



Results of the 2017 Mazama Pocket Gopher Screening in Thurston County

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EXECUTIVE SUMMARY

In April 2014, the U.S. Fish and Wildlife Service (Service) listed four subspecies of Mazama pocket gopher (MPG) as threatened species requiring protection under the federal Endangered Species Act of 1973, as amended (ESA). Three of the subspecies are endemic to Thurston County, Washington. The three subspecies are the Olympia pocket gopher (*Thomomys mazama pugetensi*), the Tenino pocket gopher (*T. m. tumuli*), and the Yelm pocket gopher (*T. m. yelmensis*). Both the Service and Thurston County (County) recognized that this listing could have an impact on the County's ability to issue building permits within their jurisdiction. To address this issue the County, with technical and financial support from the Service, began working on a comprehensive, county-wide habitat conservation plan (HCP) in 2012 to address incidental take that would result from ground disturbing activities the County both permitted and would participate in themselves. In addition, the Service recommended and the County adopted a protocol, initiating in 2014, to screen parcels with pending permit applications for the presence of MPG mounds. Subsequently, the permit review process and screening protocol have been revised in 2015, 2016, and 2017. The screening process was intended to be an interim approach while the County continued to work on their programmatic, county-wide HCP.

In 2017, the Service recommended in a series of letters to the County to implement a multi-visit screening protocol (Service 2017a,b,c). The Service's protocol, based on best available science, included two site visits 30 days apart on less-preferred soils, three site visits 30 days apart on less-preferred soils within 600 feet of a known MPG location, and three site visits 30 days apart on more-preferred soils, with the third visit occurring in September or October. After consideration of the Service's recommendation, the Thurston County Board of Commissioners voted to adopt and implement a screening protocol that included two site visits for both less- and more-preferred soils, with site visits 30 days apart, and one of the visits occurring between August 1 and October 31 for more-preferred soils (County 2017a) citing the impact to permit applicants. The Service agreed to help implement the County-adopted protocol without concurring with the Board's approach for fewer site visits to parcels with more-preferred soil types or proximate to known occupied sites.

As part of the 2017 protocol development, the Service and the County agreed to establish three teams to accomplish the Screen Team screening process; one two-person team for the majority of the properties, one multi-person team for properties over 20 acres, and a third team on an as-needed basis to address the backlog of permit applications in the latter half of the season. The Service recommended that if the initial site was positive for MPGs, a subsequent site visit was not required. No additional site visits were conducted or required if indeterminate mounds were detected, and/or if the maximum number of site visits for that soil type were met (Service 2017a). This was different than the previous two years, when the Screen Team would revisit sites that had indeterminate mounds. All or most positive MPG mounds or mound clusters were recorded via GPS at each site depending on the number of mounds at a site.

Field screening for MPG mounds was conducted from June 1 through October 31, 2017. A total of 315 sites were visited up to two times each, for a total of 584 site visits. MPG mounds were not detected at 267 sites, or 85 percent of all screened sites. The Service recommended that actions at these sites would be unlikely to result in take of MPGs. The County notified that landowner of the negative finding and normal permit processes proceeded. MPG mounds were

detected at 48 sites, or 15 percent of all screened sites. Landowners and the County were notified by the Service that future actions on properties with MPG mounds could result in prohibited take. The County also sent a letter to landowners if MPG mounds were present.

INTRODUCTION

This document describes and summarizes information collected during the 2017 MPG screening season conducted by the County and the Service within the jurisdiction of Thurston County, Washington. It is expected that the data presented in this report will inform development of the county-wide HCP, recovery planning and MPG conservation efforts, as well as future screening recommendations for MPG.

APPROACH

Mazama Pocket Gopher Screening Protocol

As in previous years, the Service recommended to the Thurston County Board of Commissioners a MPG screening protocol based on the best available science. The protocol establishes the number of site visits necessary based on soil preference and the seasonal dates the site visits are to be conducted (Service 2017a,b,c). The dates recommended by the Service were June 1 to October 31. The Service protocol included two site visits, 30 days apart on less-preferred soils; three site visits, 30 days on less-preferred soils within 600 feet of a known MPG location; and three site visits, 30 days apart on more-preferred soils with the third visit occurring in September or October.

After consideration of the Service's recommendation, the Thurston County Board of Commissioners voted to adopt and implement a screening protocol that included two site visits for both less- and more-preferred soils, with site visits 30 days apart, and one of the site visits occurring between August 1 and October 31 for more-preferred soils (County 2017a,b), citing the impact to permit applicants for not fully adopting the Service recommendation. The Service agreed to help implement the County-adopted protocol without concurring with the Board's approach for fewer site visits to parcels with more-preferred soil types or proximate to known occupied sites.

