Mazama Pocket Gopher Distribution and Habitat Survey in Western Washington - 2012

Summary Report

Mazama pocket gopher (*Photo by Bill Leonard*).

Washington Department of Fish and Wildlife

January 2013

Summary of the Work

In 2012, Washington Department of Fish and Wildlife (WDFW) embarked on a substantial effort to survey for Mazama pocket gophers (*Thomomys mazama*) in western Washington. This effort was undertaken to aid multiple entities to obtain information for conservation planning and to address ongoing concerns about extent, substance, and representation of private land in past WDFW surveys. WDFW developed and implemented a multiple-component survey of plot-based, historic, and opportunistic sites across the landscape prospectively occupied by Mazama pocket gophers in western Washington.

For 800 plots surveyed in 12 habitat strata, overall detection rate for pocket gopher mound evidence was 0.17, but detection ranged from 0.0 to 0.60 among strata. Greatest rates of mound detection were associated with grassland or agricultural land cover on loams with limited clay fines and variable rock fragments/cobble/gravel. We detected few mounds (7 of 133 detections) in open-canopy forest or clear cuts regardless of substrate category among all strata. Four habitat strata (generally on substrate with greater clay content and some type of forest cover) had no detections. Plot-based sampling intensity was sufficient to detect statistically significant differences in pocket gopher occurrence among strata. Grasslands on clay content substrates without rock fragments had significantly higher relative occurrence of pocket gophers than all other strata except grasslands in the same substrate type with rocks.

Of 93 identified historic sites in 6 counties, we examined 58 of which we detected positive mound evidence on 14 sites (2 in Clallam Co., 1 in Pierce Co., 11 in Thurston Co.) We recorded 168 opportunistic site surveys among 9 counties, with 57 positive detections of pocket gopher mounds in Clallam, Mason, Pierce, and Thurston counties. These records primarily supplemented the pattern observed through more detailed examination of plot surveys. None of these records identified sites that were unusual relative to plot-based surveys. Details of all plot, historic, and opportunistic survey records are available in spreadsheet format from WDFW.

No pocket gophers were found in the Capitol Forest or other Department of Natural Resources forest or clear cut lands. We found 7 plots with pocket gopher detections in all forest and clear cut strata combined, regardless of ownership. These locations were sparsely distributed, and all were near areas of known pocket gopher presence on sites with more open land cover. They may represent occasional use of these habitats in areas near grasslands or agricultural lands. More study is needed to determine whether these areas are consistently used by gophers and contribute significantly to longer term persistence of local populations.

Overall results depict some clear and distinguishable patterns. Grassland with low clay soils and with low to moderate rock content had the greatest relative occurrence of pocket gophers. Agricultural lands seem to support appreciable occurrences of pocket gophers. Agricultural lands often included pastures or tree farms, which might differ from grasslands in land use rather than cover characteristics. Open canopy forest and clear cuts had very low occurrence of pocket gophers. These habitats were well-surveyed in most areas with the exception of eastern Thurston County, and thus provide solid evidence that pocket gophers are not found substantially in these habitats. Additional surveys in eastern Thurston County should be conducted if possible to confirm this conclusion is applicable to the entire study area.

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In 2012, Washington Department of Fish and Wildlife (WDFW) embarked on a substantial effort to survey for Mazama pocket gophers (*Thomomys mazama*) in western Washington. This effort was undertaken to aid interests by multiple agencies to obtain information for conservation planning and to address ongoing concerns about extent and substance of past surveys and the degree of representation of private land in past surveys. This work provided substantial perspective for preparing the DRAFT Mazama Pocket Gopher Status Update and Recovery Plan distributed by WDFW for public review in January 2013. Outcomes reported in this summary culminate substantial survey effort while starting pursuit of further questions.

GOAL AND OUTCOME

WDFW designed and conducted this work to detect relative occurrence of Mazama pocket gopher mound evidence among broad substrate and land cover associations in western Washington and to determine if relative occurrences were distinguishable among such habitat associations. Additionally, the study design ensured that substantial survey effort was directed at a representative sample of public and private lands. The outcome is updated distribution descriptions and illustrations of relative occurrence of Mazama pocket gophers.

APPROACH

WDFW developed and implemented a multiple-component survey process across the landscape prospectively occupied by Mazama pocket gophers in western Washington. The survey components included:

- Plot-based surveys on a stratified random sample of locations
- Historic surveys focused on locations with reported detections prior to 2006
- Opportunistic/Directed surveys in areas that may represent prospective habitat

The plot-based surveys were a detailed examination of specific locations representing a cross-section of habitat features. We conducted historic surveys to provide insight about status of locations where this species has been reported during more than 100 years in Washington. We intended the Opportunistic/Directed surveys to ensure that additional prospective areas of occurrence were not overlooked in the process of focusing on plots and historic sites.

The geographic areas for sampling and other site examination were:

- *Plot-based surveys* – portions of Grays Harbor, Lewis, Mason, Pierce, and Thurston counties within identified sample strata based on substrate and land cover (Fig. 1),
- *Historic surveys* – vicinity of locations with prior reported occurrence in Clallam, Clark, Mason, Pierce, Thurston, and Wahkiakum counties
- *Opportunistic/Directed surveys* – parts of the above counties in areas that represent plausible substrate and land cover, plus other counties if sites features warranted

Survey efforts were conducted only on locations where WDFW obtained permission from the associated private or public landowner or their representative.

Figure 1. Depiction of the buffering boundaries around prior known Mazama pocket gopher sites that were used to delineate extent of the area for plot-based surveys in Grays Harbor, Lewis, Mason, Pierce, and Thurston counties of western Washington in 2012.

FIELD SURVEY AND SAMPLE SELECTION

For the 3 components, we only performed site examination for evidence of pocket gopher mounds. We stopped survey work at any site when mound evidence was found; thus, survey activity did not involve examination of the entire surface area of specific plots or sites unless no evidence was detected throughout. We did not include any attempt to estimate abundance or density of pocket gophers (a much more intensive type of study); therefore, our work reported here will not provide population estimates.

Plot-based surveys – These surveys involved examination of 60m x 60m (approx. 1 acre) sample plots among each of 12 strata in the 5-county area. We determined the outer boundary for the plot-based survey area by buffering existing records of pocket gopher occurrence in Mason, Pierce and Thurston counties by 10-km radius circles and delineating the maximum extent of those circles (Fig 1.). Although there were no previous records of occurrence in Grays Harbor and Lewis counties, we included portions of these counties within the buffer in the survey area.

We described strata based on substrate and land cover categories that are anticipated to represent the breadth of types potentially occupied by Mazama pocket gophers. These types included some strata for which little or no pocket gopher occurrence was expected to ensure that sampling was broadly based enough to answer questions about diversity of habitat with pocket gopher use. Those strata include substrate type (defined by texture and relative rock fragment content) and land cover categories as:

- land cover categories
  - open-canopy forest (<40% canopy cover)
  - grassland
  - clear-cut (during 2000-2009)
  - agricultural land (includes pasture)
- substrate categories
  - loams with <35% clay fines and <15% rock fragments
  - loams with <35% clay fines and 15-35% stone/cobble or 15-60% gravel
  - loams with >35% clay fines and up to 35% rock fragments

Substrate types were defined based on the United States Department of Agriculture Soil Survey Geographic (SSURGO) database (http://soils.usda.gov/survey/geography/ssurgo/), with soil type polygons classified into 496 soil types. These types were grouped into substrate categories based on type descriptions (Soil Survey Staff NRCS 2012). The standard soil texture triangle was used to assign textures to 2 groups (including an "out" category) that were further divided based on relative presence of rock fragments (Schoeneberger et al. 2002). These categories characterized prevailing views regarding association of Mazama pocket gophers with soils. All texture and rock fragment classes considered unsuitable for pocket gopher burrowing were classified as "out", and not included in the sample space. The approximate area in each category ranged from <50 acres to more than 675,000 acres (Table 1). We combined code 400 with code 300 because of the very small area of substrate 400 and its similarity in texture to substrate 300.

Table 1. Texture classes and rock fragment modifiers assigned to substrate categories used to define strata for the Mazama pocket gopher plot surveys.

Substrate code	Texture classes	Rock fragment modifier	Acreage (approx.)
100	Silt loam, loam, sandy loam, loamy sand, sandy clay loam, silt loam	None	326,760
200	Silt loam, loam, sandy loam, loamy sand, sandy clay loam, silt loam	Gravelly, very gravelly, cobbly, stony	675,033
300	Silty clay, clay loam, silty clay loam	None	56,644
400	Silty clay, clay loam, silty clay loam	Gravelly, very gravelly, cobbly, stony	47
Out	Silt, clay, sand, muck, peat, beach, rock outcrop, udifluents, headwalls, marsh, riverwash, hydraquents, gravel pit, hapludands and dsystrudepts, dystric xerochrepts	Any	102,453
	Any	Very cobbly, extremely cobbly, very stony, extremely stony, extremely gravelly	

We assigned stratum identification codes to each combination of land cover and substrate types to readily identify which combination of characteristics defined the stratum. Land cover types were assigned values as follows: 10 = open canopy forest, 30 = grasslands, 40 = clearcuts, and 50 = agriculture. We derived land cover types from conflating 3 regional datasets: ReGAP ecosystems (grasslands and agriculture) and U.S. Forest Service Forest Science Laboratory at Oregon State University Gradient Nearest Neighbor forest structure data (open canopy forests) and forest disturbance data (clear cuts) from the LEMMA (Landscape Ecology, Modeling, Mapping, & Analysis) and LandTrendr projects, respectively. Online information about the above datasets is accessible at the following:

- ReGAP - http://gap.uidaho.edu/index.php/landcover/
- LandTrendr - http://landtrendr.forestry.oregonstate.edu/
- LEMMA - http://www.fsl.orst.edu/lemma/splash.php

We assigned values to substrate types as in Table 1, and we created stratum identification codes as follows: substrate type + land cover category (e.g., clearcuts with loam, higher clay content, and few rock fragments was designated as 300 + 40 = 340) (Table 2).

Table 2. Descriptions and numbering code for 12 strata selected to guide design and comparisons for plot-based survey of Mazama pocket gophers in Washington during 2012.

	Land Cover			
Substrate	10- open canopy forest (<40% canopy cover,)	30- grasslands	40 – clear cuts (2000-2009)	50 – agricultural lands
100 – loams with <30-35% clay fines and <15% rock fragments	110	130	140	150
200 – loams with <30-35% clay fines and 15-35% stone or cobble or 15-60% gravel	210	230	240	250
300 – loams with >30-35% clay fines and <15% rock fragments	310	330	340	350

We identified plot locations for this component from a random selection of 60m x 60m plots among all of the land surface in the 5-county survey area that was identified to represent the 12 habitat strata. The initial sample selection included 4,664 potential plots.

We based the target sample size of plots to survey on 2 factors: 1) amount of effort necessary to conduct surveys, and 2) how many plots were needed to make precise estimates and meaningful comparisons among strata. The first factor took into account staff time available, travel time to plots, time to survey plots, and the possibility that some plots likely could not be surveyed (thus, would require replacement). Under the expectation that approximately 633 staff days of survey effort were available, an average of 3 plots could be surveyed per person per day, and about 40% of plots would be rejected because they could not be surveyed, we calculated that about 1,350 plots could be surveyed, or 112 plots per stratum. Rounding up to 120 plots per stratum gave us a target of 1,440 plots to survey.

We determined whether this number of plots was sufficient to provide meaningful results by conducting statistical power analyses for 2 scenarios: 1) what is the ability to detect pocket gopher presence within a stratum; and 2) what sampling is needed to detect meaningful differences in pocket gopher occurrence among strata. For scenario 1, we determined that for 120 samples we would expect a 70% probability of detecting gophers in a stratum on at least 1 plot if the occurrence rate is 1% (1 in 100). If occurrence is double that (2%) we could be nearly certain to detect gophers (probability of detection >90% on at least 1 plot). For scenario 2, we considered an ability to detect differences between strata with a sample size of 120 if the true occurrence rates ranged from 0.001 to 0.20 and found high power (>0.90) to detect differences between rates of 0.01 and ≥ 0.10, between 0.05 and 0.20, and between 0.1 and 0.001. These differences appeared sufficient to draw conclusions regarding the relative association of pocket gophers with stratum types. Thus, we set an initial target of examining 120 plots per stratum with the knowledge that actual detection rates could indicate a different sample intensity may meet thresholds for detecting differences.

