.

Site Ownership

Eighty-six (37.2%) of the 231 active sites surveyed in 2004 occurred on federal land (e.g., Bureau of Land Management, U.S. Fish and Wildlife Service), 69 (29.9%) were on private land, 37 (16.0%) were on Nature Conservancy land, 37 (16.0%) were on state land (e.g., WDFW, Department of Natural Resources), and 2 (0.9%) were on community school district land (Table 7; Appendix C). Of the 33 largest sites (i.e., those with >100 active burrows estimated), 19 (55%) were in federal ownership, 10 (30%) were on private land, three (9%) were owned by The Nature Conservancy, and two (6%) were on state-owned land.

Predator Activity

Badger burrows were present at 159 of 231 (69%) active Washington ground squirrel sites and 11 of 59 (25%) inactive squirrel sites in 2004. Badger burrows were most prevalent at squirrel sites in the Warden, Seep Lakes, and Moses Coulee Areas (Table 6). Overall, number of badger

Table 7. Ownership of Washington ground squirrel sites in Adams, Douglas, and Grant counties, Washington, in 2004.

| | Site ownership | | | | | |
|---|---|---|---|---|---|---|
| Site status | Federal | Private | State | NGO | Local school districts | Total |
| Active | 86 | 69 | 37 | 37 | 2 | 231 |
| Unconfirmed | 2 | 1 | 3 | 7 | 0 | 13 |
| Inactive | 18 | 28 | 10 | 3 | 0 | 59 |
| Total | 106 | 98 | 50 | 47 | 2 | 303 |

diggings per site showed an apparent increasing relationship with the estimated number of Washington ground squirrel burrows per site (Figure 7). However, this may be an artifact of the amount of area surveyed because more area was usually examined at sites with more squirrel burrows.

Raptors were often observed during surveys, but active hunting of ground squirrels was rarely noted, perhaps due to observer disturbance. Only one northern harrier was seen hunting at a squirrel site (at the Smyrna Bench Area). Two rattlesnakes, one coyote, and one badger were also observed at squirrel sites. In the town of Warden, Grant County, a house cat (*Felis catus*) was seen hunting Washington ground squirrels at site 39-1, which was a small lot surrounded by homes, apartments, and the grounds of a school and church. The cat captured a ground squirrel within 2 minutes of the time it was observed hunting.

New Ground Squirrel Sites

Nine new Washington ground squirrel sites were discovered during 2004, all of which occurred in Grant County. Of these, state and federal biologists reported seven, one was discovered

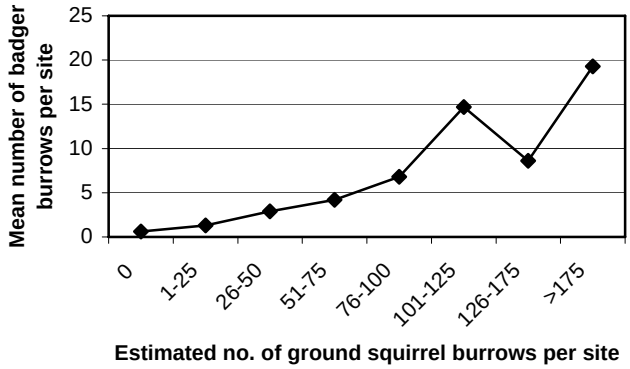


Figure 7. Relation between the number of badger burrows counted per ground squirrel site and the estimated number of squirrel burrows per site (by size category, n = 289) in Adams, Douglas, and Grant counties, Washington, in 2004.

incidentally during this study, and the public reported one. Data for these sites were not incorporated into the analyses described in this report.

Private Landowner Input

Conversations with local residents regarding trends in Washington ground squirrel abundance were inconclusive. Some people reported seeing fewer animals than in past years, while others believed Washington ground squirrels were widespread and abundant. Residents provided information on several previously unreported locations that may be occupied by ground squirrels, but we were unable to visit these sites in 2004 because of time constraints.

## DISCUSSION

Survey Coverage and Site Occupancy Trends

WDFW and others have conducted Washington ground squirrel surveys over much of the species' range in Washington since the late 1990s (Table 2). Survey results show a decline in active ground squirrel sites during this period, indicating that the overall population is continuing to decrease, as noted by earlier authors (Carlson et al. 1980, Betts 1990). Our survey, which is the most comprehensive to date, shows that declines in active sites differ among areas, suggesting that threats to the species are not uniform across its range.

Areas of Concern

Occupancy rates appear to be declining most rapidly in the Seep Lakes Area. Sherman (2001) witnessed an apparent decline of 17% of active Washington ground squirrel sites in this area from 1999 to 2001, and the number of occupied sites has fallen another 35% since then (Table 5). Although the cause(s) of these losses is unknown, cheatgrass (*Bromus tectorum*), rabbitbrush (*Chrysothamnus* spp.), and fiddleneck (*Amsinckia* spp.) are prevalent in the area, indicating a degraded range condition. Invasive exotic grasses and forbs typically do not produce enough seed to support the nutritional requirements of ground squirrels and nutritional deficiencies have been previously cited as a potential cause for the decline of Washington ground squirrel in the Seep Lakes Area (Sherman 2001). Sherman (2001) also suggested that invasion by annual exotic plants could destabilize Washington ground squirrel populations and increase susceptibility to stochastic environmental factors.

The Hatton Area supported one small active Washington ground squirrel site during 2004. Few burrows were recorded at this site and the nearest known active site is >22 km away. Landcover is predominately agricultural in this area (Figure 1), thus there is little potential for dispersal.

The Foster Coulee Area lost 40% of its active Washington ground squirrel sites from 2001-2003 to 2004 and each of its four remaining active sites had few (≤25) burrows. Surviving ground squirrel populations in the Foster Coulee Area are at risk of extinction because of the few animals remaining and their isolation from other known active sites, the nearest of which is about 30 km away.

The Soap Lake Area held four active Washington ground squirrel sites, including one not surveyed during 2001-2003. Two of the sites are adjacent to the Lakeview Golf and Country Club. Although a paved road separates the sites, it is likely that ground squirrels cross it readily and that the sites represent a single large site. In total, more than 200 active burrows were present in 2004. Both of these sites are at considerable risk from future residential development and a portion of one site has already been lost to housing construction. The two other sites in this area occur within a fragmented landscape of shrub-steppe and agriculture.

The Warden Area supported 11 active Washington ground squirrel sites and possessed the highest mean number of ground squirrel burrows per active site in the three-county survey area. These sites occurred in two clusters, with one located at the Sage Hills Golf Course (five sites) and the other in the town of Warden (six sites). Burrowing activity at the golf course was numerous enough to damage the course grounds, causing golf course management to express interest in squirrel control. According to the manager, burrows existed in the course's roughs and fairways, but not the putting greens. It may be desirable to work with the course manager to ensure the security of ground squirrels at these sites. Most of the occupied sites in the town of Warden are at significant risk from future residential and school development.

The Ritzville Area supported four active Washington ground squirrel sites during 2004. However, three of these with a combined total of >100 active burrows occurred in close proximity to each other at and adjacent to a livestock feedlot and could be considered one site. The feedlot itself had little vegetative cover or forage, but alfalfa fields grew on both sides of the lot and contained Washington ground squirrel burrows. According to the landowner, these sites were sprayed for weed control several days before our survey. The landowner appeared impartial to the squirrels and reported seeing fewer than in the past. Landcover in the Ritzville Area is predominately agricultural (Figure 1), giving squirrels limited potential for dispersal.

The Lind Area supported four active Washington ground squirrel sites, three of which occurred within city limits and one at Paha Coulee. Few active burrows were observed at Paha Coulee, whereas the town sites combined supported numerous active burrows on both sides of State Route 21. Landcover in the Lind Area is predominately agricultural (Figure 1), thus dispersal opportunities appear limited.

The Duffy Creek Area may warrant special attention in the future. Nearly all ground squirrel sites in this area were still active, but burrow counts were in the lowest abundance category at nearly all locations.

Survey Biases

Several aspects of our surveys potentially suffer from biases that may affect some results. Estimates of burrow numbers per site should be interpreted with caution for several reasons. First, techniques for counting burrows yielded approximations of numbers rather than exact tallies, especially at larger sites. Second, burrow abundance often increases during the last half of the active season as juveniles mature and create their own burrows. Our site visits, which were conducted from late March to early June, overlapped extensively with this period and may

have encountered higher burrow numbers as the survey progressed. Thus, our estimates of burrow abundance may have suffered from a seasonal effect. Washington ground squirrels likely use multiple burrows and create more than one entrance per burrow, as noted in other *Spermophilus* (Alcorn 1940, Yensen et al. 1991). Burrows counts usually do not correlate with actual ground squirrel abundance (Quade 1994, Van Horne et al. 1997), thus we have not attempted to derive estimates of squirrel numbers based on our burrow estimates.

Germaine et al. (in press) reported a bias in Washington ground squirrel sites being located near roads, which probably reflects that greater search effort and more incidental discovery of sites have occurred near roads over the years. In addition, non-WDFW surveys in recent years have concentrated on agency- and Nature Conservancy-owned lands. These problems may result in biased summaries of land ownership for squirrel sites. Sites on private lands are most likely to be underrepresented in the current inventory of sites.

### Area Delineation

Delineation of areas was intended to provide a means to describe loss of Washington ground squirrel sites by geographic subregion. Future refinement of delineated areas based on biologically meaningful boundaries (e.g., habitat, soils, slope, elevation, etc.) may be useful.

### Translocations

Translocations of Washington ground squirrels are potentially desirable in managing the species, particularly where sites are in imminent danger of loss from human development. However, caution is currently advised due to limited knowledge of the possible impacts on population genetics, the spread of disease, and other potential negative effects.

## RECOMMENDATIONS FOR FUTURE SURVEYS

The primary objectives of surveying Washington ground squirrels in Washington are to: (1) maintain an inventory of sites occupied by the species, (2) assist in determining if management of sites is needed, (3) improve the effectiveness of management actions directed at the species, and (4) evaluate population trends. Keeping data current for ground squirrel sites is challenging because of their low density and the species' somewhat cryptic nature. Active management requires that known sites be periodically surveyed to maintain accurate data records. A well-designed and repeatable survey protocol is important to ensure that sites are surveyed thoroughly and objectively and that appropriate data are collected.