As part of the 2017 protocol development, the Service and the County agreed to establish three teams to accomplish the screening process; one two-person team (one FWS contract employee and one County employee) would screen the majority of the properties, one multi-person team for properties over 20 acres, and a third team on an as-needed basis to address the backlog expected in the latter half of the season. The Service recommended that if the initial site was positive for MPGs, a subsequent site visit was not required. This was intended to save staff time and resources.

All or most positive MPG mounds or mound clusters were recorded with a Trimble Geo7x geographic positioning system (GPS) unit at each site depending on the number of mounds at a site. No additional site visits were conducted or required if indeterminate mounds were detected, if the maximum number of site visits for that soil type was met (Service 2017a). Properties with pending County permit applications were prioritized for site visits.

Consistent with County Critical Area Ordinance (COA) review of permit applications, sites were subject to review if they were located on or within 300 feet of MPG soils (Appendices A), or were within 600 feet of a previously confirmed MPG location. Sites that have the potential to support MPG are first identified for review by the County by examining soil type, vegetative cover, impervious surfaces, and distance from previously known MPG detections (County 2017 a,b).

Field Procedures

The County notified landowners by telephone and email that screening would be conducted on their property. The notification generally occurred 2-3 weeks before the site visit, but often much sooner than the five working days in advance required by the County (County 2017b). The County asked that sites be mowed and otherwise accessible to field crews. Field crews also had the option to request mowing if lack of visibility prevented proper screening. Screenings were typically conducted between approximately 8:00 am and 4:00 pm. At least one person with training and experience in MPG mound identification were present on every Screen Team survey. On the larger teams, other persons were used to help locate potential mounds, but the experienced staff would make the final determination. Additional staff were essential when screening large parcels.

Screening began once the Screen Team arrived at a site, assessed site conditions, and determined a route for walking the entire parcel. Members of the screen team would walk transects by lining up in a single line with about 10-15 feet between each member of the team. Using this method, the team would traverse the entire property, confer on proper identification of any mounds, and record MPG mound data on field forms and with a GPS unit. MPG mound locations were also hand drawn on the aerial photo. In some instances, a picture was taken of the mound(s). The survey path or transect walked was recorded with the same GPS unit, in addition to being recorded by hand on a diagram or aerial photograph of the site. The GPS points were differentially corrected to increase accuracy. The digital data were downloaded weekly and checked for accuracy against field forms, then transmitted regularly to Thurston County and Washington Department of Fish and Wildlife for incorporation into their databases.

Screenings were conducted at least 30 days apart to account for variation in environmental and biological factors. Variation in environmental and biological factors may include rain, temperature, reproductive timing, and dispersal of young. Mounds with MPG characteristics are considered an indicator of occupancy. However, factors such as season and weather can influence mounding or mound appearance. Once mounds with MPG characteristics were confirmed, no further site visits were required by the protocol. Other sites were precluded from further visits by the screen team with concurrence by the Service based on onsite characteristics.

Soils

Knowledge of the type and location of soils in Thurston County helped to inform our understanding of MPG use relative to soil type. The term “gopher soils” refers to certain soil types that MPGs are known to use. Soil types were placed in more-preferred and less-preferred categories by the Service based on the relative occurrence of MPG in those soil types, as compared to the abundance of those soil types in Thurston County (Appendices C and D). Due

to time constraints this year, and because soil data had already been collected throughout Thurston County, onsite soil evaluation/verification was not conducted in 2017. However, soil data were used to evaluate parcels for screening and comprised a valuable tool in the MPG screening process.

RESULTS

The following results are based on field data collected by the Screen Teams for the 5-month period between June 1 and October 31, 2017. Results may have been influenced by environmental conditions, which in turn may have influenced the behavior and life history of MPGs.

Environmental Conditions

Overall, 2017 was both a year of extremes in temperature and of contrasting climate conditions. The winter of 2016-2017 was one of the coldest and wettest winters in decades, but the summer of 2017 was nearly as dry and hot as the drought in 2015. In addition, there were also wildfires both locally and regionally that affected air quality. Monthly temperature and precipitation data collected from 2010-2017 at the Olympia Airport in Thurston County are shown in Figures 1 and 2.