We obtained a sample of plots through a random selection process to ensure representativeness of sampling. We first assigned random numbers to all plots in a 60m x 60m grid in each stratum, and then ordered the plots by random number. Because we expected that some plots would not be surveyable (e.g., too heavily vegetated, no permission), we initially selected many more plots per stratum than needed to meet sample size targets. Therefore, if we rejected a plot for any reason, it could be replaced with the next random plot on the list, giving regard to ensure representation of public and private land. The initial sample list was then subjected to a visual screening process whereby plot locations were overlaid on 2011 aerial orthoimages and determined whether there were any obvious errors in classification or placement of plots (e.g., plots that contained buildings or were within water features were removed). Most of the plots removed from the sample were due to obvious canopy closure (>40% wooded). We sought to identify at least 300 plots per stratum from 4,664 potential plots across all strata.

We summarized tax parcel records to identify landowners of record to contact regarding willingness to include lands in the sampling effort. That approach yielded about 3.2 times as many plot locations as needed to meet the sampling target to allow for some properties not being available for use. We requested access in standard letter format mailed to 1,246 addressees who owned 1 or 2 identified parcels containing prospective plots; we scheduled direct contact by WDFW Regional staff for 111 other distinct owners of >2 parcels.

WDFW maintained a master data base throughout the project to track status of survey plots. As we received permission responses from landowners, we updated the “Access” field from “Pending” to “Yes” or “No” depending on the reply. Only plots for which Access was “Yes” were eligible to be assigned for surveys. Although plots were ordered by their random number assignments, plots on small private landownerships were surveyed as permissions became available to ensure that private land representation was maintained.

To reduce potential biases associated with temporal differences in pocket gopher mounding activity, we spread the plot survey assignments throughout the survey period by releasing plots in several waves. Each wave consisted of plots for each stratum over the entire sample area, and these were assigned to staff as applicable. We released new waves as previous wave assignments were completed, using similar attempts to distribute random plots among strata. As we assigned plots to field staff, plot status was updated in the master data base to include the assignment date, when plot results were received, and status change that. We conducted plot-based surveys during early August to early November 2012. This time frame overlapped the generally identified most active period (WDFW file data) for Mazama pocket gophers.

We ultimately compared the proportion of occurrence among all strata pairs. Exact 95% confidence intervals (CIs) on the estimates were constructed using the “exactci()” function in R package (PropCIs). We calculated P-values for comparisons of proportions between strata using Fisher’s Exact Test, specifically the function “fisher.test()” in program R. For this process, examination of all comparisons at alpha=0.05 yields significance for individual comparisons at 0.00076 (0.05/66).

Historic Site surveys – We focused these surveys on and near sites reported in technical literature, museum records, past survey reports, and other similar documentation as having had Mazama pocket gopher occurrence anytime from the late 1800s to 2005. We identified 93 such locations for these surveys in 6 counties. These surveys were not plot-based because the prospective area to examine varied depending on the nature of past reported information. We performed these surveys to update the status of historically occupied areas and to examine possible degree of past known occurrence. In some instances where an historic site had been examined sometime during 2006-2011, we included results of that site examination in our data.

Opportunistic/Directed surveys – These surveys occurred only to the extent that field staff time allowed beyond plot-based and historic sites surveys and the extent to which we found prospective areas with substrate and land cover similar to the strata described for the plot-based surveys. This component provided a relatively rapid opportunistic and specifically directed assessment of a larger area that contributed additional information about general distribution of Mazama pocket gophers. We reviewed these data for general content and distribution but the information was not appropriate to subject to statistical analysis.

DATA COLLECTION

We captured data for all components in electronic files prepared by field staff with WDFW and submitted the information to a WDFW data compiler and manager in Olympia. Those data for each site included:

- Plot identifier/descriptor
- Observer name and contact information
- Date examined
- Site coordinates
- County
- Landowner (identified only as public or private, not to name)
- Land use category
- Land cover category
- Indication of presence or not of pocket gopher mound evidence
- Confidence of the observer regarding mound identification
- Indication of mound presence in the vicinity but not on the plot (plot-based survey only)
- Whether a substrate sample was collected (only for sites with confirmed mounds)

Appendix A details the data format used by surveyors, with directions for completing the forms. We directed specific efforts at recording pocket gopher mound presence and confidence of the observer in making the identification. Mound identification is not an exact process, despite a number of characteristics that are more often attributed to pocket gophers. Moles sometimes form mounds that may be confused with pocket gopher mounds. The context in which the mound is found (habitat, slope, etc.), the age of the mound, any disturbance to the area, weather conditions, and the soil type can all contribute to ambiguity about the mound origin. Rather than force surveyors to make definitive calls when such were not reasonable, we used categories to assign the relative degree of confidence of mound identification. We instructed observers to indicate "No" for pocket gopher mound presence if they saw no mounds of any kind or they were confident that any mounds seen were made by moles or other animals. They were to record "Uncertain" if they were about equally unsure if the mound could be made by a pocket gopher or a mole, but asked to record "Yes" if they thought that the mound was more likely to be made by a pocket gopher than a mole or other animal. If they responded "Yes", surveyors rated their confidence that the mound was made by a pocket gopher. "Definite" was recorded if the observer was certain the mound was made by a pocket gopher, "Probable" was recorded if the observer felt that there was a >75% chance that mounds were pocket gopher, and "Possible" was recorded if observers considered there to be a 50-75% chance mounds were pocket gopher.

Field staff created an electronic results record (in Excel format) for each plot assigned to them, whether they were able to survey the plot or not, and periodically submitted results to staff in Olympia. We collated these results and updated the plot status to reflect completed surveys in master status files (1 file for plot-based surveys, 1 file for historic/opportunistic/directed surveys). We followed up all plot surveys that had an "Uncertain" mound detection or a "Yes" detection with a confidence rating of "Possible" using re-surveys conducted by personnel other than the original surveyor. Staff performing follow-up surveys had multiple years of experience in pocket gopher mound identification and additional experience with trapping pocket gophers. In almost all cases, the follow-up survey was able to determine gopher presence or absence with high confidence. In a few cases, we conducted live-trapping to verify whether gophers were present if mound identification continued to be uncertain. We then replaced the original survey results with the re-survey results for the final analyses.

RESULTS AND DISCUSSION

Historic Site Surveys

Of 93 identified historic sites in 6 counties, we examined 58 and 7 others were attempted but we did not obtain sufficient access. Of the 58 historic sites examined, we detected positive mound evidence on 14 sites (2 in Clallam Co., 1 in Pierce Co. and 11 in Thurston Co.), which generally illustrates the substantial relationship of Thurston County habitat to continued existence of Mazama pocket gophers (Table 3). Specific coordinates or other explicit location information were lacking for 23 historic records, thus we could not reasonably locate some sites to perform surveys. A file named **MPG2012HistOppDirSuveyRecord_FINAL_01232013.xls** details all of these records and is available from WDFW.

Table 3. Extent and distribution of historic sites examined for Mazama pocket gophers in 2012 and pattern of mound detection among 6 counties in western Washington.

County	No. Historic Sites	No. Sites Examined	No. Sites with Mounds Detected
Clallam	8	6	2
Clark	12	12	0
Mason	7	0	-
Pierce	29	22	1
Thurston	36	17	11
Wahkiakum	1	1	0
TOTAL	93	58	14

Opportunistic Site Surveys

Field staff recorded 168 Opportunistic/Directed site surveys among 9 counties, with 57 positive detections of pocket gopher mounds (Table 4). All sites that contained pocket gopher mound evidence were in Clallam, Mason, Pierce, and Thurston counties. These records primarily supplemented the pattern observed through more detailed examination of plot surveys (described below). None of these records identified any sites that were unusual with respect to the general coverage of habitat among strata represented in the plot-based surveys. All of these records are detailed in a file named **MPG2012HistOppDirSuveyRecord_FINAL_01232013.xls** that is available from WDFW.

Table 4. Extent and distribution of opportunistic/directed site surveys for Mazama pocket gophers in 2012 and extent of mound detection among 7 counties in western Washington.

County	No. Sites Examined	No. Sites with Definitive Mound Evidence
Clallam	11	6
Clark	1	0
Cowlitz	1	0
Grays Harbor	8	0
Jefferson	6	0
Lewis	6	0
Mason	20	12
Pierce	33	8
Thurston	82	31
TOTAL	168	57

Plot surveys

Of 4,664 prospective plots that we sought permission to survey, we received confirmed access to 1,911 (41%). Access permissions were not evenly distributed by stratum (Table 5). The 3 agriculture strata (150, 250, and 350) were among the lowest proportion of plots accessible (13.6, 17.3, and 11.7 percent, respectively), and therefore sample sizes were limited in those strata. Stratum 330 (grasslands with high clay soils) also had few accessible plots, reflecting the high rate of private ownership of this habitat type. Our target sample sizes were only achievable in 5 strata, as the number of plots with access was <120 in the other 7 strata (Table 5).

Table 5. Distribution of prospective survey plots among strata before and after landowner access permission was sought and obtained for Mazama pocket gopher surveys in western Washington in 2012.

Stratum ID	Number of plots with no response or permission denied	Number of plots with access allowed	Total plots	Percent of plots with access permission granted
110	216	102	318	32.1
130	268	116	384	30.2
140	167	188	355	53.0
150	331	52	383	13.6
210	104	228	332	68.7
230	174	441	615	71.7
240	75	300	375	80.0
250	344	72	416	17.3
310	187	111	298	37.2
330	372	56	428	131
340	145	196	341	57.5
350	370	49	429	11.7
Total	2,753	1,911	4,664	40.9

We assigned 1,070 plots to be surveyed, of which 800 were surveyable (Fig 2). The 270 plots that were deemed "unsurveyable" when visited by field staff occurred for a variety of reasons, but most often because the plot was inundated with water or covered with impenetrable vegetation. The latter was especially problematic in clear cut strata because older clear cuts were sometimes so thick with regeneration growth that the ground could not be seen. Staff always attempted to survey any open areas for mounds but if they felt that the survey was not adequate, the plot was not considered surveyable.

For 800 plots surveyed, there was an overall detection rate for pocket gopher mound evidence of 0.17, but detection among the 12 strata ranged from 0.0 to 0.60 (Table 6). There were 4 strata (140, 310, 330, and 340) that had no detections. Greatest rates of mound detection were associated with strata having grassland or agricultural land cover on loams with limited clay fines and variable rock fragments/cobble/gravel (Table 6). We detected few mounds in strata with open-canopy forest or clear cuts regardless of substrate category, representing 7 (~5%) of the 133 detections among all strata. Details of all plot survey records are contained in a file named **MPGPlotSuveyFINALResultsFile01022013.xlsx** that is available from WDFW.