Goodman (2003) developed an initial protocol for surveying Washington ground squirrels, which was used by WDFW personnel during field surveys in 2003 and 2004. Here, we recommend changes in the protocol to enhance the likelihood of accomplishing future survey objectives.

Although Goodman's (2003) survey protocol fulfills Objectives 1 (maintain an inventory of occupied sites) and 2 (determine if site management is needed), we recommend several changes to increase the effectiveness of surveys. The current protocol does not produce data necessary to

achieve Objectives 3 (improve the effectiveness of management actions) and 4 (evaluate population trends). We therefore offer suggestions and a revised data form to meet Objective 3. We suggest that a new survey may be necessary to accomplish Objective 4 and provide a rough estimate of the annual survey hours needed for obtaining sufficient data to estimate abundance trends in Washington, based on site density and detection rates in Oregon.

Following these recommendations, we identify several variables in collecting Washington ground squirrel survey data that would benefit from more stringent definition so that they are interpreted consistently among observers. We also discuss potential implications and methods for tracking site drift. Finally, we identify potential problems with the Washington ground squirrel data currently held in the Heritage database.

Survey Objective 1 – Maintain an Inventory of Occupied Sites

The survey protocol of Goodman (2003) satisfies this objective for the short-term, but is inadequate over the long-term because the number of known occupied sites will decline over time if vacancy rates exceed the incidental discovery of new sites. Conducting random searches for additional sites can help evaluate the completeness of the existing inventory of sites in the Heritage database. Transects can be generated and stratified by habitat types occurring in the Thematic Mapper data (Jacobson and Snyder 2000). If transects are selected at random, it would be possible to collect unbiased data for locations with and without ground squirrels. Further, if the effective search width of transects is known, densities of Washington ground squirrel sites can be estimated within portions of the species' range.

Completeness of the current inventory of sites can be judged based on whether future searches find few or many new sites. Random searches, if used, should be regularly evaluated by cost-benefit analysis because of the likelihood that detection rates will be too low for surveys to be economically practical. GIS has the potential to improve survey efficiency for Washington ground squirrels.

Survey Objective 2 – Determine if Site Management is Needed

The current survey protocol meets this objective by producing estimates of active burrow abundance that are useful in assessing trends in occupation over time, thereby indicating whether specific sites are at risk of extinction. For example, sites with negative trends in burrow counts may be at risk. A problem exists, however, for large sites with >100 active burrows because counts are lumped into a "101+" category, making declines difficult to recognize until sites decrease to smaller size categories.

An alternative to estimating burrow abundance by category (i.e., 1-25, 26-50, etc.) is to estimate geographic extent (i.e., amount of area occupied) and active burrow density per site. Active burrow abundance can then be calculated as the product of geographic extent and active burrow density. Geographic extent can be estimated by looking at pockets of activity recorded on a GPS. If the scale bar is set to equal 100 m, the number of hectares can be estimated by looking at the arrangement of points (indicating where activity was located) and the scale bar, keeping in mind that 1 ha is equal to 100 m x 100 m.

Densities of active burrows can be estimated by walking one or more radial transects through a site, as described by Goodman (2003) for searching for squirrel sign. The desired radii of the transects can vary based on the size of the site, but can be followed using the GPS distance display to the selected point (i.e., site center). All active burrows within 2 m of the radial transect, or some other specified distance where the probability of detection approaches 100%, are then counted, with burrow density calculated by the following equation:

$$\text{Active burrow density} = \frac{\text{total active burrows}}{\pi(\text{radius} + x)^2 - \pi(\text{radius} - x)^2}$$

where radius equals the transect radius in meters and $x$ equals a distance (e.g., 2 m) on both sides of the transect where the probability of burrow detection is 100%.

Additional considerations when estimating burrow abundance are that detection probability is likely to vary with observer search effort, timing of surveys, and environmental conditions (i.e., temperature, wind speed, and precipitation), yet little is known regarding the extent or thresholds at which detection probability varies. During 2004, there was repeated indication that rainfall and wind obscured signs of burrow use. Further, cool temperatures appear to reduce aboveground activity by ground squirrels. Rainfall followed by cool temperatures can therefore make occupied burrows appear inactive for days. The effects of weather and observer on detection probability of active burrows warrant future investigation. Until these relationships are understood, it is recommended that surveys following rain be postponed until the soil around burrow entrances is dry and loose. This will ensure that evidence of activity can be detected upon the resumption of survey work.

Deciding whether active management is needed for single Washington ground squirrel sites or a group of sites can be made at the landscape scale. Area delineation, where geographic boundaries are created around clusters of sites occurring in localities with similar and continuous habitat, may increase the ability to identify subregions in need of active management. For example, we might expect site activity trends to differ between the Seep Lakes and Beezley Hills Areas because of variation in habitat (e.g., rangeland condition, soil composition, etc.). Identifying such differences may also provide clues to the factors (e.g., landscape level changes) driving population dynamics and increase the effectiveness of management.

Ideally, defined areas for ground squirrels should (1) encompass at least 10 sites, (2) contain similar vegetative and soil characteristics, (3) contain contiguous habitat suitable for squirrels, and (4) have boundaries that are clearly defined by obvious features (e.g., roads, power lines, county lines, water bodies) on common maps (e.g., DeLorme gazetteer).

Survey Objective 3 – Improve the Effectiveness of Management Actions

Increasing the effectiveness of management requires an understanding of the reasons that Washington ground squirrels disappear from sites. Loss and degradation of suitable habitat is generally accepted as having the greatest negative impact on the species. Currently, there is no

protocol for collecting habitat data at squirrel sites, thus survey efforts are limited with regards to satisfying this objective. Detailed habitat data are important for effective management.

Categorical habitat descriptions can be recorded through qualitative assessment. Suggested categories include amount of shrub cover, shrub distribution, composition of native and exotic plants, grazing intensity, and occurrence of plant species common in Washington ground squirrel diets (see Tarifa and Yensen 2004). These data should be collected in the core area of sites and along associated 60-m and 90-m transects. Our observations indicate that recording habitat data beyond the 90-m transect is not time effective.

These habitat categories may provide an understanding of why ground squirrel abundance, as loosely reflected in numbers of active burrows, declines or increases at some sites and may provide a foundation for developing quantitative, habitat-driven surveys in the future. Other important habitat data (e.g., soils, slope, aspect, and elevation) can be derived from GIS models.

Survey Objective 4 – Evaluate Population Trends

Annual averages of active burrow abundance at sites may be a useful indicator of trends in Washington ground squirrel populations. However, currently known sites may not be representative of all sites existing in the state. Many documented sites occur within 200 m of roads, which suggests a bias in the manner in which sites are detected (Germaine et al. in press). A stringent evaluation of population trends in Washington will probably require a random survey design focusing on uncultivated lands in the species' range.

All known active Washington ground squirrel sites in Washington occur in Adams, Douglas, Franklin, Grant, Lincoln, and Walla Walla counties. These counties contain more than 890,000 ha of shrub-steppe (Dobler et al. 1996) that potentially could be occupied by the species. Because the squirrels appear to occur in low densities relative to the amount of suitable habitat, detecting population trends is likely to be expensive and time consuming.

Random transects on the Boardman Bombing Range in Morrow County, Oregon, produced a mean detection rate of one Washington ground squirrel site per 13.6 km of transect (Greene 1999). Assuming a similar density in Washington, a person walking 3.5 km per hour (2.2 mph) might locate 1-2 new sites per 8-hr day (assuming 6 hr of actual survey time). As previously discussed, potential exists for GIS to improve survey efficiency in areas of undocumented activity.

Improvement of Definitions

Some variables used in the collection of Washington ground squirrel site data are inadequately defined. Definitions of terms, as they apply to the surveys of 2003 and 2004, appear in Appendix A, but we suggest that some of these be improved to encourage consistency in data collection among future observers. First, "significant pocket of activity" was mentioned in the 2003 protocol, but was not specifically described. For the sake of simplicity, a pocket of activity should be defined as one or more active burrows at a location. During 2004, we recorded pockets of activity when they occurred ≥30 m from other pockets of activity or the site center

(Goodman 2003), but felt that 30 m was too short of distance because excessive pockets of activity were documented. Eric Yensen (pers. comm.) suggests that Washington ground squirrel activity be recorded at 100-m intervals. Documenting pockets of activity at this distance would facilitate estimation of site size because 1 ha equals a 100 m x 100 m square.

Second, the term "badger burrow" was not defined in the original protocol, which may result in all large excavated holes in the ground being labeled as recent badger burrows regardless of age, condition, or species that dug them. Badger burrows remain evident for multiple years (Whitford and Kay 1997, Eldridge 2004), confounding attempts to quantify recent badger activity and explain ground squirrel site loss due to badger depredation. Signs indicative of old burrows include various amounts of soil collapse and, to a lesser degree, vegetation growth inside the burrow (vegetation appears to grow quickly in freshly dug burrow entrances if moisture is available). To collect more meaningful data on badger activity, we recommend excluding from counts burrows that display >50% collapse or have vegetation growing inside. However, freshly plugged burrows of the appropriate size indicate occupation by a badger and should be counted. Coyote dens are occasionally created by digging out old badger burrows, typically resulting in holes that are nearly double the diameter of badger burrows. Coyote dens often occur in ditch banks, rock piles, and rock crevices, and are usually well concealed.

Third, the term "colony", which appears commonly in older reports (e.g., Carlson et al. 1980, Betts 1990, Greene 1999), has never been defined. More recent reports (e.g., Betts 1999, Morgan and Nugent 1999, Morgan 2002, Klein 2005) instead use the term "site" when describing locations occupied by Washington ground squirrels. This change in terminology may have occurred because "colony" implies independence from other locations supporting ground squirrels. In most cases, independence cannot be confirmed without an extensive survey of the surrounding area. Until "colony" is defined, use of the term should be avoided when writing survey results. We recommend describing Washington ground squirrel activity at the site level. The term "site" is less presumptive and simply represents a location where ground squirrel activity occurs or has occurred historically.