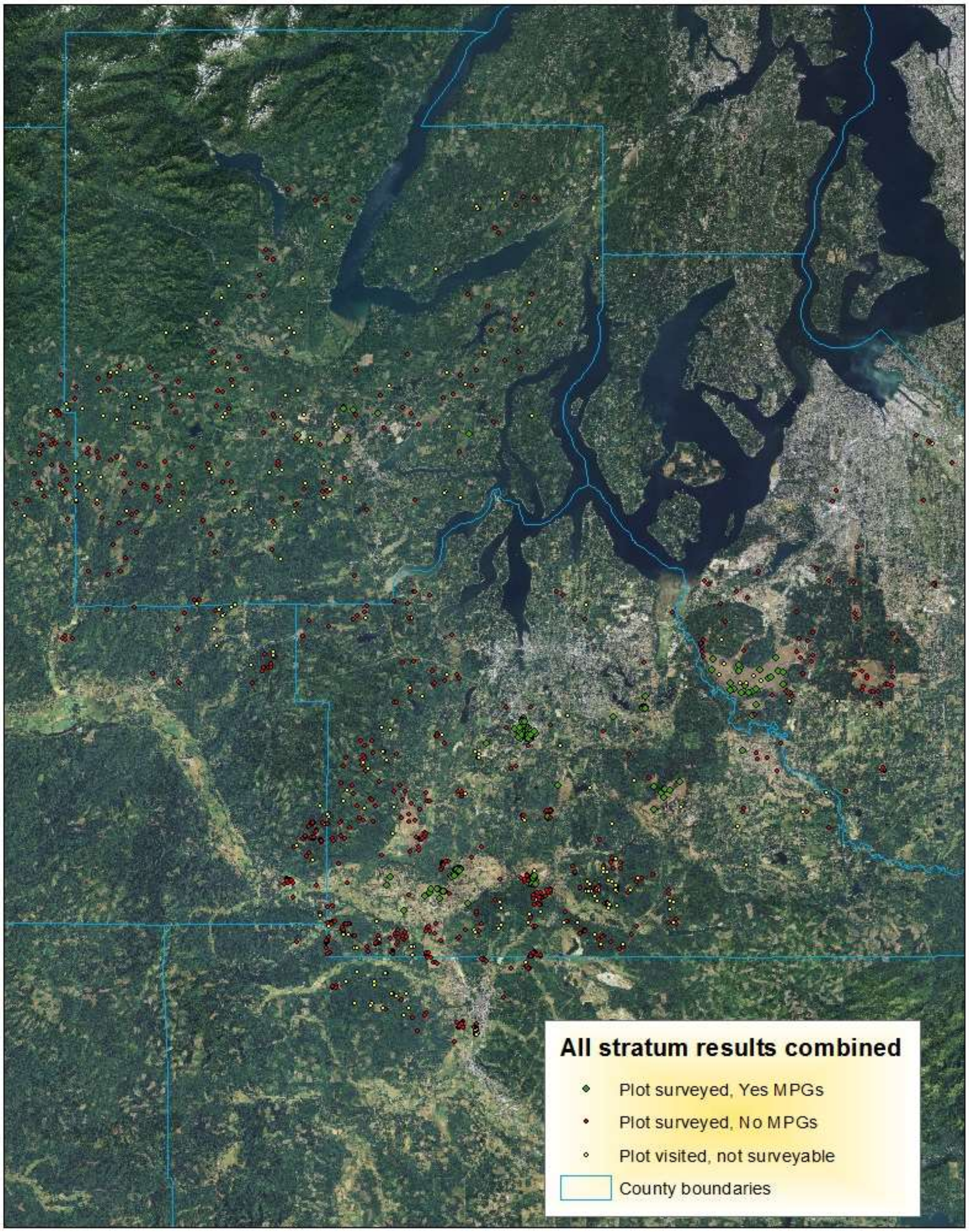

Figure 2. Distribution of plots and detection results from random surveys of Mazama pocket gophers in western Washington, August-November 2012.

Table 6. Number and proportion of plots with positive mound detections among 800 random plots surveyed for Mazama pocket gophers in 5 counties of western Washington during 2012

Stratum ID	No. Plots Surveyed	No. Plots with Positive Pocket Gopher Detections	Proportion of Positive Detections
110	57	1	0.02
130	93	56	0.60
140	73	0	0.00
150	49	9	0.18
210	71	4	0.06
230	88	40	0.45
240	76	2	0.03
250	66	20	0.30
310	55	0	0.00
330	46	0	0.00
340	89	0	0.00
350	37	1	0.03
Total	800	133	0.17

Note: Distribution of all plots surveyed is shown in Fig. 2.

Despite extensive effort by field staff, our sampling intensity was about 60% of the initial target sample size overall among strata. Difficulties in reaching sampling targets included a late start to the survey season, temporary suspension of access because of high fire danger on some private timber ownerships during the fall dry season, and an overestimate of the effort available.

Sampling intensity was sufficient to detect statistically significant differences in pocket gopher occurrence among strata (Fig. 3, Table 7), primarily because we detected mounds at a greater rate than initially estimated during planning scenarios. Grasslands with low clay soils without rock fragments had significantly higher relative occurrence of pocket gophers than all other strata except grasslands in the same substrate type with rocks (Table 7). The latter stratum was not statistically different from agricultural lands with the same substrate type and rock fragments. We also examined these relationships with land cover derived from different sources. When land cover was considered to be what was specifically observed on a plot or when only plots with observed land cover matching specifically with pre-specified stratum land cover, we observed the same patterns for differences in detection rates among strata.

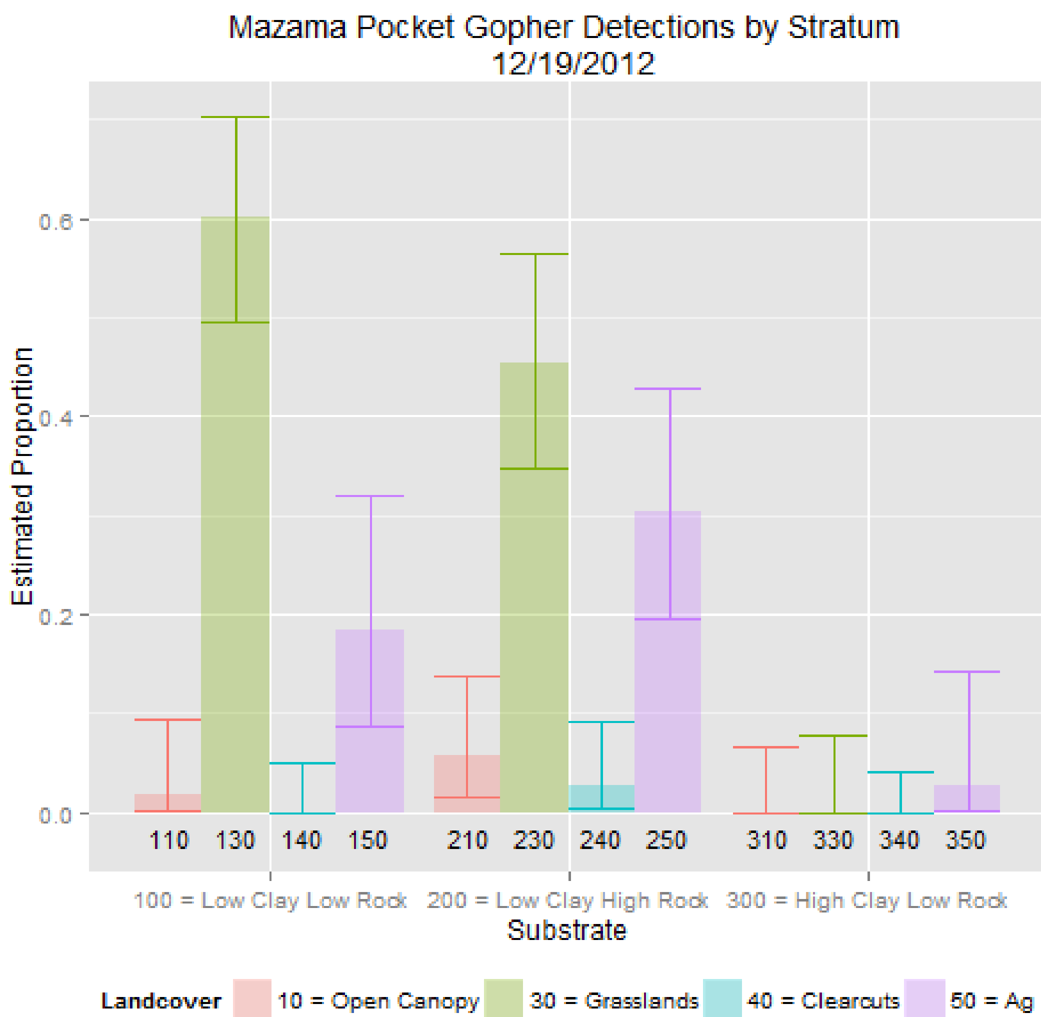

Figure 3. Estimated proportion of mound detection rates and associated 95% confidence intervals among 12 habitat strata for Mazama pocket gopher survey in western Washington in 2012

The distribution of plots surveyed, with pocket gopher mound detection results, is displayed by stratum in Figures B1-B12 in Appendix B. Map A in each Appendix B illustration shows the distribution of all the plots in each stratum and gives an indication of how representative the surveyed sample was to all plots in the stratum. Map B shows the distribution of the plots for which we requested access (a random sample of all plots) and shows how accessibility may have influenced the pattern of results.

In general, plots with pocket gopher detections were within or near areas of previously known pocket gopher presence, with the exception of a few plots in Mason County. Given that pocket gopher distribution in that area was somewhat poorly understood, these additional locations are valuable contributions to our knowledge and warrant further evaluation.

Table 7. Results from Fisher's exact test comparisons of relative pocket gopher occurrence between all possible pairs of strata. Entries in the table indicate the probability that differences as extreme or more extreme than observed would occur by chance if, in fact, there was no difference in occurrence between the given pair of strata. Bold asterisks indicate significant differences with a Bonferroni correction applied to account for multiple comparisons and "nd" indicates no statistical difference.

Stratum ID	110	130	140	150	210	230	240	250	310	330	340	350
110		*	nd	nd	nd	*	nd	*	nd	nd	nd	nd
130			*	*	*	nd	*	*	*	*	*	*
140				*	nd	*	nd	*	nd	nd	nd	nd
150					nd	nd	nd	nd	*	nd	*	nd
210						*	nd	*	nd	nd	nd	nd
230							*	nd	*	*	*	*
240								*	nd	nd	nd	nd
250									*	*	*	*
310										nd	nd	nd
330											nd	nd
340												nd
350												

Note: the table is symmetrical, so only the upper diagonal shown.

No pocket gophers were found in the Capitol Forest or other Department of Natural Resources forest or clear cut lands. We found 7 plots with pocket gopher detections in all forest and clear cut strata combined, regardless of ownership. These locations were sparsely distributed, and all were near areas of known pocket gopher presence on sites with more open land cover. They may represent occasional use of these habitats in areas near grasslands or agricultural lands that seem to have greater pocket gopher mound evidence. More study is needed to determine whether these areas are consistently used by gophers and contribute significantly to longer term persistence of local populations.

Our ability to extrapolate results from our samples to all plots within strata was potentially limited by inability to survey many plots for which access permission was not obtained. The maps (Appendix B) illustrate that we did not have access to large areas, especially in eastern and southeastern Thurston County. For those strata with mostly private lands, especially agricultural lands, this resulted in reduced sample size. In those strata that had a significant public lands component, results were strongly influenced by plots on public land. This is especially striking in stratum 130 (grasslands with loamy, low clay soils and few rocks), where all but 1 pocket gopher detection were on 2 properties: Scatter Creek Wildlife Area, and the Olympia Airport. These are both areas of known concentrations of pocket gophers and some plots surveyed within those areas may not be independent (i.e., presence of gophers in 1 plot may correlate with presence of gophers on other plots). This does not invalidate comparison of relative occurrence to other strata, but if public/quasi-public lands were sampled at a greater rate than would be proportional in those strata and if such lands were more likely to have gophers, then estimates of occurrence could be biased. A similar situation may have occurred in stratum 230 except that public lands made up the majority of that stratum, and thus sampled plots were probably representative of all plots in the stratum.

Regardless of some technical limitations in the intensity of the plot-based surveys, the overall results depict some clear and distinguishable patterns. Grassland with low clay soils and with low to moderate rock content had the greatest relative occurrence of pocket gophers. Agricultural lands seem to support appreciable occurrences of pocket gophers. Within our study area, agricultural lands were often composed of pastures or tree farms, which might differ from grasslands in land use rather than cover characteristics. Open canopy forest and clear cuts had very low occurrence of pocket gophers. These habitats were well-surveyed in most areas with the exception of eastern Thurston County, and thus provide solid evidence that pocket gophers are not found substantially in these habitats. Additional surveys in eastern Thurston County should be conducted if possible to confirm this conclusion is applicable to the entire study area.

Additionally, given the role of substrate texture in gopher burrowing, substrate samples were taken from 50 sites (30 plot-based, 20 opportunistic) where we recorded definite pocket gopher mound detection. These 200-300 gram samples of substrate casting from a single mound will be preliminarily analyzed (Bouyoucos 1962) to provide a general description of sand-silt-clay composition associated with definite pocket gopher occurrence. These data will not be subjected to statistical analyses because these texture assessment procedures are not appropriate for detailed analyses (Gee and Bauder 1986). These analyses require specific laboratory facilities, equipment, and supplies that were not available until January 2013, thus analyses are pending and will be reported separately later. This work is just exploratory; if patterns appear evident in initial analysis, more controlled sampling and analysis will be considered to support inferences about substrate texture associated with Mazama pocket gopher habitat.