Guidelines for Determining Site Designation and Predator Activity

Currently, it is difficult to determine trends in the proportion of active to inactive Washington ground squirrel sites because of the lack of guidelines for establishing whether (1) newly discovered activity represents a new site, particularly when found near another known site, and (2) a known site has been "lost". These problems likely result from a limited understanding of the species' behavior (e.g., habitat preferences, dispersal, genetics) and an inability thus far to create justifiable guidelines for site designation. However, the risks of allowing subjectivity in site designation may outweigh those of creating guidelines that lack sufficient biological justification. This is because, if guidelines for site designation are not established, those researchers analyzing data will not know how the sites were labeled. This may result in misguided data analyses. Therefore, guidelines should be established and adjusted as the understanding of Washington ground squirrel behavior improves.

A distance threshold may be useful for objectively determining whether newly discovered ground squirrel activity represents a new site or is part of an existing site. For example, we

might suggest that any squirrel activity >300 m (or preferably a biologically meaningful distance such as mean dispersal of juvenile males) from other squirrel activity be considered a unique or new site. Ground squirrel sites should be considered inactive only when burrows no longer occur within 300 m of the recorded site boundaries.

Specific guidelines do not exist for documenting predator activity at Washington ground squirrel sites. Judgments on the impact of predators on ground squirrels require that predator sign (e.g., burrows, animals seen) be noted consistently at active and inactive sites. This is relatively straightforward at active sites, where predator evidence can be recorded near active squirrel burrows. However, documenting predator evidence at inactive sites is more difficult because of the lack of clear site boundaries due to the absence of squirrel burrows. Thus, we recommend that predator activity be recorded within 30 m of the site center and along 60-m and 90-m radial transects extending from the site center for active and inactive sites alike. Our observations indicate that recording activity beyond 90 m is not time effective.

Site Drift

Little is known regarding the distances that Washington ground squirrel sites move or "drift" over time, the proportion of sites at which this occurs, or the processes involved. A better understanding of drift will allow surveys to be designed to maximize field personnel efficiency while maintaining an effective search radius. For example, if one knew that the maximum drift distance for a given Washington ground squirrel site was ≤30 m annually and it had been 4 years since the last survey was conducted, the search radius could be reduced to 120 m and still account for drift. In this example, eliminating the 150-m transect from the survey could reduce survey time at the site by nearly 30 minutes.

Site drift may be quantifiable by tracking the movement of site centers over time. Although estimating drift is currently not an objective of Washington ground squirrel surveys, the information could prove useful over the long-term by saving survey time or indicating a need to extend the survey radius beyond 150 m.

Database Management

The Heritage database uses two site identification units, "occurrence" and "sequence." Occurrence is defined as the "number assigned sequentially to occurrences of a given species." Sites within an occurrence are numbered by sequence. Sequence is defined as the "sequence number of an observation to uniquely identify it from other observations comprising one occurrence (OCCUR). Generally, several [bird] nests within one territory are given different sequence numbers within an OCCUR or occurrence, or several observations within a single survey effort are given different sequence numbers within an OCCUR." There appears to be no explanation of how one occurrence is differentiated from another. These identification units should be clearly defined and applied when classifying Washington ground squirrel sites. We recommend using a GIS model to objectively categorize population units based on distance from other Washington ground squirrel sites. However, this issue warrants further thought for two reasons. First, the criteria for categorizing should be biologically meaningful. Second, one must understand that by using such a method, site occurrence and sequence numbers might change.

For example, site growth might cause two unique occurrences to merge and be considered as one occurrence. This could complicate data analyses.

Additional concerns associated with the Heritage database entries for Washington ground squirrels are:

1) Entries have been found within 50 m of each other, yet they are designated as different occurrences.
2) Two sites occasionally occur within 30 m of each other, yet they are labeled with different sequence numbers.
3) Some locations are based only on a visual sighting or an alarm call. Although this is not problematic, these entries should be made identifiable in the database system to allow censorship from certain analyses.
4) Entries with approximated locations occur in the database, for example, the location is listed by section or quarter section. These should be flagged to allow censorship from certain analyses because the current survey protocol assumes that every site has a precise GPS location.
5) Some sites may be inaccurately designated as "zapped" (i.e., they no longer possess viable habitat for a species) and should be resurveyed for squirrels.

Suggested Survey Protocol

Our suggested survey protocol is an amendment to that of Goodman (2003) and is for surveying known sites. The suggested protocol is intended to satisfy Objectives 1-3. However, to better satisfy Objective 1, we suggest using random transects to ensure that the inventory of occupied sites does not decline. Our protocol does not attempt to satisfy Objective 4 because we believe that it requires randomly collected data. We recommend a separate survey design for locating new Washington ground squirrel activity and evaluating trends at the population level.

A revised data form is provided in Appendix D and should be completed by the surveyor using the protocol below. This protocol assumes that the surveyor (1) is properly trained to detect Washington ground squirrel sign, (2) has successfully passed a True Tone hearing exam, thereby confirming that he/she can reliably hear Washington ground squirrel alarm calls, (3) postpones surveys during windy (Table 3) or wet conditions, and (4) adheres to the definitions provided in the Improvement of Definitions. Ideally, surveys should be conducted from early April to late May, which is the period when Washington ground squirrel activity is most obvious in Washington.

**Initial investigation**

1) Navigate to the site center,

2) Thoroughly search for ground squirrels and their signs within the core area (i.e., 30 m from site center),

    a. Ground squirrel presence not confirmed (i.e., sign not detected), proceed to step 3,

b. Ground squirrel presence confirmed (i.e., sign detected), proceed to step 9,

3) Conduct radial transects at 30-m intervals (starting at 60 m) until ground squirrel presence is confirmed or the 150-m radius transect is completed,

   a. Presence unconfirmed, proceed to step 4,

   b. Presence confirmed, proceed to step 9,

**Presence unconfirmed**

4) Record the site as inactive in Section 1 of data form,

5) Leave Section 2 blank,

6) In Section 3, record habitat characteristics and document all predator sign and observations within core area and from 60-m and 90-m transects (using the site center),

7) Document disturbance and/or make additional comments, if applicable, in Section 4,

8) Survey completed.

**Presence confirmed**

9) Record site occupancy and activity confirmation in Section 1 of data form,

10) Using GPS tracklog as a guide, walk the outer perimeter where burrows and/or alarm calls occur and collect pockets of activity at about 100-m intervals (i.e., a pocket of activity should not be recorded unless it is at least 100 m from other recorded pockets of activity). Once the perimeter has been determined, walk inside the perimeter and record pockets of activity until all have been located,

11) If necessary, update the site center in Section 2 by averaging the X (Northing) and Y (Easting) coordinates,

12) Using pockets of activity recorded by the GPS, estimate the geographic extent of the site in hectares and record in Section 2,

13) Conduct one complete circle of a radial transect around the site center and count active ground squirrel burrows found within 2 m of the transect. The radius should be selected such that it is as large as possible but does not exceed 100 m and is completely within the site. Record transect radius and number of active squirrel burrows observed in Section 2,

14) Survey the core area and 60-m and 90-m transects for habitat characteristics and predator activity, and fill out Section 3,

15) Document disturbance and habitat variability, and make additional comments if necessary, in Section 4,

16) Survey completed.

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## Appendix A. Definitions of terms.

**Active Washington ground squirrel site.** Any location where Washington ground squirrel activity was confirmed by fresh droppings, alarm calls, or visual confirmation of animals.

**Area.** A defined geographic subregion used to compare trends in Washington ground squirrel site occupancy. See Methods section for details.

**Badger burrow.** For the purpose of the survey, a badger burrow was defined as any burrow measuring >18 cm (>7 in) in diameter with more >50% of the opening intact. A badger burrow was concurrently defined as an active Washington ground squirrel burrow if squirrel sign was present in the burrow or around the entrance.

**Pocket of activity.** Four or more Washington ground squirrel-sized burrows that appeared to be used by ground squirrels (i.e., droppings in at least one burrow, an alarm call heard within 30 m, or visual confirmation of a Washington ground squirrel within 30 m) and were located within a radius of 10 m of each other.

**Predator activity.** Sightings of coyotes, raptors, snakes, other predatory animals, and their sign (e.g., badger burrows) were used to establish predator presence at specific locations.

**Washington ground squirrel burrow.** A typical Washington ground squirrel burrow was 5.7-7 cm (2¼-2¾ in) in diameter (Goodman 2003), but the species is known to occupy badger burrows and pocket gopher tunnels as well. Any burrow ≥5.7 cm in diameter was considered active if ground squirrel droppings were found in it. A 5.7-7-cm-diameter burrow without ground squirrel droppings was considered active if a pocket of activity was identified within 100 m, the burrow appeared used, and there were no signs of other rodents using the burrow. A burrow with a diameter >18 cm (i.e., badger-sized) was considered actively used by ground squirrels if it was not freshly made (i.e., showed signs of tunnel collapse, or vegetation was collecting or growing in it), the tunnel showed signs of small mammal traffic, scat from other rodents was absent, and it occurred within 100 m of a pocket of activity.

**Washington ground squirrel dropping.** These are typically about 1.2 cm (½ in) in length, but can vary in length from 0.6 – 2.5 cm (¼ – 1 in). Diameter of droppings ranges from 0.3-0.6 cm (⅛-¼ in). Fresh droppings are moist and dark green to black in color. Older droppings turn gray on the periphery. Only droppings from the current season were used to determine occupancy of a Washington ground squirrel site. If a dropping crumbled when squeezed firmly between two fingers, it was not considered to have been from the current season (i.e., old). A second test was breaking the dropping in half. If the dropping was brown in the center, it was not considered to have been from the current season. If a dropping was green or black and pliable inside, it was considered to be from the current season (i.e., fresh).

**Washington ground squirrel sign.** Includes visual confirmations, alarm calls, and droppings.

**Washington ground squirrel site.** For this survey, these sites were any Washington ground squirrel location entry in WDFW's Heritage database. Sites should not be interpreted as representing distinct populations of squirrels.

Appendix B. Boundary descriptions for 15 Washington ground squirrel areas in Adams, Douglas, and Grant counties, Washington.

**Beezley Hills (Grant Co.)**. Beginning at junction of Baird Springs Rd and Overen Rd (western Grant Co. approximately 10 km N of Quincy); NE on Overen Rd to Rd 20NW; E on Rd 20NW to Rd J NW; N on Rd J NW to Sagebrush Flat Rd; SE on Sagebrush Flat Rd to SR 28 (Ephrata); SW and W on SR 28 through Quincy to Baird Springs Rd; NE on Baird Springs Rd to Overen Rd and point of beginning.

**Black Rock Coulee (Grant Co.)**. Beginning at junction of SR 28 and Rd J NE (Stratford Rd) in the town of Stratford; W on SR 28 to Crab Creek; E on Crab Creek to Grant-Lincoln Co. line; S on Grant-Lincoln Co. line to Grant-Adams Co. line; S on Grant-Adams Co. line to Rd 7 NE; W on Rd 7 NE to Rd P NE, N on Rd P NE to Rd 8 NE, W on Rd 8 NE to Rd M NE, S on Rd M NE to Rd 7 NE, W on Rd 7 NE to Rd J NE (Stratford Rd); N on Rd J NE (Stratford Rd) to SR 28 and point of beginning (Stratford).

**Duffy Creek (Douglas Co.)**. Beginning at junction of Badger Mountain Rd and Baseline Rd (3 km SW of Waterville); W on Baseline Rd to Douglas Creek; S along Douglas Creek to Rd 24 NW (Palisades Rd); SW on Rd 24 NW (Palisades Rd) to SR 28; N on SR 28 to Rock Island Creek; N along Rock Island Creek to Badger Mountain Rd; NE on Badger Mountain Rd to Baseline Rd and point of beginning.

**Foster Coulee (Douglas Co.)**. Beginning at Niles Corner (10 km N of Leahy Junction); due N to Columbia River; E along Columbia River to Alec Canyon Creek; E along Alec Canyon Creek to Trefry Rd; E and S on Trefrey Rd to Rd Y.5 NE; SE on Rd Y.5 NE to SR 174; E on SR 174 to Barker Canyon Rd; S on Barker Canyon Rd to Douglas-Grant Co. line; S and W along Douglas-Grant Co. line to Hawks Cliff Rd; W and N on Hawks Cliff Rd to SR 17; N on SR 17 to Leahy Rd North (Leahy Junction); NW on Leahy Rd N to Nilles Rd; N on Nilles Rd to Nilles Corner and point of beginning.

**Hatton (Adams Co.)**. Beginning at junction of Herman Rd and Johnson Rd (8 km NW of Cunningham); E on Herman Rd to Neilson Rd, S on Neilson Rd to US Hwy 395; SW on US Hwy 395 to Jantz Rd; S on Jantz Rd to Adams-Franklin Co. line; W along Adams-Franklin Co. line to Johnson Rd; N on Johnson Rd to Herman Rd and point of beginning.

**Jameson Lake (Douglas Co.)**. Beginning at junction of US Hwy 2 and SR 172 in Farmer; N and E on SR 172 to SR 17 (Sims Corner); S on SR 17 to US Hwy 2; W on US Hwy 2 to SR 172 (Farmer) and point of beginning.

**Lind (Adams Co.)**. Beginning at junction of I-90 and Deal Rd (8 km E of Grant-Adams Co. line); E on I-90 to Paha-Packard Rd; S on Paha-Packard Rd to US Hwy 395; NE on US Hwy 395 to Sackman Rd; SE on Sackman Rd to Dewald Rd; S on Dewald Rd to Hiller Rd; E on Hiller Rd to Bauer Rd; S on Bauer Rd to Presnell Rd, E on Presnell Rd to Theil Rd; S on Theil Rd to Providence Rd; W on Providence Rd to US Hwy 395; S on US Hwy 395 to Neilson Rd; SW on Neilson Rd to Herman Rd; W on Herman Rd to Johnson Rd; N on Johnson Rd to Lind-Warden Rd; E on Lind-Warden Rd to Deal Rd; N on Deal Rd to I-90 and point of beginning.

**Moses Coulee (Douglas and Grant Cos.)**. Beginning at junction of SR 28 and Palisades Rd (10 km SE of Rock Island); NE and E on Palisades Rd to Moses Coulee Rd; S on Moses Coulee Rd to Rd 23 NW; E on Rd 23 NW to Sagebrush Flat Rd; S on Sagebrush Flat to Rd J NW; S on Rd J NW to Rd 20 NW; W on Rd 20 NW to Overen Rd; SW on Overen Rd to Baird Springs Rd; SW on Baird Springs Rd to SR 28; W & N on SR 28 to Palisades Rd and point of beginning.

**Ritzville (Adams Co.)**. Beginning at junction of Adams-Lincoln Co. line and Paha-Packard Rd (11 km S of Lamona); E along Adams-Lincoln Co. line to Hills Rd; S on Hills Rd to Wellsandt Rd; W on Wellsandt Rd to I-90; W on I-90 to Paha-Packard Rd; N on Paha-Packard Rd to Adams-Lincoln Co. line and point of beginning.

**Saddle Mountains (Grant & Adams Cos.)**. Beginning at junction of SR 243 and SR 26 (2-km SE of Vantage); E on SR 26 to SR 24 (Othello); S & W on SR 24 to Rd 24 SW; W on Rd 24 SW to SR 243; N on SR 243 to SR 26 and point of beginning. The Smyrna Bench Area is entirely enclosed within this area, but is excluded from consideration.

**Sagebrush Flats (Douglas Co.)**. Beginning at junction of US Hwy 2 and Moses Coulee Rd (7 km SSW of Jameson Lake); NE & E on US Hwy 2 to Rd J SE (Highland School Rd); S and E on Rd J SE (Highland School Rd) to Douglas-Grant Co. line; S & W along Douglas-Grant Co. line to Moses Coulee Rd; N on Moses Coulee Rd to US Hwy 2 and point of beginning.

**Seep Lakes (Grant and Adams Cos.)**. Beginning at junction of Rd 7 SE (O'Sullivan Dam Rd) and Rd A SE (3 km N of Royal Camp); E on Rd 7 SE (O' Sullivan Dam Rd) to O' Sullivan Dam and Potholes Reservoir; E along Potholes Reservoir to Lind Coulee; E along Lind Coulee to Rd M; S on Rd M to Rd 7 SE; E on Rd 7 SE to SR 17; S on SR 17 to Irrigation canal at T17N R29E S13 NE¼; S along irrigation canal to Rd 12 SE; E on Rd 12 SE to SR 17; S on SR 17 to SR 26; W on SR 26 to Rd A SE; N on Rd A SE to Rd 7 SE (O'Sullivan Dam Rd) and point of beginning.

**Smyrna Bench (Grant Co.)**. Sections 32-36 of T16N R25E including only those areas south of the Gillis Rd (Lower Crab Creek Rd); Sections 31-35 of T16N R26E including only those areas south of the Gillis Rd (Lower Crab Creek Rd); all of Sections 1-5 and Sections 8-12 of T15N R 25E; and all of Sections 2-11 of T15N R26E. This area is enclosed within the Saddle Mountains Area.

**Soap Lake (Grant Co.)**. Beginning at junction of Rd B NW and Grant-Douglas Co. line (2 km W of Little Soap Lake); E along Grant-Douglas Co. line to SE corner of Grant-Douglas Co. line near Little Soap Lake; E from SE corner of Grant-Douglas Co. line to Rd A NE; S on Rd A NE to Rd 23 NE; E on Rd 23 NE to Adrian Rd; S on Adrian Rd to Rd 20 NE; W on Rd 20 NE to Rd B NE; S on Rd B NE to Rd B .5 NE; S and E on Rd B .5 NE to Rocky Ford Hatchery and Hatchery Rd; W on Hatchery Rd to SR 17; S on SR 17 to SR 282; NW on SR 282 to SR 28 (Ephrata); N on SR 28 to Rd 8 NW; N on Rd B NW to Grant-Douglas Co. line and point of beginning.

**Warden (Grant Co.)**. Beginning at junction of SR 17 and Rd 6 SE (6 km WNW of Warden); E on Rd 6 SE to Grant-Adams Co. line; S & W along Grant-Adams Co. line to irrigation canal at T17N R29E S35 W1/2; N on irrigation canal to SR 17; N SR 17 to Rd 6 SE and point of beginning.

Appendix C. Data from Washington ground squirrel surveys in Adams, Douglas, and Grant counties, Washington, in 2004, including area, site identification number, county, date surveyed, occupancy status, burrow estimate, and ownership.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area[a] | County[b] | Site ID[c] | Date[d] | Occ[e] | Burrows[f] | POA[g] | Badger[h] | Ownership[i] | Occ[j] |
| Beezley Hills | Gr | 227-1 | May 5 | Y | 1-25 | 1 | 2 | Non-government Organization | Y |
| Beezley Hills | Gr | 227-2 | May 5 | U | -[k] | -[11] | 1 | Non-government Organization | Y |
| Beezley Hills | Gr | 227-3 | May 5 | Y | 1-25 | 2 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 228-1 | May 6 | Y | 1-25 | 1 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 229-1 | May 6 | U | - | - | 2 | Non-government Organization | Y |
| Beezley Hills | Gr | 229-2 | May 6 | Y | 1-25 | 1 | 1 | Non-government Organization | Y |
| Beezley Hills | Gr | 229-3 | May 6 | Y | 1-25 | 1 | 1 | Non-government Organization | Y |
| Beezley Hills | Gr | 229-4 | May 7 | Y | 51-75 | 5 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 229-5 | May 7 | U | - | - | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 229-6 | May 7 | U | - | - | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 230-1 | May 3 | U | - | - | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 230-2 | May 3 | N | 0 | 0 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 230-3 | May 3 | N | 0 | 0 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 230-4 | May 3 | U | - | - | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 230-5 | May 3 | U | - | - | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 231-1 | Jun 3 | Y | 101-125 | 13 | 18 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-1 | Apr 29 | Y | 1-25 | 1 | 2 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-10 | Apr 29 | Y | 26-50 | 3 | 2 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-11 | Apr 29 | Y | 26-50 | 4 | 2 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-12 | Apr 29 | Y | 1-25 | 1 | 0 | Non-government Organization | Y |

[a] Defined area where the Washington ground squirrel site occurs (see Figures 1 and 2).
[b] County where the site occurs: Ad = Adams County; Do = Douglas County; Gr = Grant County.
[c] Unique site designation created by concatenating “OCCUR” and “SEQNO” from the Heritage database (i.e., “OCCUR”-“SEQNO”).
[d] Date surveyed in 2004.
[e] Occupancy status of the site during 2004 survey: Y = confirmed active; U = status unconfirmed; N = confirmed vacant.
[f] Estimated number of Washington ground squirrel burrows per site.
[g] Number of “pockets of activity” documented during 2004 survey. Number listed includes the original site.
[h] Number of badger holes documented during 2004 survey.
[i] Ownership of land containing the site. These data were obtained from the corresponding county tax assessor offices, public accounts during field investigations, or Department of Natural Resources – Washington State Public Lands Maps.
[j] Occupancy status of the site during surveys conducted from 2001-2003: Y = confirmed active during at least one year; U = status unconfirmed during all years surveyed; N = confirmed vacant during all years surveyed; - = not surveyed at any time during 2001-2003.
[k] No estimate made for unconfirmed sites.