ACKNOWLEDGMENTS

This work had broad interest and support from a variety of cooperators, chief among them WDFW, Washington Department of Natural Resources, Thurston County, U.S. Fish and Wildlife Service, municipalities, and many private landowners. This diverse interest led to extensive survey efforts with costs covered among WDFW funds (Personalized License Plate) and federal support (State Wildlife Grant, Section 6 Conservation Planning Grant). Without that support, survey outcomes could not have been realized. WDFW respects the landowners (public and private) that chose not to allow access for surveys and gratefully acknowledges the many public and private landowners who granted access to their lands for pocket gopher survey. Significant contributors (not an exhaustive list) to this work included WDFW Wildlife Program field staff in Regions 4, 5, and 6 (especially Mick Cope), Wildlife Program headquarters staff (especially Jeff Foisy, Shannon Knapp, Gail Olson, Scott Pearson, Derek Stinson, Bruce Thompson, and Lisa Thompson-Randolph), John Fleckenstein and Noelle Nordstrom with Washington Department of Natural Resources, and students with the New Market Skills Center in Tumwater.

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Appendix A
Instructions for Field Staff Observers Participating in Mazama Pocket Gopher Survey

Mazama Pocket Gopher Mounds Survey
Data Form Reference List and Suggestions
3 August 2012 (previous version obsolete)

Please use the following information as guidance in conducting and documenting pocket gopher mound surveys, whether historic, opportunistic, directed, or plot-based. This guidance relates to paper form (MSWord original) or electronic form (Excel original) as applicable.

Location ID or Plot ID:

- Plot IDs are assigned in Olympia and must be used as assigned to identify any data record related to sample plots.
- Location IDs for Opportunistic/Directed surveys are assigned by the observer in the following format (Local Descriptor + Distance/Direction from a Recognizable Landmark [e.g., PipelineRoad4kmWSWVail]).
- Descriptors for Historic Sites are provided in the list of those locations. If mounds are found there, a Location ID is used on a Opportunistic/Directed form as adapted from the Historic Location descriptor using the format for Opportunistic/Directed form described above.

Observer: Each field for this category on paper or electronic data forms should be self-explanatory

Location (UTM): Record all locations in UTM Easting (6 digit) and Northing (7 digits) and specifically indicate the Datum. The Zone is likely to be 10 for all locations included in survey, but please indicate for clarity, given that there are 2 zones in WA. The Random Plot coordinates are in WGS1984, Zone10N. Record only the SW corner of the plot on the form. The Historic List has many locations described by lat-long and/or Town-Range-Sec. Use those for reference, but <u>provide UTM coordinates for any data records prepared</u>.

County: Can be check-marked (paper form) or selected from drop-down lists (electronic form)
Note that this is any of 6 counties for the plot-based surveys, but allows for any of 16 counties for Opportunistic/Directed and Historic surveys

Land Ownership: Check-mark or select from drop-down as applicable

Plot Surveyed?: Enter YES if you are able to survey the plot. If NO, indicate a reason in next field (check or drop-down as applicable). If you did not survey the plot you do not have to enter any of the remaining fields.

Land Use: Critical that you indicate what category you observe at the site, not something previous or future. Categories are:

1 - Built-up Area (residential, business, or combination with some undeveloped land)
2 - Primarily undeveloped land, but with substantive buildings, roads, and disturbed ground
3 - Rural (Only scattered buildings, roads, etc)
4 - Other than above (anything not in above categories and includes otherwise covered by pavement, gravel, or buildings

Land Cover: <u>Critical that you indicate what category you observe at the site</u>, not what you presume the site was previously or may have potential to be. For any category where more explanation is needed (e.g., a shrub community with Scotch broom overstory), include brief explanation or description in Comments. Categories are:

10 - Open-Canopy Forest (<40% canopy cover)
20 - Shrublands (dominated by shrubby plant cover)
30 - Grasslands (dominated by grass cover [some shrubs may be present])

40 - Clear cut (clear cut since 2002; varied land cover)
50 - Agricultural Land (involved in agricultural crop or animal production)
60 - Other (any land cover not described by 5 categories above; describe in Comments)

Pocket Gopher Mounds Detected:

- YES = if you are more than 50% sure you've detected one or more gopher mounds (indicate relative confidence in next section)
- NO = you did not detect evidence of any mounds or the only mounds you found were most likely mole
- UNCERTAIN = you detected evidence of mound(s) but they were not distinctive enough to determine species

Confidence in Mound Detection: Indicate your relative level of certainty only if you indicated YES for previous field (indicate only 1 category)

- Definite = you are >90% sure that you have detected one or more gopher mounds with distinctive characteristics
- Probable = you are >75% sure that the mound(s) you detected were made by a gopher.
- Possible = you think the mounds are likely to be made by a gopher but are unsure due to lack of distinctive characteristics, too few mounds to make determination (1-2), and/or site characteristics do not seem gopher-like

Substrate Sample Collected:
Collected using a 3" diameter x 4-5" high metal can; samples held until later instructions for transport to Olympia)

- YES = a substrate sample collected and <u>sealed in labeled Ziploc-style bag</u> (1 definite mound only)
- NO = no substrate sample collected because no qualifying mound was present at site OR forgot to collect

Gopher Evidence Near but not on the Plot: (***applicable to plot-based surveys only***)
This is <u>not intended to involve extensive survey outside the plot</u>; the intent is to capture an indication of whether there was pocket gopher evidence readily observed in the near vicinity but not on the specific plot. A response should be indicated, whether or not mound(s) were found on the plot

- YES = evidence of pocket gopher mound(s) was detected within 100m outside the plot,
- NO = evidence of pocket gopher mound(s) was not detected outside the plot, whether or not

It is especially important for you to note if there was mound evidence observed outside the plot when there was no mound evidence detected on the plot.

Comments: (brief, but informative)
You may include any comments that you consider important to understand the data you recorded for the location or plot related to the data form. If in doubt about anything, include a comment here to describe/explain.

- This is especially applicable for explanations of Land Cover or Land Use observed at the site.
- If you selected code "60 Other" for Land Cover, definitely explain here
- May be used to briefly explain when you detected mound(s) but indicated "Uncertain"

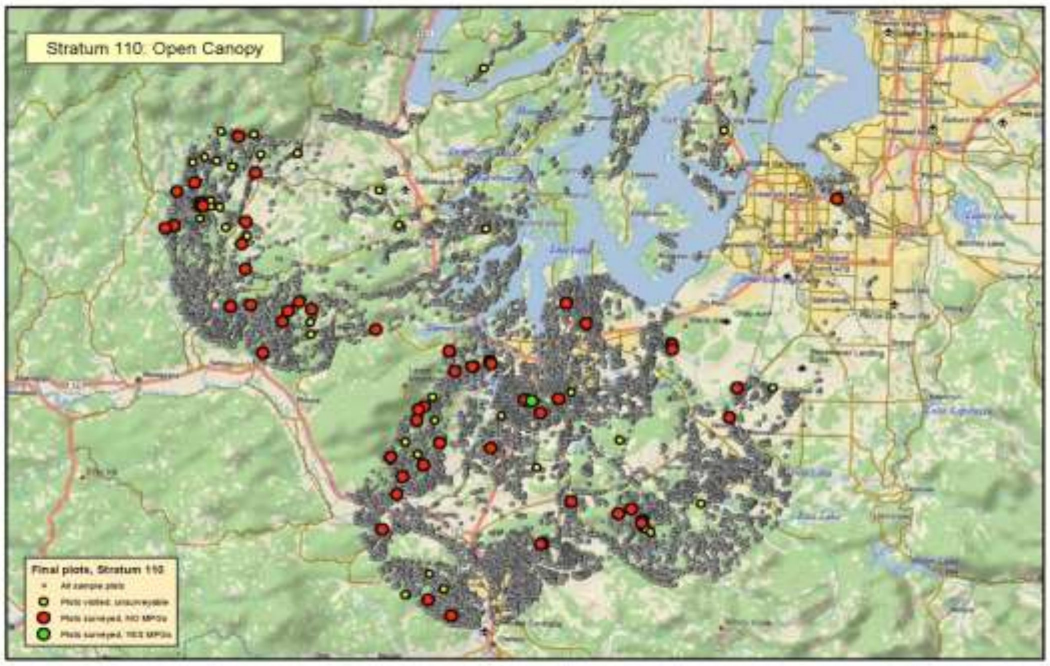
General for Data Form Use and Submission:
You may use either "paper" (MSWord file original) or "electronic" (Excel file original) form to record and submit data, depending on your situation with field sites, computing capability, etc. Some data transmittal considerations:

- Electronic form (Excel format) is preferred for ease of data management and reduction of transcription errors
- Electronic forms contain numerous fields that have drop-down menus to show the only appropriate choices for that field. Just click on a cell, click the down arrow at right side of cell, and click the appropriate choice, which will place that entry in the cell.
- Paper forms may be submitted as paper, as an MSWord file with blanks completed, or as a .pdf of a completed form (MSWord converted to .pdf OR a form scanned to .pdf). A .pdf is preferred.

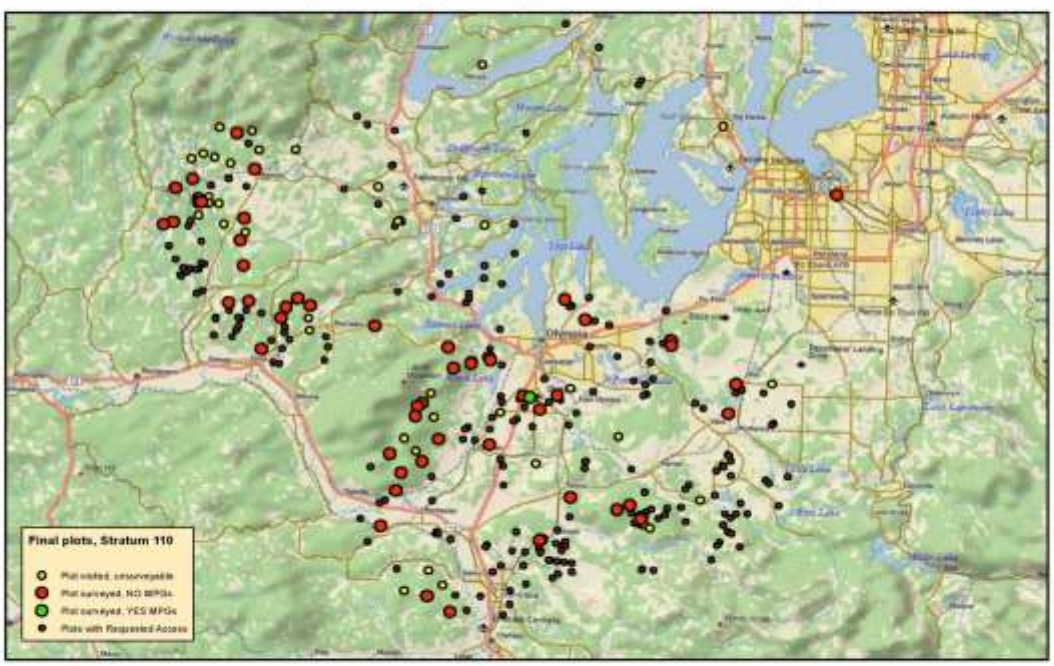
- Keep a copy of any data form you prepare before you transmit the data to Olympia
- Submit data forms at least weekly, but may be more frequent depending on number of sites visited or special instructions.
- Use the following file-naming format:
    - For Opportunistic/Directed and Historic surveys – "OppDirHistMPGSurvey" followed by first initial & last name + date range" (file and associated date range can be short term or cumulative to date)
        e.g.,**OppDirHistMPGSurveyFormsMTirhi15-22June2012**
        NOTE: Opp/Dir and Historic data forms are in different worksheets in same spreadsheet
    - For plot-based surveys – "PlotMPGSurveyForms followed by first initial & last name + date range" (file and associated date range can be short term or cumulative to date)
        e.g., **PlotMPGSurveyFormsBHoenes4-8July2012**

Appendix B
Distribution of Plot-based Surveys Among 12 Habitat Strata

Figure B1. Mazama pocket gopher survey results from Stratum 110 (open canopy forest with low clay soils and few rocks) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