Appendix C. Continued.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area | County | Site ID | Date | Occ | Burrows | POA | Badger | Ownership | Occ |
| Beezley Hills | Gr | 233-13 | Apr 29 | Y | 1-25 | 1 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-14 | Apr 29 | Y | 1-25 | 1 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-15 | Apr 29 | Y | 1-25 | 1 | 1 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-2 | Apr 29 | Y | 26-50 | 2 | 4 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-3 | May 3 | Y | 1-25 | 1 | 3 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-4 | May 3 | Y | 1-25 | 1 | 1 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-5 | May 3 | Y | 1-25 | 1 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-6 | May 3 | Y | 26-50 | 3 | 2 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-7 | May 3 | Y | 1-25 | 1 | 1 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-8 | May 3 | Y | 51-75 | 3 | 4 | Non-government Organization | Y |
| Beezley Hills | Gr | 233-9 | May 3 | Y | 76-100 | 5 | 8 | Non-government Organization | Y |
| Beezley Hills | Gr | 234-1 | May 5 | Y | 26-50 | 2 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 234-2 | May 5 | Y | 1-25 | 1 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 234-3 | May 5 | Y | 26-50 | 2 | 0 | US Federal Government | Y |
| Beezley Hills | Gr | 234-4 | May 6 | N | 0 | 0 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 234-5 | May 6 | Y | 1-25 | 1 | 1 | Non-government Organization | Y |
| Beezley Hills | Gr | 234-6 | May 6 | Y | 1-25 | 2 | 2 | Non-government Organization | Y |
| Beezley Hills | Gr | 234-7 | May 6 | Y | 1-25 | 1 | 1 | Non-government Organization | Y |
| Beezley Hills | Gr | 234-8 | May 6 | Y | 1-25 | 2 | 1 | US Federal Government | Y |
| Beezley Hills | Gr | 239-1 | May 21 | Y | 1-25 | 1 | 1 | Private | Y |
| Beezley Hills | Gr | 239-2 | May 21 | Y | 26-50 | 3 | 0 | Private | Y |
| Beezley Hills | Gr | 275-1 | Apr 29 | Y | 126-150 | 9 | 3 | US Federal Government | Y |
| Beezley Hills | Gr | 316-1 | Jun 3 | Y | x[l] | 9 | 0 | Private | Y |
| Beezley Hills | Gr | 356-1 | May 21 | Y | 1-25 | 2 | 0 | Private | Y |
| Beezley Hills | Gr | 357-1 | May 21 | Y | 1-25 | 1 | 3 | Private | Y |
| Beezley Hills | Gr | 361-1 | May 7 | Y | 51-75 | 2 | 3 | Non-government Organization | N |
| Beezley Hills | Gr | 368-1 | May 21 | Y | 1-25 | 1 | 0 | Private | Y |
| Beezley Hills | Gr | 369-1 | May 21 | Y | 1-25 | 2 | 2 | Private | Y |
| Beezley Hills | Gr | 370-1 | May 21 | Y | 1-25 | 5 | 0 | Non-government Organization | Y |
| Beezley Hills | Gr | 371-1 | May 21 | Y | 1-25 | 1 | 3 | Private | Y |
| Beezley Hills | Gr | 373-1 | May 21 | Y | 1-25 | 3 | 2 | Private | Y |
| Beezley Hills | Gr | 374-1 | Apr 29 | Y | 1-25 | 1 | 0 | Non-government Organization | N |
| Beezley Hills | Gr | 375-1 | May 7 | N | 0 | 0 | 0 | Washington State | N |

[l] Survey incomplete; no burrow estimate made.

Appendix C. Continued.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area | County | Site ID | Date | Occ | Burrows | POA | Badger | Ownership | Occ |
| Beezley Hills | Gr | 376-1 | May 5 | Y | 176-200 | 6 | 3 | Non-government Organization | Y |
| Beezley Hills | Gr | 377-1 | May 7 | Y | 151-175 | 10 | 7 | Non-government Organization | Y |
| Beezley Hills | Gr | 378-1 | May 7 | Y | 26-50 | 3 | 3 | US Federal Government | Y |
| Black Rock Coulee | Gr | 137-2 | Apr 19 | Y | 51-75 | 4 | 0 | Private | Y |
| Black Rock Coulee | Gr | 137-3 | Apr 19 | N | 0 | 0 | 0 | US Federal Government | Y |
| Black Rock Coulee | Gr | 236-1 | Apr 19 | Y | 1-50 | 2 | 0 | Private | Y |
| Black Rock Coulee | Gr | 236-2 | Apr 19 | N | 0 | 0 | 0 | Private | Y |
| Black Rock Coulee | Gr | 236-3 | Apr 19 | Y | 1-25 | 1 | 1 | Private | Y |
| Black Rock Coulee | Gr | 236-4 | Apr 19 | Y | 1-25 | 1 | 4 | Private | Y |
| Black Rock Coulee | Gr | 236-5 | Apr 19 | Y | 1-25 | 1 | 0 | Private | Y |
| Black Rock Coulee | Gr | 236-6 | Apr 19 | Y | 1-25 | 1 | 4 | Private | Y |
| Black Rock Coulee | Gr | 249-1 | Apr 23 | Y | 151-175 | 9 | 1 | US Federal Government | Y |
| Black Rock Coulee | Gr | 314-1 | Apr 22 | Y | 1-25 | 2 | 3 | Washington State | Y |
| Black Rock Coulee | Gr | 314-2 | Apr 22 | Y | 51-75 | 5 | 2 | Washington State | Y |
| Black Rock Coulee | Gr | 314-3 | Apr 22 | Y | 26-50 | 3 | 2 | Washington State | Y |
| Black Rock Coulee | Gr | 348-1 | Apr 22 | Y | 1-25 | 3 | 3 | Washington State | Y |
| Black Rock Coulee | Gr | 348-2 | Apr 22 | Y | 1-50 | 3 | 0 | Washington State | Y |
| Black Rock Coulee | Gr | 348-3 | Apr 22 | Y | 1-25 | 1 | 0 | Washington State | Y |
| Black Rock Coulee | Gr | 349-1 | Apr 22 | Y | 1-25 | 2 | 1 | Washington State | Y |
| Black Rock Coulee | Gr | 353-1 | Apr 23 | Y | 101-125 | 4 | 7 | US Federal Government | Y |
| Black Rock Coulee | Gr | 8-1 | Apr 15 | N | 0 | 0 | 0 | Private | N |
| Black Rock Coulee | Gr | 84-1 | Apr 14 | Y | 51-75 | 4 | 8 | Private | Y |
| Black Rock Coulee | Gr | 85-1 | Apr 14 | N | 0 | 0 | 0 | Private | Y |
| Black Rock Coulee | Gr | 86-2 | Apr 19 | Y | 26-50 | 2 | 0 | Private | Y |
| Black Rock Coulee | Gr | 9-1 | Apr 15 | N | 0 | 0 | 0 | Private | N |
| Duffy Creek | Do | 205-1 | May 20 | Y | 1-25 | 1 | 1 | US Federal Government | Y |
| Duffy Creek | Do | 211-1 | May 24 | Y | 51-75 | 4 | 1 | US Federal Government | Y |
| Duffy Creek | Do | 212-1 | May 24 | Y | 1-25 | 1 | 0 | Private | Y |
| Duffy Creek | Do | 308-1 | May 13 | N | 0 | 0 | 0 | Private | Y |
| Duffy Creek | Do | 309-1 | May 13 | Y | 1-25 | 1 | 2 | Private | Y |
| Duffy Creek | Do | 310-1 | May 13 | Y | 26-100 | 4 | 3 | Private | Y |
| Duffy Creek | Do | 311-1 | May 20 | Y | 1-25 | 3 | 0 | US Federal Government | Y |
| Duffy Creek | Do | 312-1 | May 20 | Y | 1-25 | 1 | 0 | US Federal Government | Y |
| Duffy Creek | Do | 313-1 | May 20 | Y | 1-25 | 1 | 0 | US Federal Government | Y |

Appendix C. Continued.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area | County | Site ID | Date | Occ | Burrows | POA | Badger | Ownership | Occ |
| Duffy Creek | Do | 313-2 | May 20 | Y | 1-25 | 2 | 0 | US Federal Government | Y |
| Duffy Creek | Do | 318-1 | May 13 | Y | 1-25 | 2 | 1 | US Federal Government | Y |
| Duffy Creek | Do | 319-1 | May 13 | Y | 1-25 | 2 | 0 | US Federal Government | Y |
| Duffy Creek | Do | 320-1 | May 13 | Y | 1-25 | 1 | 2 | US Federal Government | Y |
| Duffy Creek | Do | 321-1 | May 13 | Y | 1-25 | 2 | 1 | US Federal Government | Y |
| Duffy Creek | Do | 322-1 | May 20 | Y | 1-25 | 3 | 0 | US Federal Government | Y |
| Duffy Creek | Do | 323-1 | May 20 | Y | 1-25 | 2 | 1 | US Federal Government | Y |
| Duffy Creek | Do | 324-1 | May 20 | Y | 1-25 | 3 | 0 | US Federal Government | Y |
| Duffy Creek | Do | 325-1 | May 24 | Y | 26-50 | 5 | 1 | US Federal Government | Y |
| Duffy Creek | Do | 326-1 | May 24 | Y | 1-25 | 2 | 1 | Private | Y |
| Duffy Creek | Do | 327-1 | May 24 | Y | 1-25 | 1 | 0 | Private | Y |
| Duffy Creek | Do | 328-1 | May 24 | Y | 26-50 | 3 | 1 | Private | Y |
| Duffy Creek | Do | 329-1 | May 24 | Y | 1-25 | 1 | 0 | Private | Y |
| Foster Coulee | Do | 132-1 | May 26 | N | 0 | 0 | 3 | Washington State | - |
| Foster Coulee | Do | 213-1 | May 26 | Y | 1-25 | 1 | 0 | Washington State | Y |
| Foster Coulee | Do | 221-1 | May 26 | Y | 1-25 | 3 | 4 | Private | N |
| Foster Coulee | Do | 222-1 | May 26 | N | 0 | 0 | 3 | Washington State | Y |
| Foster Coulee | Do | 222-2 | May 26 | N | 0 | 0 | 3 | Washington State | N |
| Foster Coulee | Do | 222-3 | May 26 | N | 0 | 0 | 3 | Washington State | Y |
| Foster Coulee | Do | 222-4 | May 26 | Y | 1-25 | 2 | 3 | Washington State | N |
| Foster Coulee | Do | 223-1 | May 26 | Y | 1-25 | 1 | 2 | Private | Y |
| Foster Coulee | Do | 363-1 | May 26 | Y | 1-25 | 3 | 1 | Washington State | Y |
| Hatton | Ad | 32-1 | Apr 9 | N | 0 | 0 | 0 | Private | N |
| Hatton | Ad | 354-1 | Apr 9 | Y | 1-25 | 1 | 0 | Private | Y |
| Hatton | Ad | 355-1 | Apr 9 | N | 0 | 0 | 3 | Private | Y |
| Hatton | Ad | 40-1 | Apr 9 | N | 0 | 0 | 0 | Washington State | N |
| Hatton | Ad | 41-1 | Apr 9 | N | 0 | 0 | 0 | Private | N |
| Jameson Lake | Do | 120-2 | Jun 1 | Y | 1-25 | 2 | 1 | Private | Y |
| Jameson Lake | Do | 120-3 | Jun 1 | Y | 1-25 | 1 | 1 | Private | Y |
| Jameson Lake | Do | 135-2 | Jun 1 | Y | 1-25 | 3 | 0 | Private | Y |
| Jameson Lake | Do | 207-1 | May 19 | Y | 1-25 | 3 | 5 | Non-government Organization | Y |
| Jameson Lake | Do | 208-1 | May 19 | Y | 1-25 | 2 | 3 | Non-government Organization | Y |
| Jameson Lake | Do | 209-1 | May 19 | Y | 76-100 | 7 | 2 | Non-government Organization | Y |
| Jameson Lake | Do | 209-2 | May 19 | Y | 51-75 | 4 | 3 | Non-government Organization | Y |

Appendix C. Continued.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area | County | Site ID | Date | Occ | Burrows | POA | Badger | Ownership | Occ |
| Jameson Lake | Do | 210-1 | May 19 | Y | 51-75 | 9 | 8 | Non-government Organization | Y |
| Jameson Lake | Do | 217-1 | May 19 | N | 0 | 0 | 0 | US Federal Government | U |
| Jameson Lake | Do | 220-1 | May 19 | Y | 1-25 | 1 | 0 | Private | Y |
| Jameson Lake | Do | 364-1 | Jun 1 | Y | 51-75 | 8 | 1 | Washington State | Y |
| Jameson Lake | Do | 365-1 | Jun 1 | Y | 1-25 | 2 | 0 | Private | Y |
| Jameson Lake | Do | 366-1 | May 19 | Y | 1-25 | 2 | 2 | Private | Y |
| Lind | Ad | 16-1 | Apr 9 | N | 0 | 0 | 0 | Private | N |
| Lind | Ad | 33-1 | Apr 9 | N | 0 | 0 | 0 | Private | N |
| Lind | Ad | 34-2 | Jun 2 | Y | 1-25 | 1 | 2 | Private | Y |
| Lind | Ad | 52-1 | Apr 9 | Y | 51-75 | 2 | 5 | Private | Y |
| Lind | Ad | 53-1 | Apr 9 | Y | 26-75 | 3 | 1 | Private | Y |
| Lind | Ad | 53-2 | Apr 9 | Y | 101-125 | 4 | 5 | Private | Y |
| Lind | Ad | 54-1 | Apr 9 | N | 0 | 0 | 0 | Private | N |
| Moses Coulee | Gr | 276-1 | May 25 | Y | 201-225 | 13 | 11 | US Federal Government | Y |
| Moses Coulee | Gr | 277-1 | May 27 | Y | 51-75 | 7 | 2 | US Federal Government | Y |
| Moses Coulee | Gr | 278-1 | May 27 | N | 0 | 0 | 0 | US Federal Government | Y |
| Moses Coulee | Gr | 279-1 | May 27 | Y | 126-150 | 12 | 8 | US Federal Government | Y |
| Moses Coulee | Gr | 280-1 | May 10 | Y | 26-50 | 4 | 3 | US Federal Government | Y |
| Moses Coulee | Gr | 281-1 | May 10 | Y | 151-175 | 8 | 20 | US Federal Government | Y |
| Moses Coulee | Gr | 281-2 | May 10 | Y | 76-100 | 5 | 3 | US Federal Government | Y |
| Moses Coulee | Gr | 282-1 | May 10 | Y | 251-275 | 17 | 40 | US Federal Government | Y |
| Moses Coulee | Gr | 283-1 | May 27 | Y | 1-25 | 2 | 6 | US Federal Government | Y |
| Moses Coulee | Gr | 284-1 | May 27 | Y | 26-50 | 3 | 4 | US Federal Government | Y |
| Moses Coulee | Gr | 285-1 | May 27 | Y | 26-50 | 3 | 4 | US Federal Government | Y |
| Moses Coulee | Gr | 286-1 | May 27 | Y | 26-50 | 4 | 2 | US Federal Government | Y |
| Moses Coulee | Gr | 287-1 | May 27 | Y | 26-50 | 4 | 4 | US Federal Government | Y |
| Moses Coulee | Gr | 288-1 | May 10 | Y | 151-175 | 7 | 17 | US Federal Government | Y |
| Moses Coulee | Gr | 289-1 | May 10 | Y | 51-75 | 5 | 1 | US Federal Government | Y |
| Moses Coulee | Gr | 290-1 | May 10 | Y | 1-25 | 2 | 0 | US Federal Government | Y |
| Moses Coulee | Gr | 291-1 | May 10 | Y | 276-300 | 12 | 19 | US Federal Government | Y |
| Moses Coulee | Gr | 292-1 | May 10 | Y | 1-25 | 3 | 1 | US Federal Government | Y |
| Moses Coulee | Gr | 293-1 | May 25 | Y | 1-25 | 1 | 0 | US Federal Government | Y |
| Moses Coulee | Gr | 295-1 | May 14 | Y | 1-25 | 3 | 2 | US Federal Government | Y |
| Moses Coulee | Gr | 296-1 | May 14 | Y | 26-50 | 5 | 5 | US Federal Government | Y |

Appendix C. Continued.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area | County | Site ID | Date | Occ | Burrows | POA | Badger | Ownership | Occ |
| Moses Coulee | Gr | 297-1 | May 14 | Y | 126-150 | 8 | 5 | US Federal Government | Y |
| Moses Coulee | Gr | 298-1 | May 14 | Y | 126-150 | 7 | 6 | US Federal Government | Y |
| Moses Coulee | Gr | 299-1 | May 14 | Y | 126-150 | 10 | 7 | US Federal Government | Y |
| Moses Coulee | Gr | 300-1 | May 14 | Y | 26-50 | 1 | 1 | US Federal Government | Y |
| Moses Coulee | Gr | 301-1 | May 14 | Y | 1-25 | 1 | 0 | US Federal Government | Y |
| Moses Coulee | Gr | 302-1 | May 24 | Y | 51-75 | 6 | 6 | US Federal Government | Y |
| Moses Coulee | Gr | 303-1 | May 25 | Y | 51-75 | 4 | 5 | US Federal Government | Y |
| Moses Coulee | Gr | 304-1 | May 25 | Y | 151-175 | 7 | 1 | US Federal Government | Y |
| Moses Coulee | Gr | 305-1 | May 25 | Y | 1-25 | 3 | 1 | US Federal Government | Y |
| Moses Coulee | Gr | 306-1 | May 25 | Y | 1-25 | 1 | 0 | US Federal Government | Y |
| Ritzville | Ad | 242-1 | Jun 2 | Y | 1-25 | 1 | 0 | Private | Y |
| Ritzville | Ad | 242-2 | Jun 2 | Y | 76-100 | 5 | 12 | Private | Y |
| Ritzville | Ad | 242-3 | Jun 2 | Y | 1-25 | 1 | 0 | Private | Y |
| Ritzville | Ad | 45-2 | Jun 2 | Y | 1-25 | 1 | 2 | Private | Y |
| Saddle Mountains | Gr | 160-1 | Mar 29 | Y | 101-125 | 1 | 7 | US Federal Government | Y |
| Saddle Mountains | Gr | 160-2 | Mar 29 | Y | 51-75 | 1 | 4 | US Federal Government | Y |
| Saddle Mountains | Gr | 160-3 | Mar 29 | Y | 26-75 | 2 | 9 | Private | Y |
| Saddle Mountains | Gr | 160-4 | Mar 29 | Y | 1-25 | 1 | 0 | Private | Y |
| Saddle Mountains | Ad | 246-1 | May 4 | Y | 1-25 | 4 | 0 | Washington State | Y |
| Saddle Mountains | Ad | 246-2 | May 4 | Y | 26-50 | 1 | 1 | Washington State | Y |
| Saddle Mountains | Ad | 247-4 | May 4 | Y | 1-25 | 2 | 2 | Private | Y |
| Saddle Mountains | Gr | 263-1 | Mar 29 | Y | 1-50 | 2 | 0 | US Federal Government | Y |
| Saddle Mountains | Ad | 334-1 | May 4 | Y | 26-50 | 2 | 0 | Private | Y |
| Saddle Mountains | Ad | 335-1 | May 4 | Y | 1-25 | 1 | 0 | US Federal Government | Y |
| Saddle Mountains | Ad | 336-1 | May 4 | Y | 1-25 | 4 | 1 | US Federal Government | Y |
| Saddle Mountains | Ad | 336-2 | May 4 | Y | 1-25 | 3 | 6 | US Federal Government | U |
| Saddle Mountains | Gr | 337-1 | May 4 | Y | 1-25 | 1 | 0 | US Federal Government | Y |
| Saddle Mountains | Gr | 337-2 | May 4 | Y | 26-50 | 1 | 4 | US Federal Government | U |
| Saddle Mountains | Gr | 338-1 | May 4 | N | 0 | 0 | 0 | US Federal Government | Y |
| Saddle Mountains | Ad | 339-1 | May 4 | Y | 1-25 | 1 | 2 | US Federal Government | Y |
| Sagebrush Flats | Do | 127-2 | May 12 | Y | 1-25 | 2 | 1 | Washington State | Y |
| Sagebrush Flats | Do | 136-2 | May 12 | Y | 1-25 | 3 | 2 | Washington State | Y |
| Sagebrush Flats | Do | 203-1 | May 12 | Y | 1-25 | 1 | 2 | Washington State | N |
| Sagebrush Flats | Do | 204-1 | May 12 | Y | 1-25 | 3 | 2 | Washington State | Y |