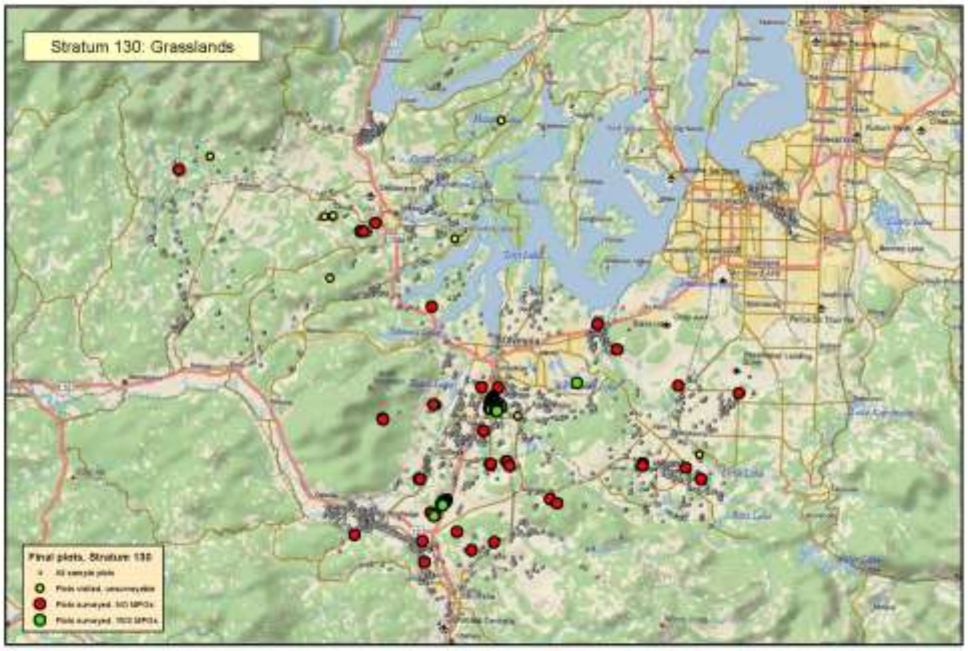


A. Plots sampled among entire population of stratum sample plots

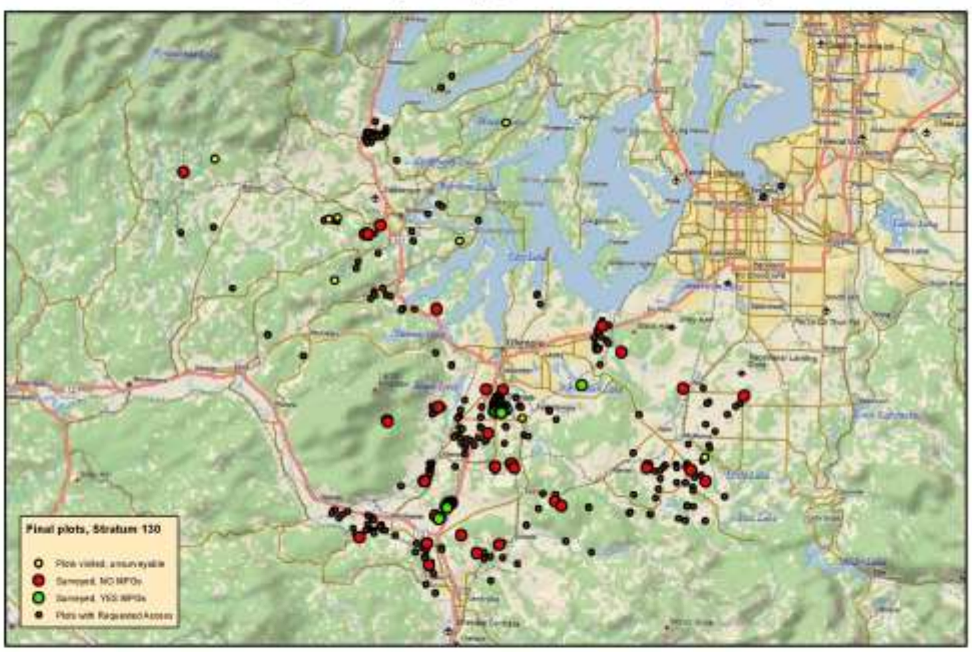


B. Plots sampled by stratum among plots to which access was requested

Figure B2. Mazama pocket gopher survey results from Stratum 130 (grasslands with low clay soils and few rocks) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

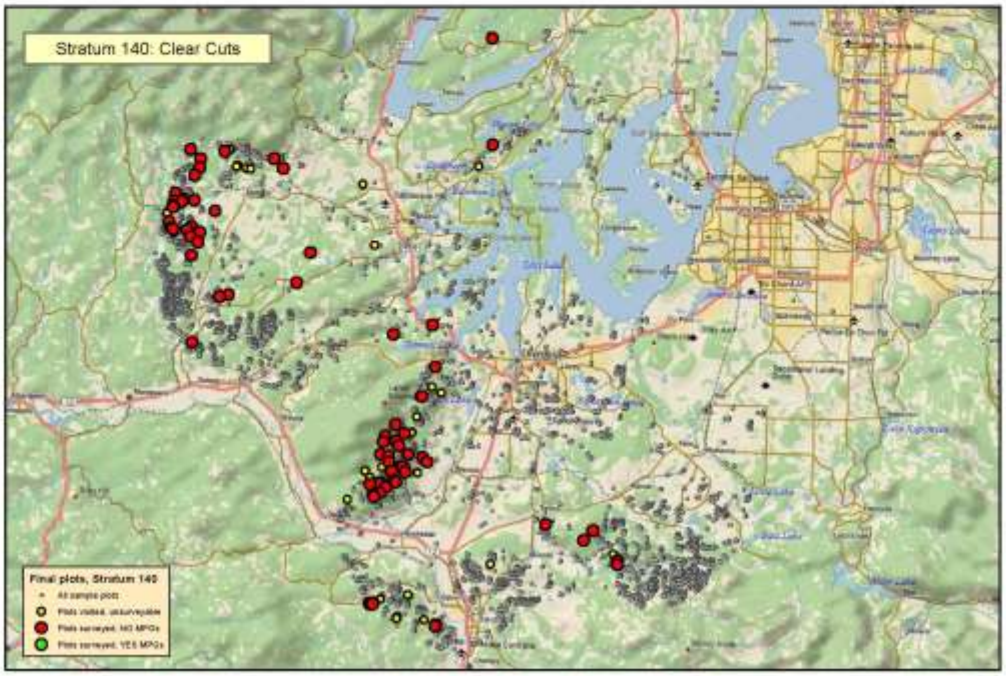


A. Plots sampled among entire population of stratum sample plots

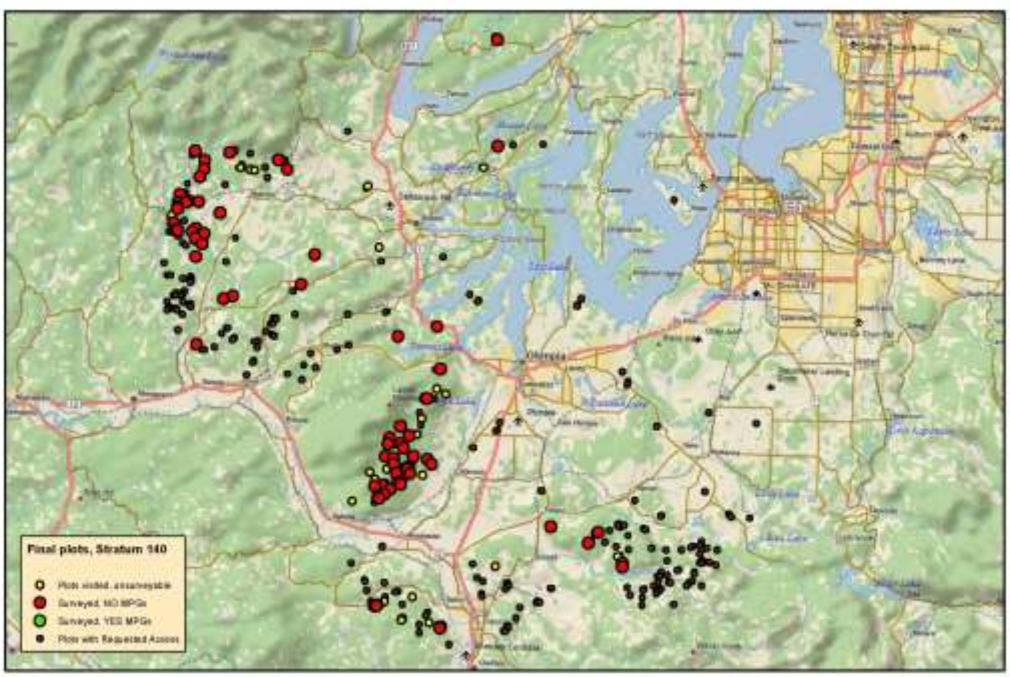


B. Plots sampled by stratum among plots to which access was requested

Figure B3. Mazama pocket gopher survey results from Stratum 140 (clearcuts with low clay soils and few rocks) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

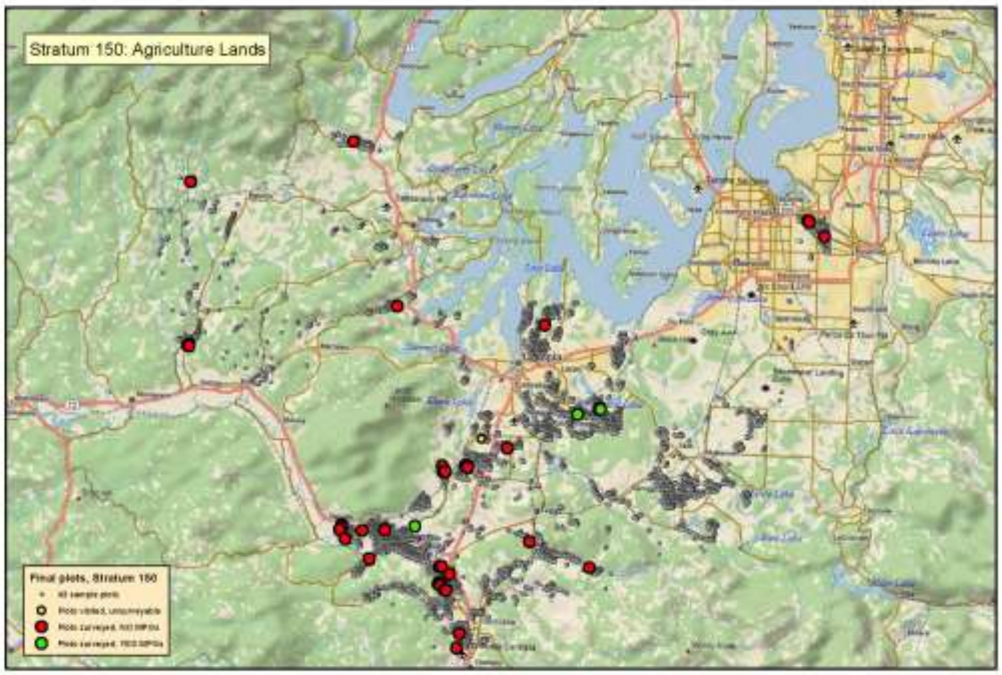


A. Plots sampled among entire population of stratum sample plots

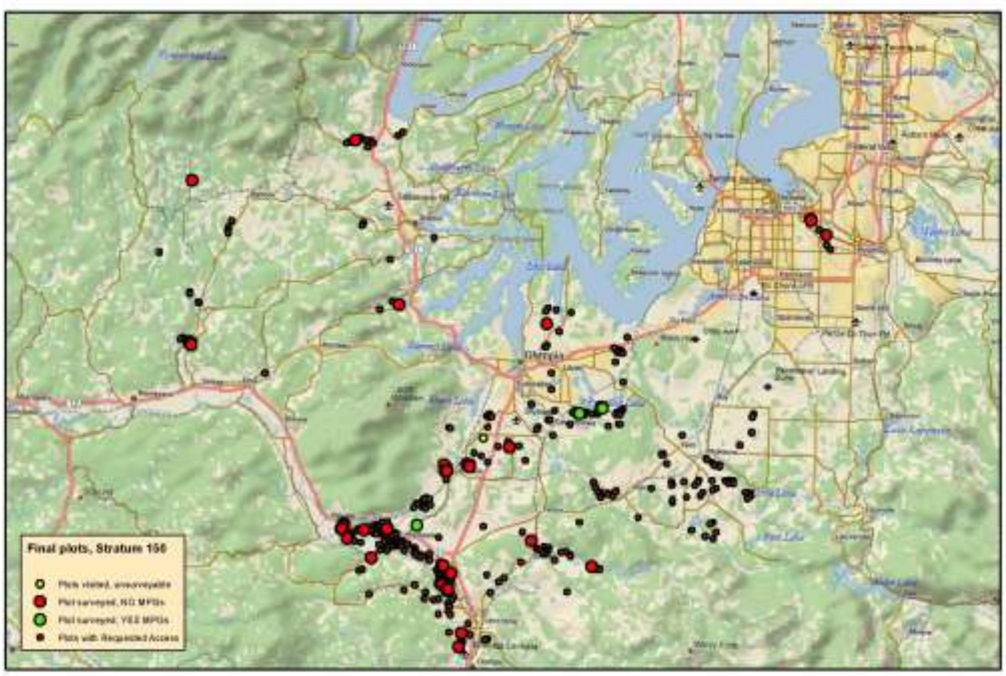


B. Plots sampled by stratum among plots to which access was requested

Figure B4. Mazama pocket gopher survey results from Stratum 150 (agricultural lands with low clays soils and few rocks) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