Appendix C. Continued.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area | County | Site ID | Date | Occ | Burrows | POA | Badger | Ownership | Occ |
| Sagebrush Flats | Do | 224-1 | May 12 | Y | 26-75 | 4 | 6 | Washington State | Y |
| Sagebrush Flats | Do | 224-2 | May 12 | Y | 1-25 | 2 | 1 | Washington State | Y |
| Sagebrush Flats | Do | 225-1 | May 12 | Y | 26-50 | 2 | 2 | Washington State | Y |
| Sagebrush Flats | Do | 235-1 | May 12 | Y | 76-100 | 5 | 3 | Washington State | Y |
| Sagebrush Flats | Do | 330-1 | May 13 | N | 0 | 0 | 4 | Washington State | N |
| Sagebrush Flats | Do | 362-1 | May 12 | N | 0 | 0 | 2 | Washington State | Y |
| Sagebrush Flats | Do | 367-1 | May 12 | Y | 1-25 | 1 | 3 | Washington State | Y |
| Seep Lakes | Gr | 143-1 | Apr 6 | N | 0 | 0 | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 143-2 | Apr 6 | N | 0 | 0 | 0 | Washington State | Y |
| Seep Lakes | Gr | 143-3 | Apr 26 | Y | 1-25 | 1 | 0 | Washington State | Y |
| Seep Lakes | Gr | 143-4 | Apr 26 | N | 0 | 0 | 1 | Washington State | Y |
| Seep Lakes | Gr | 144-1 | Apr 8 | Y | 1-25 | 1 | 3 | US Federal Government | N |
| Seep Lakes | Gr | 144-2 | Apr 8 | Y | 101-150 | 4 | 9 | US Federal Government | Y |
| Seep Lakes | Gr | 144-3 | Apr 5 | Y | 1-25 | 1 | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 148-1 | Apr 12 | N | 0 | 0 | 6 | US Federal Government | Y |
| Seep Lakes | Gr | 148-2 | Apr 12 | N | 0 | 0 | 0 | US Federal Government | N |
| Seep Lakes | Gr | 149-1 | Apr 12 | N | 0 | 0 | 0 | US Federal Government | N |
| Seep Lakes | Gr | 150-1 | Apr 12 | N | 0 | 0 | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 151-1 | Apr 12 | N | 0 | 0 | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 151-2 | Apr 12 | N | 0 | 0 | 0 | US Federal Government | N |
| Seep Lakes | Gr | 151-3 | Apr 12 | N | 0 | 0 | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 151-4 | Apr 12 | N | 0 | 0 | 0 | US Federal Government | N |
| Seep Lakes | Gr | 152-1 | Apr 13 | N | 0 | 0 | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 152-2 | Apr 13 | N | 0 | 0 | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 152-3 | Apr 13 | N | 0 | 0 | 0 | US Federal Government | U |
| Seep Lakes | Gr | 152-4 | Apr 13 | Y | 26-50 | 1 | 6 | US Federal Government | Y |
| Seep Lakes | Ad | 156-1 | Apr 27 | Y | 51-75 | 5 | 12 | US Federal Government | Y |
| Seep Lakes | Ad | 156-2 | Apr 27 | Y | 51-100 | 3 | 34 | US Federal Government | Y |
| Seep Lakes | Ad | 157-1 | Apr 27 | U | - | - | 1 | Private | Y |
| Seep Lakes | Ad | 157-2 | Apr 27 | Y | 1-25 | 1 | 0 | Private | Y |
| Seep Lakes | Ad | 157-3 | Apr 27 | Y | 26-50 | 1 | 2 | Private | Y |
| Seep Lakes | Ad | 159-1 | Apr 27 | N | 0 | 0 | 0 | Private | Y |
| Seep Lakes | Ad | 159-2 | Apr 27 | Y | 1-25 | 1 | 0 | Private | Y |
| Seep Lakes | Ad | 159-3 | Apr 27 | Y | 126-150 | 2 | 38 | Private | Y |

Appendix C. Continued.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area | County | Site ID | Date | Occ | Burrows | POA | Badger | Ownership | Occ |
| Seep Lakes | Ad | 161-1 | Apr 28 | N | 0 | 0 | 0 | Private | N |
| Seep Lakes | Ad | 161-2 | Apr 28 | Y | 1-25 | 1 | 0 | Private | Y |
| Seep Lakes | Gr | 191-1 | Apr 28 | Y | 26-50 | 4 | 0 | US Federal Government | N |
| Seep Lakes | Gr | 191-2 | Apr 2 | Y | 1-25 | 1 | 1 | Private | N |
| Seep Lakes | Gr | 191-3 | Apr 2 | Y | 1-25 | 2 | 0 | US Federal Government | N |
| Seep Lakes | Gr | 191-4 | Apr 2 | Y | 26-50 | 1 | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 192-1 | Apr 2 | N | 0 | 0 | 0 | Private | N |
| Seep Lakes | Gr | 192-2 | Apr 2 | N | 0 | 0 | 1 | Private | N |
| Seep Lakes | Gr | 192-3 | Apr 2 | N | 0 | 0 | 0 | Private | N |
| Seep Lakes | Gr | 193-1 | Apr 6 | N | 0 | 0 | 0 | Private | N |
| Seep Lakes | Gr | 193-2 | Apr 6 | N | 0 | 0 | 0 | Private | N |
| Seep Lakes | Gr | 194-1 | Apr 6 | N | 0 | 0 | 0 | Private | N |
| Seep Lakes | Gr | 194-2 | Apr 5 | N | 0 | 0 | 6 | Private | Y |
| Seep Lakes | Gr | 194-3 | Apr 5 | Y | 26-50 | 2 | 20 | Private | Y |
| Seep Lakes | Gr | 194-4 | Apr 5 | N | 0 | 0 | 0 | Private | Y |
| Seep Lakes | Gr | 195-1 | Apr 26 | Y | 51-75 | 3 | 3 | Private | Y |
| Seep Lakes | Gr | 195-2 | Apr 26 | N | 0 | 0 | 0 | Private | Y |
| Seep Lakes | Gr | 196-1 | Apr 6 | Y | 76-100 | 5 | 8 | Washington State | Y |
| Seep Lakes | Gr | 196-2 | Apr 6 | Y | 1-25 | 1 | 4 | Washington State | Y |
| Seep Lakes | Gr | 196-3 | Apr 8 | Y | 26-50 | 4 | 2 | Washington State | Y |
| Seep Lakes | Gr | 196-4 | Apr 8 | Y | 1-75 | 10 | 9 | Washington State | Y |
| Seep Lakes | Gr | 201-1 | Apr 26 | Y | 101-150 | 6 | 10 | Private | Y |
| Seep Lakes | Gr | 201-2 | Apr 26 | N | 0 | 0 | 0 | Private | N |
| Seep Lakes | Gr | 201-3 | Apr 26 | N | 0 | 0 | 0 | Private | N |
| Seep Lakes | Gr | 23-1 | Apr 26 | Y | 51-75 | 4 | 8 | US Federal Government | Y |
| Seep Lakes | Gr | 23-2 | Apr 26 | N | 0 | 0 | 0 | Private | - |
| Seep Lakes | Gr | 23-3 | Apr 23 | N | 0 | 0 | 0 | US Federal Government | - |
| Seep Lakes | Gr | 23-4 | Apr 26 | Y | 201-300 | 8 | 34 | US Federal Government | Y |
| Seep Lakes | Gr | 23-5 | Apr 1 | Y | 101-125 | 4 | 40 | Private | Y |
| Seep Lakes | Gr | 23-6 | Apr 1 | Y | 26-50 | 1 | 4 | US Federal Government | Y |
| Seep Lakes | Gr | 23-7 | Apr 1 | Y | 76-100 | 3 | 25 | US Federal Government | Y |
| Seep Lakes | Gr | 23-8 | Apr 1 | Y | 76-175 | 4 | 9 | US Federal Government | - |
| Seep Lakes | Gr | 25-1 | Apr 13 | Y | 51-75 | 3 | 2 | US Federal Government | Y |
| Seep Lakes | Ad | 25-2 | Apr 28 | Y | 1-25 | 1 | 2 | US Federal Government | Y |

Appendix C. Continued.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area | County | Site ID | Date | Occ | Burrows | POA | Badger | Ownership | Occ |
| Seep Lakes | Ad | 25-3 | Apr 13 | Y | 1-25 | 4 | 0 | US Federal Government | Y |
| Seep Lakes | Ad | 25-4 | Apr 27 | N | 0 | 0 | 0 | Private | Y |
| Seep Lakes | Gr | 344-1 | Apr 8 | Y | 151-175 | 3 | 7 | US Federal Government | Y |
| Seep Lakes | Gr | 345-1 | Apr 8 | Y | 1-50 | 3 | 18 | US Federal Government | Y |
| Seep Lakes | Gr | 346-1 | Apr 8 | N | 0 | 0 | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 347-1 | Apr 6 | Y | 1-25 | 1 | 0 | Private | Y |
| Seep Lakes | Gr | 57-1 | Apr 5 | U | - | - | 0 | US Federal Government | Y |
| Seep Lakes | Gr | 57-2 | Apr 5 | N | 0 | 0 | 0 | Private | Y |
| Seep Lakes | Gr | 58-1 | Apr 5 | N | 0 | 0 | 0 | Private | N |
| Smyrna Bench | Gr | 250-2 | Apr 7 | Y | 1-25 | 2 | 0 | Washington State | Y |
| Smyrna Bench | Gr | 250-3 | Apr 7 | Y | 1-25 | 1 | 2 | Washington State | Y |
| Smyrna Bench | Gr | 250-4 | Apr 7 | Y | 26-75 | 2 | 7 | Washington State | Y |
| Smyrna Bench | Gr | 250-5 | Apr 7 | Y | 51-75 | 1 | 1 | Washington State | Y |
| Smyrna Bench | Gr | 251-1 | Apr 7 | U | - | - | 3 | Washington State | Y |
| Smyrna Bench | Gr | 251-2 | Apr 7 | Y | 151-175 | 4 | 0 | Washington State | Y |
| Smyrna Bench | Gr | 251-3 | Apr 7 | Y | 51-75 | 3 | 6 | Washington State | Y |
| Smyrna Bench | Gr | 251-4 | Apr 7 | U | - | - | 0 | Washington State | Y |
| Smyrna Bench | Gr | 251-5 | Apr 7 | Y | 51-75 | 1 | 0 | Washington State | Y |
| Smyrna Bench | Gr | 254-1 | Apr 7 | U | - | - | 0 | Washington State | Y |
| Smyrna Bench | Gr | 254-2 | Apr 7 | Y | 1-25 | 1 | 0 | Washington State | Y |
| Smyrna Bench | Gr | 264-1 | Apr 21 | Y | 76-125 | 4 | 3 | US Federal Government | Y |
| Smyrna Bench | Gr | 265-1 | Apr 21 | Y | 51-75 | 3 | 2 | Private | Y |
| Smyrna Bench | Gr | 266-1 | Apr 21 | U | - | - | 1 | US Federal Government | Y |
| Smyrna Bench | Gr | 267-1 | Apr 21 | Y | 51-100 | 6 | 2 | US Federal Government | Y |
| Smyrna Bench | Gr | 268-1 | Apr 21 | Y | 51-100 | 4 | 1 | US Federal Government | Y |
| Smyrna Bench | Gr | 269-1 | Apr 21 | Y | 76-125 | 7 | 0 | US Federal Government | Y |
| Smyrna Bench | Gr | 270-1 | Apr 21 | Y | 1-25 | 1 | 0 | US Federal Government | Y |
| Smyrna Bench | Gr | 271-1 | Apr 21 | Y | 1-25 | 2 | 5 | US Federal Government | Y |
| Smyrna Bench | Gr | 272-1 | Apr 21 | Y | 1-25 | 3 | 0 | US Federal Government | Y |
| Smyrna Bench | Gr | 274-1 | Apr 21 | Y | 201-400 | 5 | 9 | US Federal Government | Y |
| Smyrna Bench | Gr | 333-1 | Apr 7 | Y | 26-50 | 1 | 3 | Washington State | Y |
| Soap Lake | Gr | 133-1 | Apr 14 | Y | 51-75 | 1 | 0 | Private | Y |
| Soap Lake | Gr | 141-1 | Apr 14 | Y | 1-25 | 1 | 0 | Private | N |
| Soap Lake | Gr | 237-1 | Apr 14 | Y | 201+ | 10 | 8 | Private | Y |

Appendix C. Continued.

| | | | 2004 survey results | | | | | | 2001-2003 results |
|---|---|---|---|---|---|---|---|---|---|
| Area | County | Site ID | Date | Occ | Burrows | POA | Badger | Ownership | Occ |
| Soap Lake | Gr | 237-2 | Apr 14 | Y | 1-25 | 1 | 0 | Private | Y |
| Warden | Gr | 243-1 | Apr 16 | Y | 101-125 | 3 | 30 | Private | Y |
| Warden | Gr | 244-1 | Apr 16 | Y | 76-125 | 9 | 4 | Private | Y |
| Warden | Gr | 358-1 | Apr 16 | Y | 151-200 | 5 | 1 | Washington State | Y |
| Warden | Gr | 359-1 | Apr 16 | Y | 51-75 | 1 | 1 | Private | Y |
| Warden | Gr | 360-1 | Apr 16 | Y | 326+ | 14 | 1 | Private | Y |
| Warden | Gr | 360-2 | Apr 16 | Y | 126-150 | 7 | 0 | Private | Y |
| Warden | Gr | 38-1 | Apr 16 | Y | 551-700 | 15 | 67 | Private | Y |
| Warden | Gr | 38-2 | Apr 16 | Y | 101-125 | 4 | 12 | Private | Y |
| Warden | Gr | 38-3 | Apr 16 | Y | 51-100 | 8 | 2 | Private | Y |
| Warden | Gr | 39-1 | Apr 16 | Y | 26-50 | 1 | 0 | School District | Y |
| Warden | Gr | 39-2 | Apr 16 | Y | 26-50 | 2 | 0 | School District | Y |

Appendix D. Revised data sheet for the suggested Washington ground squirrel (SPWA) survey protocol.

## SECTION 1. OCCUPANCY

**Site Occupancy**
1 = Confirmed active[a]
2 = Confirmed inactive[b]
3 = Possible activity[c]
☐

**Activity Confirmation**[d]
1 = SPWA visual
2 = SPWA alarm call
3 = SPWA scat[e]
☐

## SECTION 2. BURROW DENSITY AND DISTRIBUTION

**Pockets of Activity** (UTM NAD 83)
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____
N: _____ E: _____

**Site Center Update** (UTM NAD 83)[f]
Average N: _____ Average E: _____

**Geographic Extent**
Hectares[g] ☐

**Burrow Density Variables**
Transect radius[h] ☐

No. active SPWA burrows[i] ☐

## SECTION 3. HABITAT CHARACTERISTICS AND PREDATOR ACTIVITY[j]

**Shrub Cover** ☐
1 = <1 %
2 = 1-10%
3 = 11-20%
4 = 21-40%
5 = 41-60%
6 = 61-81%
7 = 81-100%

**Shrub Distribution** ☐
1 = Patchy[k]
2 = Homogenous[l]
0 = Unknown or N/A[m]

**Plant Species Composition** ☐
1 = Native species dominate (>60%)[n]
2 = Exotic species dominate (>60%)[o]
3 = Neither natives nor exotics dominate[p]
0 = Unknown[q]

**Grazing Intensity** ☐
1 = No grazing
2 = Light[r]
3 = Moderate[s]
4 = Heavy[t]
0 = Unknown[u]

**Important Dietary Components**
1 = Uncommon or absent[v]
2 = Common[w]
3 = Abundant[x]
0 = Unknown[y]

☐ *Poa* sp.
☐ *Lupinus* sp.
☐ *Delphinium* sp.
☐ *Bromus* sp.
☐ *Phlox* sp.
☐ *Lomatium* sp.

**Predator Sign**[z]
Number of badger burrows ☐

Other predator sign or observations (describe): _____

## SECTION 4. ADDITIONAL COMMENTS

**Habitat Variability**[aa]. If applicable, explain differences between occupied and unoccupied habitat.

_____

_____

**Disturbance**[bb]. If applicable, provide detailed description of disturbance.

_____

_____

**Other Comments:** _____

_____

_____

Appendix D. Continued.

**SECTION 1. Occupancy**

**Site Occupancy**

[a] Confirmation includes seeing Washington ground squirrels, hearing their alarm calls, or finding fresh droppings.

[b] Inactivity is confirmed when all transects have been completed and no evidence of Washington ground squirrel is found.

[c] Activity not confirmed, but Washington ground squirrel-sized burrows occur on the site. A typical Washington ground squirrel burrow is 5.7-7 cm (2¼-2¾ in) in diameter.

**Activity Confirmation**

[d] Enter all that apply in box provided.

[e] Use caution around rock outcrops because the scat of bushy-tailed woodrats is similar to that of Washington ground squirrels.

**SECTION 2. Burrow Density and Distribution**

**Site Center Update**

[f] Enter the new site center by averaging the Northing and Easting coordinates of the recorded pockets of activity.

**Geographic Extent**

[g] Estimate by using pockets of activity displayed on GPS. For reference, a hectare is 100 m x 100 m.

**Burrow Density**

[h] Enter the radius of the transect used to estimate active burrow density.

[i] Enter the number of active burrows observed within 2 m of the transect.

**SECTION 3. HABITAT CHARACTERISTICS AND PREDATOR ACTIVITY**

[j] All data for Section 3 should be collected within the core area and from what is observable from the 60-m and 90-m transects.

**Shrub Distribution**

[k] Three or more ≥200 $m^2$ patches with no shrubs exceeding 30 cm in height occur within a 90-m radius around the site center.

[l] There appears to be a normal distribution of shrubs within a 90-m radius around the site center.

[m] Observer is unable to make this determination reliably.

Appendix D. Continued.

**Species Composition**

[n] Greater than 60% of the plants are native species.
[o] Greater than 60% of the plants are exotic species.
[p] Native and exotic species occur in nearly equal abundance (i.e., abundance of both native and exotic plants is between 40-60%).
[q] Observer is unable to make this determination reliably.

**Grazing Intensity**

[r] Livestock droppings present, but little or no evidence of grazing on vegetation.
[s] Livestock droppings present and evidence of grazing on vegetation is apparent, but grasses are not cropped low to the ground.
[t] Livestock droppings present and grasses are trampled and cropped low to the ground (within 5 cm). Bare ground occurs over at least 20% of the site in areas where soil conditions should support vegetation.
[u] Observer is unable to make this determination reliably.

**Important Dietary Components**

[v] Fewer than 5 plants occur within ½ ha (100 m x 50 m) of representative habitat.
[w] Between 5 and 50 plants occur within ½ ha (100 m x 50 m) of representative habitat.
[x] More than 50 plants occur within ½ ha (100 m x 50 m) of representative habitat.
[y] Observer is unable to make this determination reliably.

**Predator Sign**

[z] All evidence or direct observations of predators should be recorded within the core area or along the 60-m and 90-m transects.

**SECTION 4. ADDITIONAL COMMENTS**

**Habitat Variability**

[aa] If habitat at an active site is different from the areas surrounding the site (within 100 m), provide a description of the habitat outside of the occupied area (attempt to describe using categories and values describing habitat characteristics).

**Disturbance**

[bb] If natural or human disturbance is evident, provide a detailed description of location and type of disturbance (e.g., fire, erosion, cultivation, off-road vehicle traffic, road construction, refuse piles, etc.), as well as anticipated impact on Washington ground squirrels at the site.