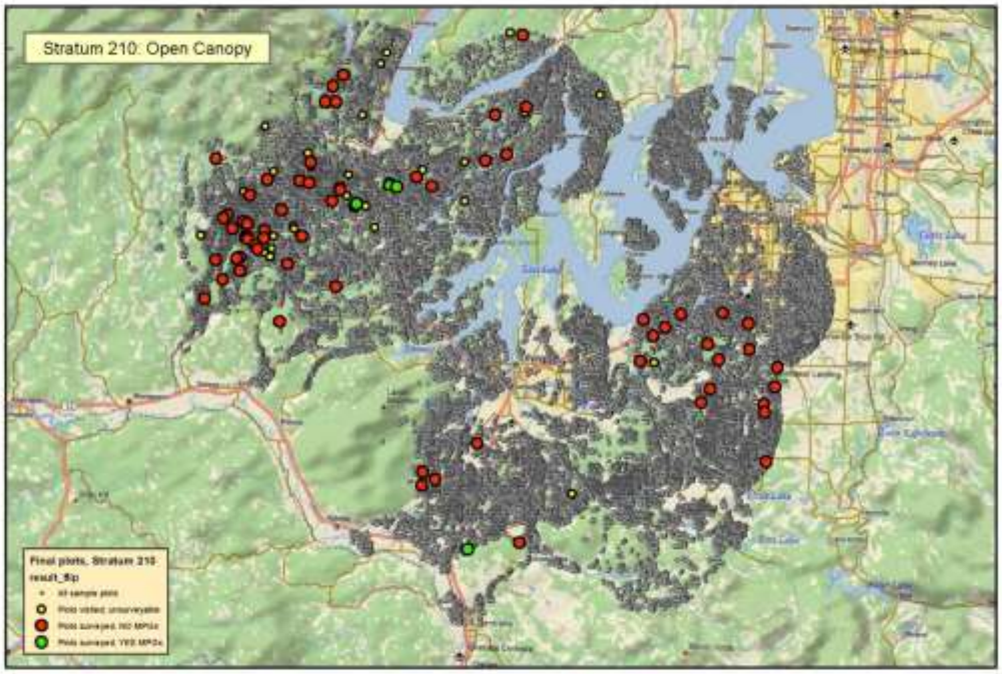


A. Plots sampled among entire population of stratum sample plots

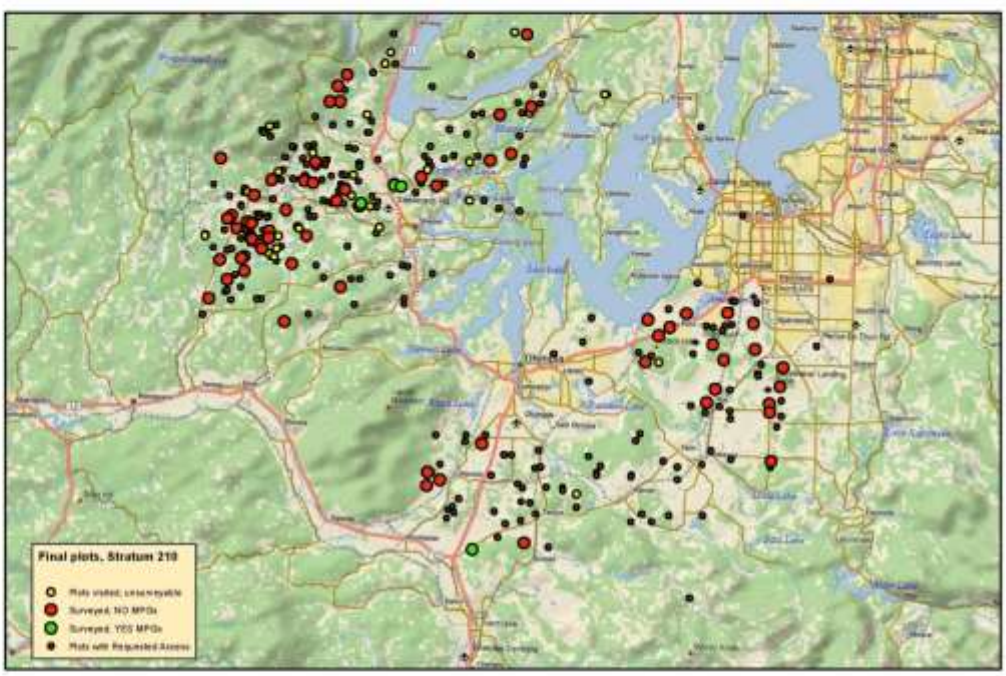


B. Plots sampled by stratum among plots to which access was requested

Figure B5. Mazama pocket gopher survey results from Stratum 210 (open canopy forest with low clays soils with rock fragments) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

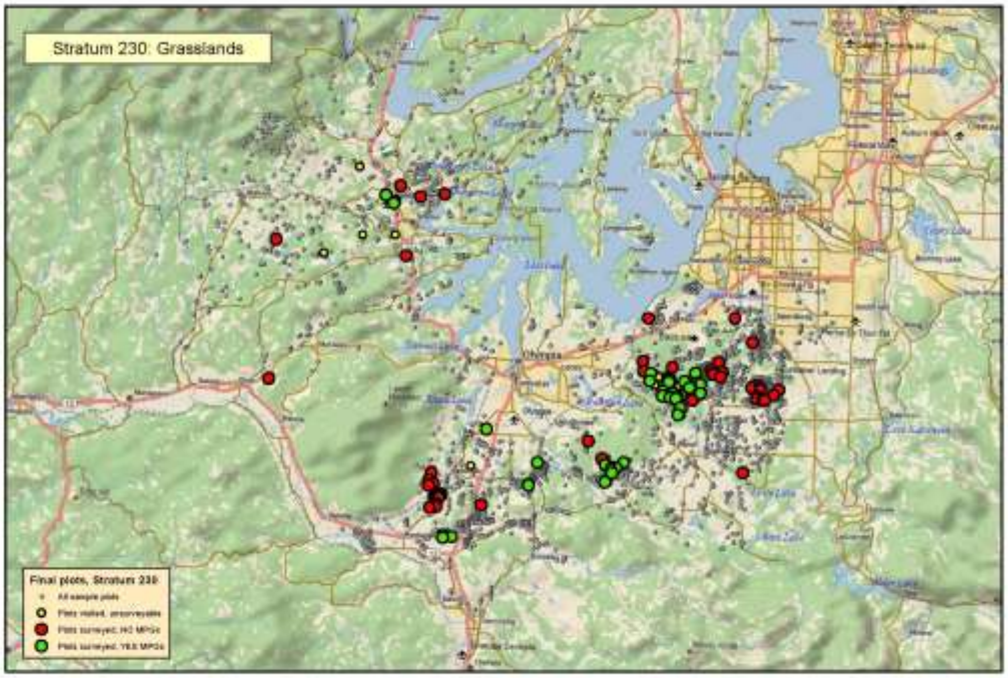


A. Plots sampled among entire population of stratum sample plots

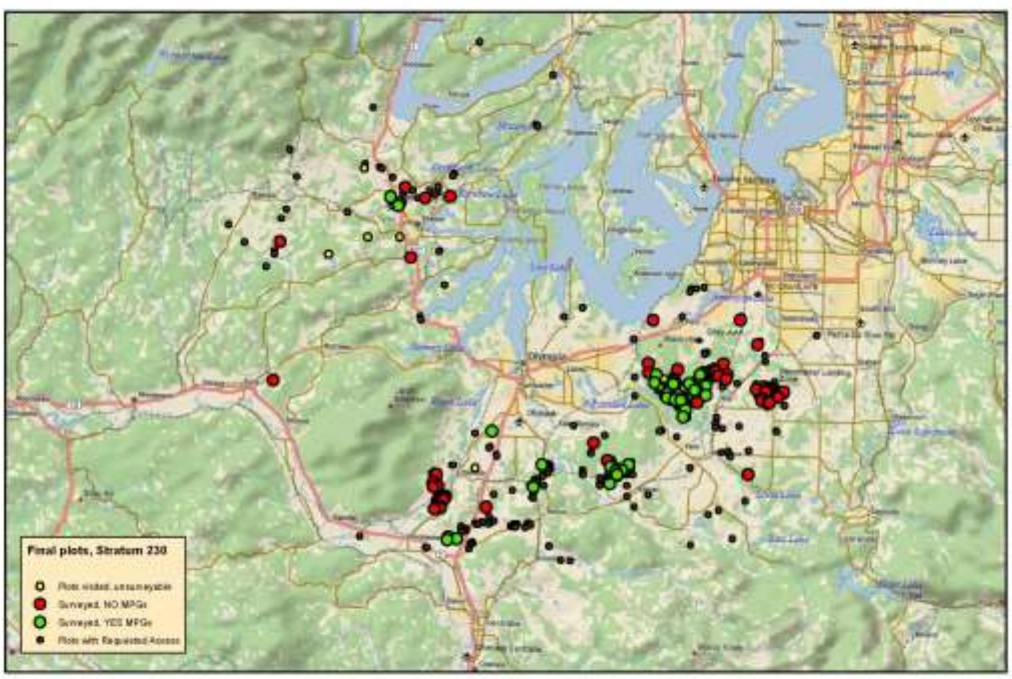


B. Plots sampled by stratum among plots to which access was requested

Figure B6. Mazama pocket gopher survey results from Stratum 230 (grasslands with low clays soils with rock fragments) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

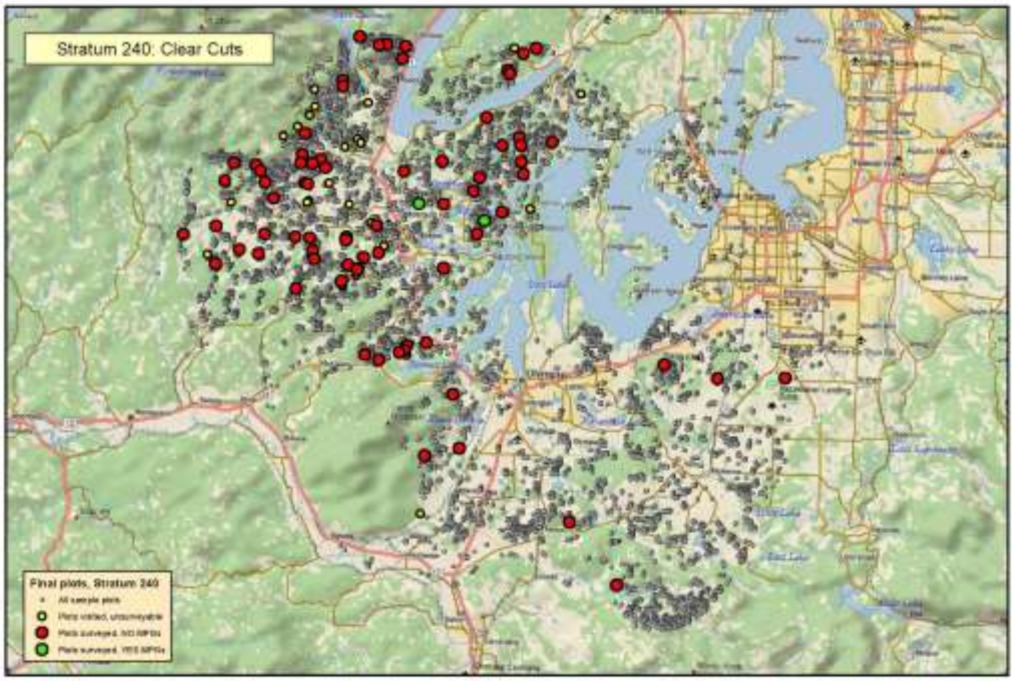


A. Plots sampled among entire population of stratum sample plots

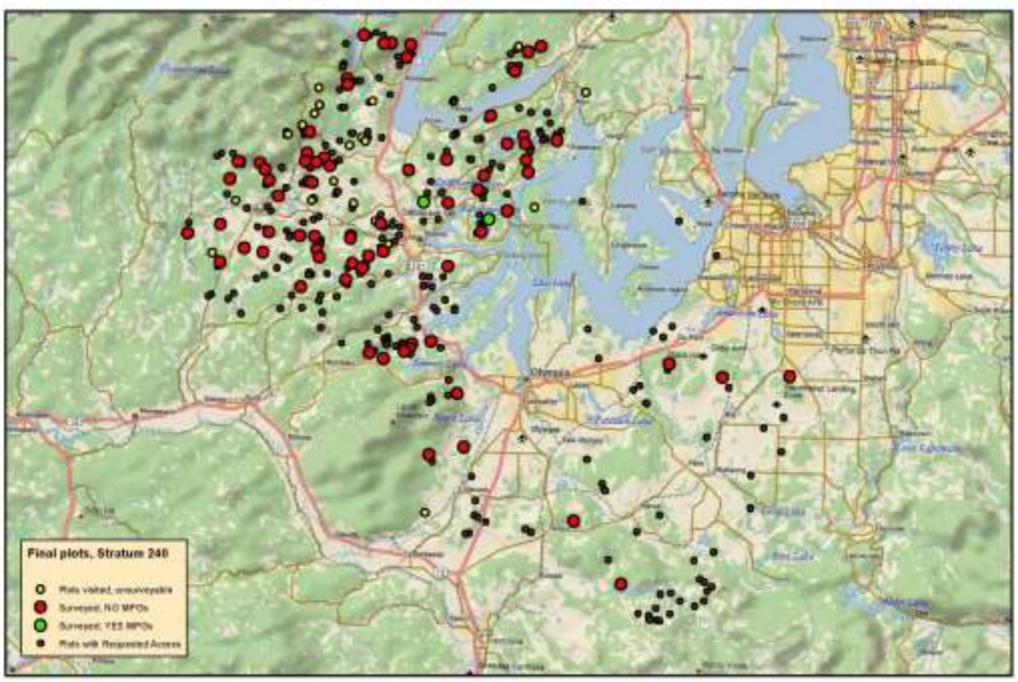


B. Plots sampled by stratum among plots to which access was requested

Figure B7. Mazama pocket gopher survey results from Stratum 240 (clearcuts with low clays soils with rock fragments) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

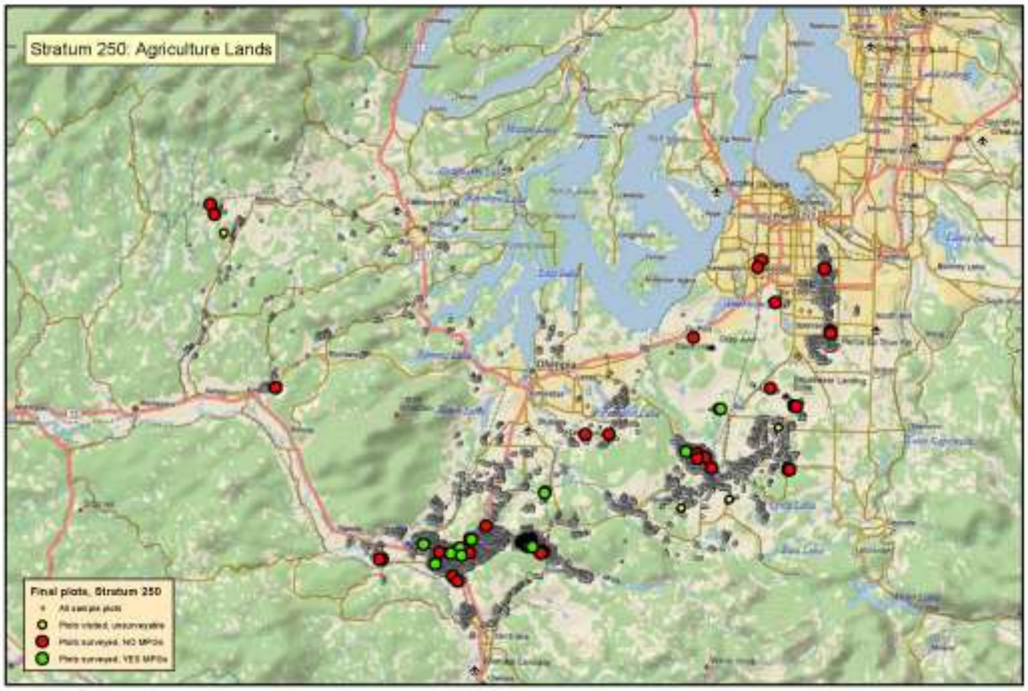


A. Plots sampled among entire population of stratum sample plots

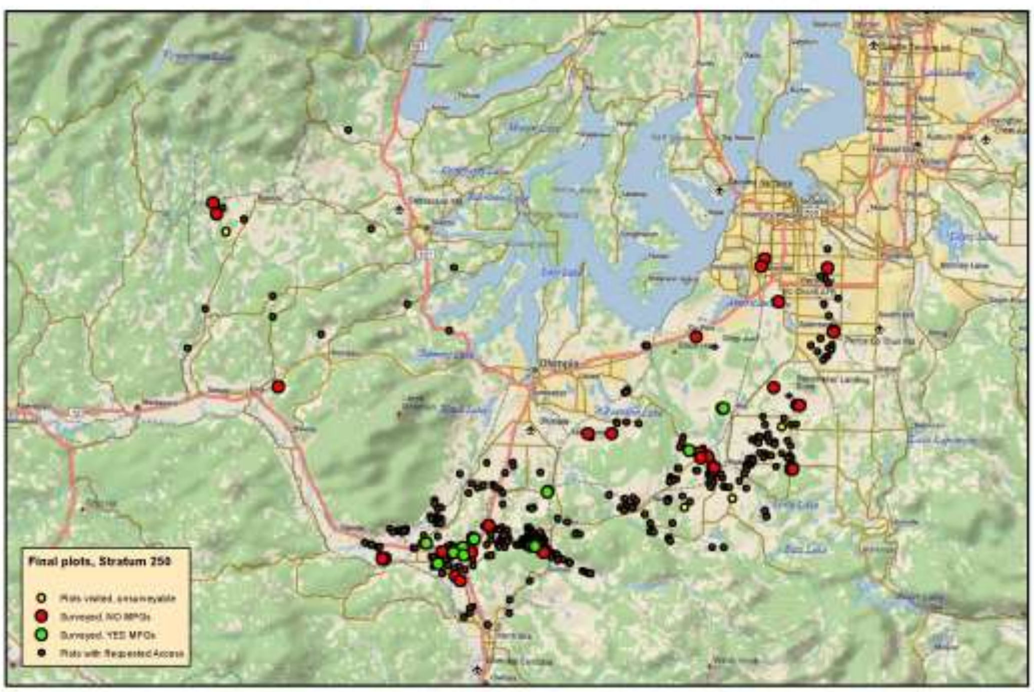


B. Plots sampled by stratum among plots to which access was requested

Figure B8. Mazama pocket gopher survey results from Stratum 250 (agricultural lands with low clays soils with rock fragments) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

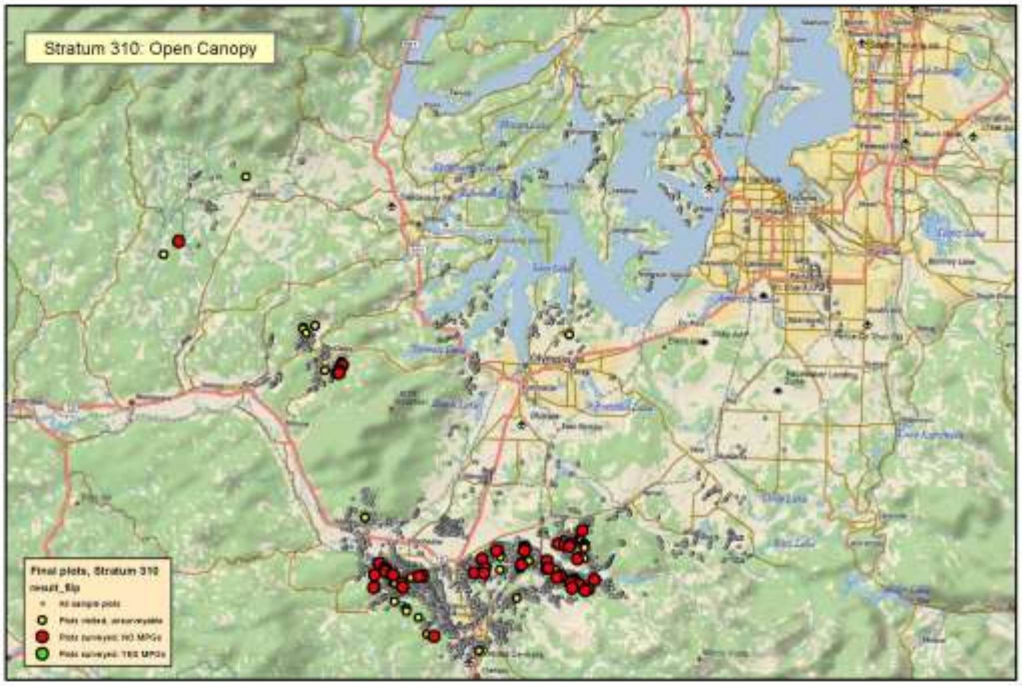


A. Plots sampled among entire population of stratum sample plots

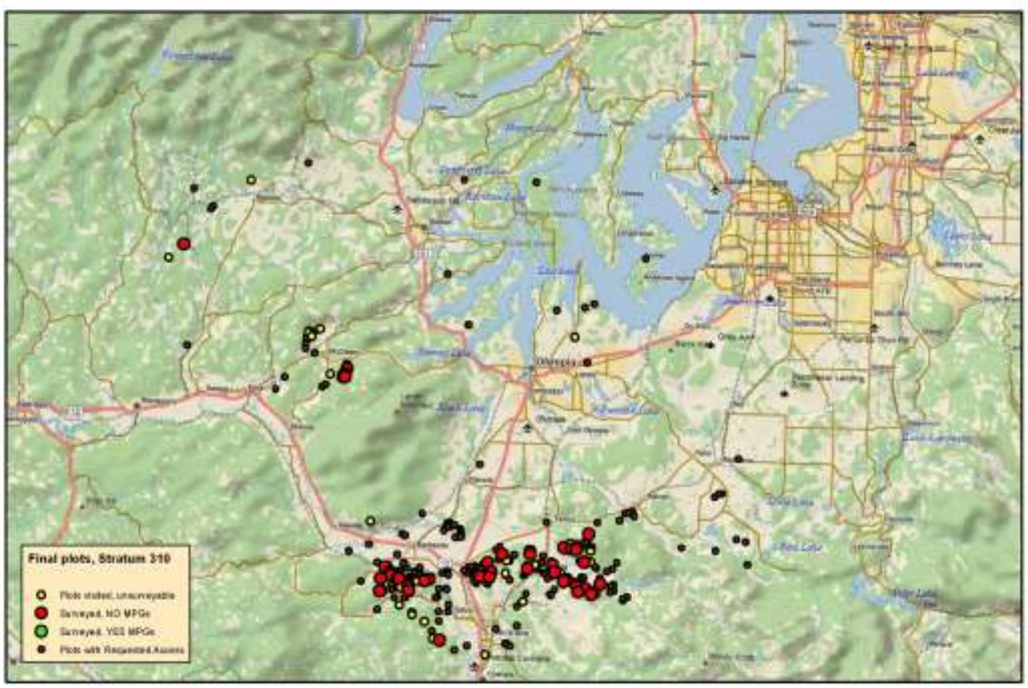


B. Plots sampled by stratum among plots to which access was requested

Figure B9. Mazama pocket gopher survey results from Stratum 310 (open canopy forests with high clay soils) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

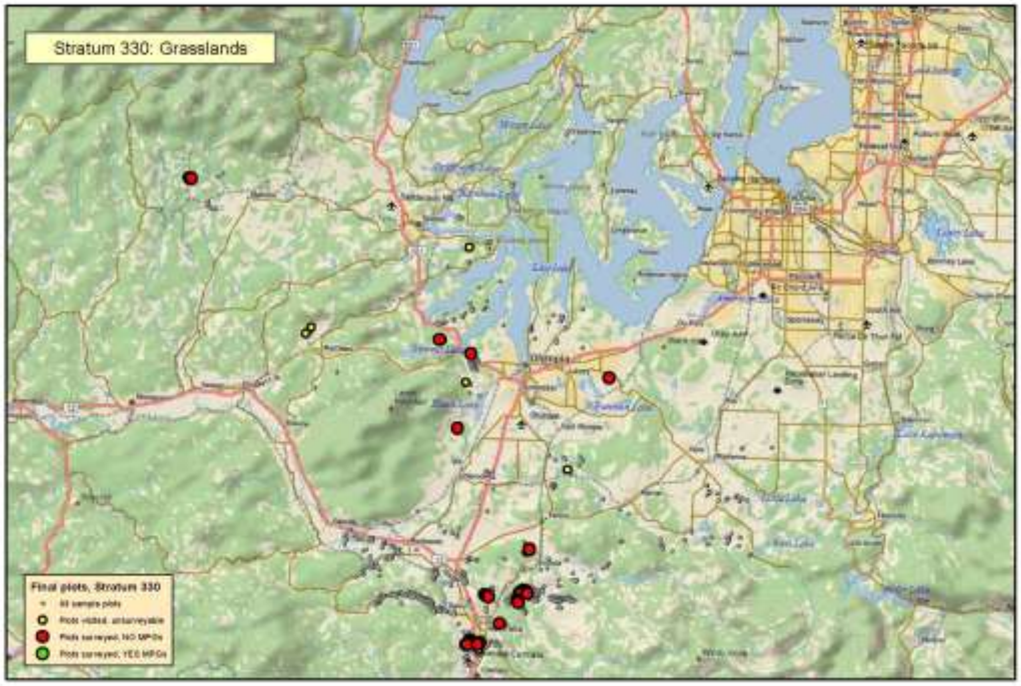


A. Plots sampled among entire population of stratum sample plots

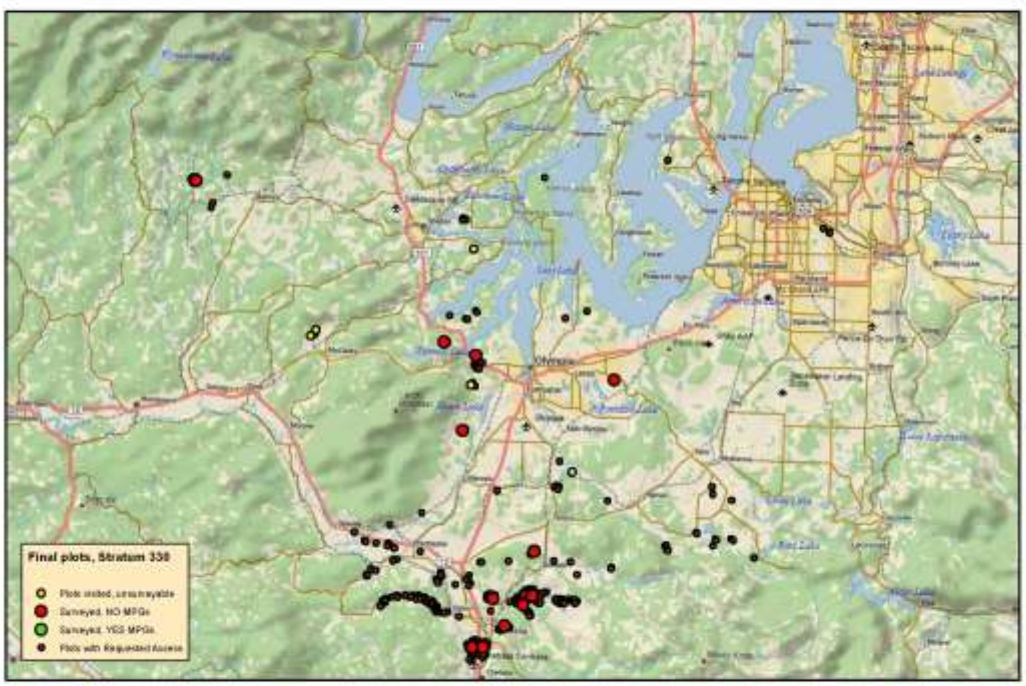


B. Plots sampled by stratum among plots to which access was requested

Figure B10. Mazama pocket gopher survey results from Stratum 330 (grasslands with high clay soils) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.



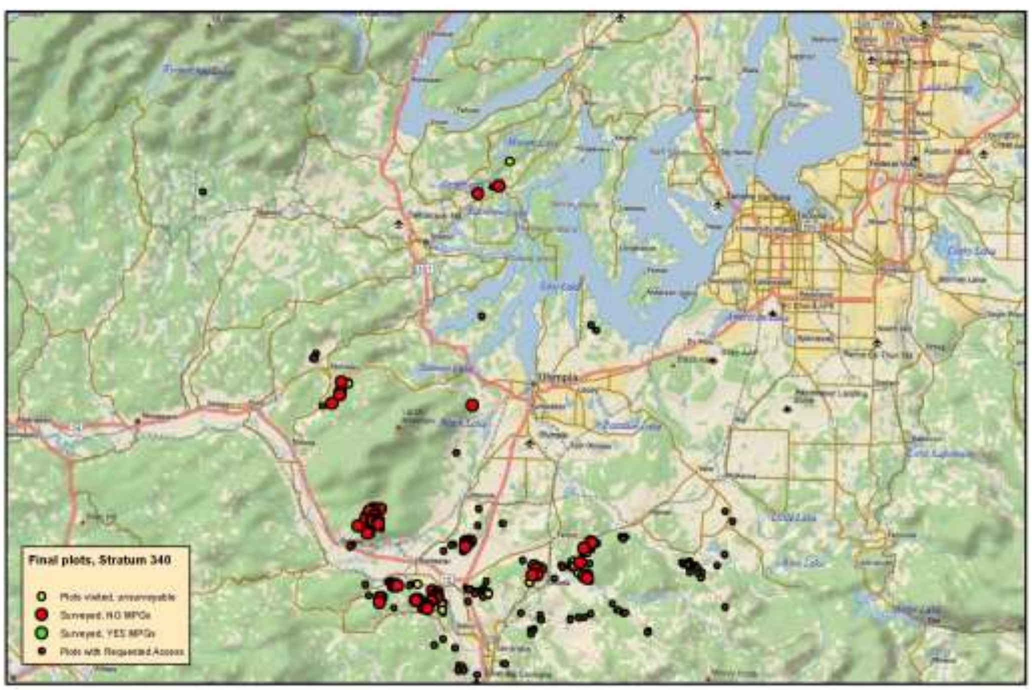
A. Plots sampled among entire population of stratum sample plots



B. Plots sampled by stratum among plots to which access was requested

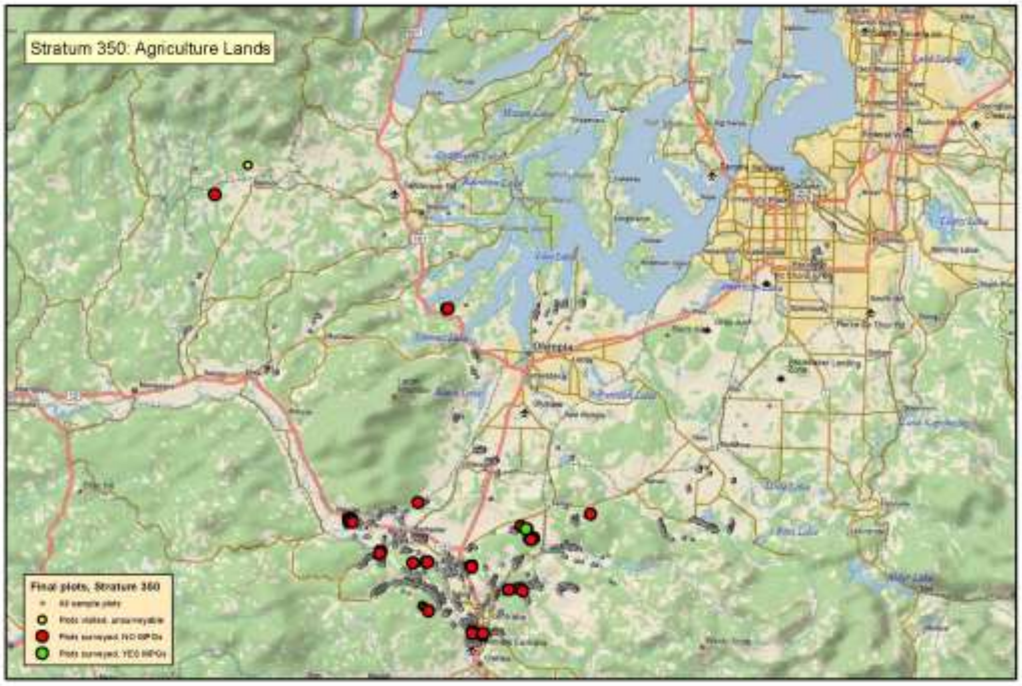
Figure B11. Mazama pocket gopher survey results from Stratum 340 (clearcuts with high clay soils) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.

A. Plots sampled among entire population of stratum sample plots

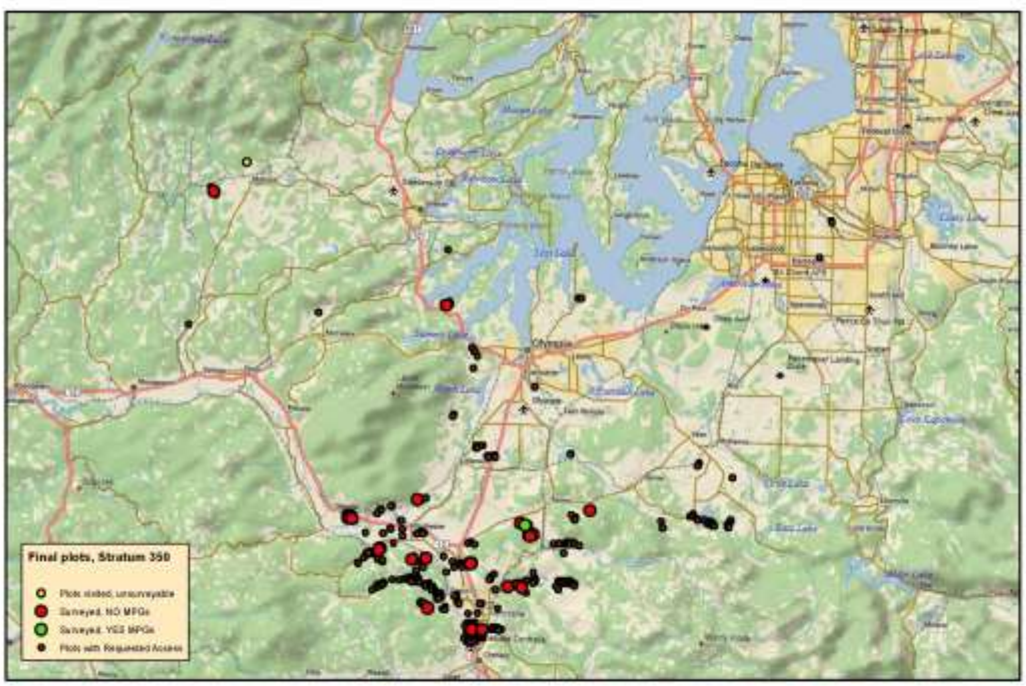


B. Plots sampled by stratum among plots to which access was requested

Figure B12. Mazama pocket gopher survey results from Stratum 350 (agricultural lands with high clay soils) overlaid on A) all plots and B) a random sample of plots to which access was requested from landowners (public and private). Symbols are not to scale of map.



A. Plots sampled among entire population of stratum sample plots



B. Plots sampled by stratum among plots to which access was requested