The winter and spring of 2017 averaged 10-15 °F below normal temperatures (Figure 1). Over 71 inches of precipitation were recorded, which was 20 inches over the normal average of 51 inches per year (Figure 2). 2017 ranks in the top five wettest years since 1897. As a result, snow pack levels at higher elevations were at 120 to 150 percent of average levels (NOAA 2017).

Following the very wet winter and spring was a summer that rivaled the drought of 2015 in both temperature and duration. The wet conditions of spring buffered the effects of the drought somewhat, and kept the soils wetter than expected for the drought conditions of summer. The lack of rain was significant, with almost four months of less than 2.5 inches of rain per month from June to September 2017. July was noteworthy in how little rain fell. Some places received just 0.01 inch of rain, while in many places, there was no rain for the entire month of July (NOAA 2017).

Temperatures were higher than average throughout the summer. July temperatures averaged 82 degrees F, and August temperatures averaged 84 degrees F (NOAA 2017).. This coupling of higher than average temperatures and below average precipitation resulted in very rapid melting of snow pack on local peaks, and altered flows in lowland streams and rivers.

Lastly, there were several fires burning both locally and regionally that influenced air quality in the area. Air quality alerts were issued for 16 days for fires locally near Thurston County and near Mt. Rainier, and as far away as Northern British Columbia and Southern Oregon. The largest fire locally that directly affected MPG habitat burned approximately 400 acres in and around the Scatter Creek Wildlife Area. The dry summer added to the amount of fuel available for the fires to spread.

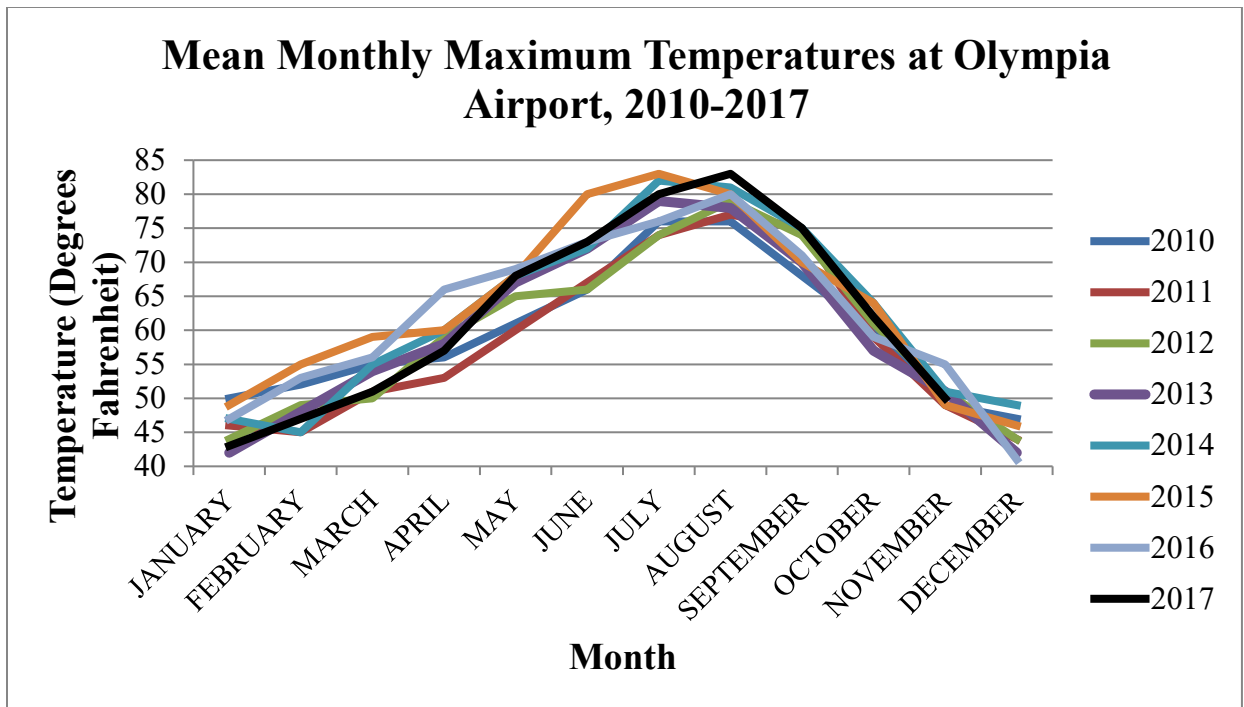


Figure 1. Mean monthly maximum temperatures as recorded by the Olympia Municipal Airport weather station in Thurston County, WA relevant to the MPG screening area from 2010 to 2017.

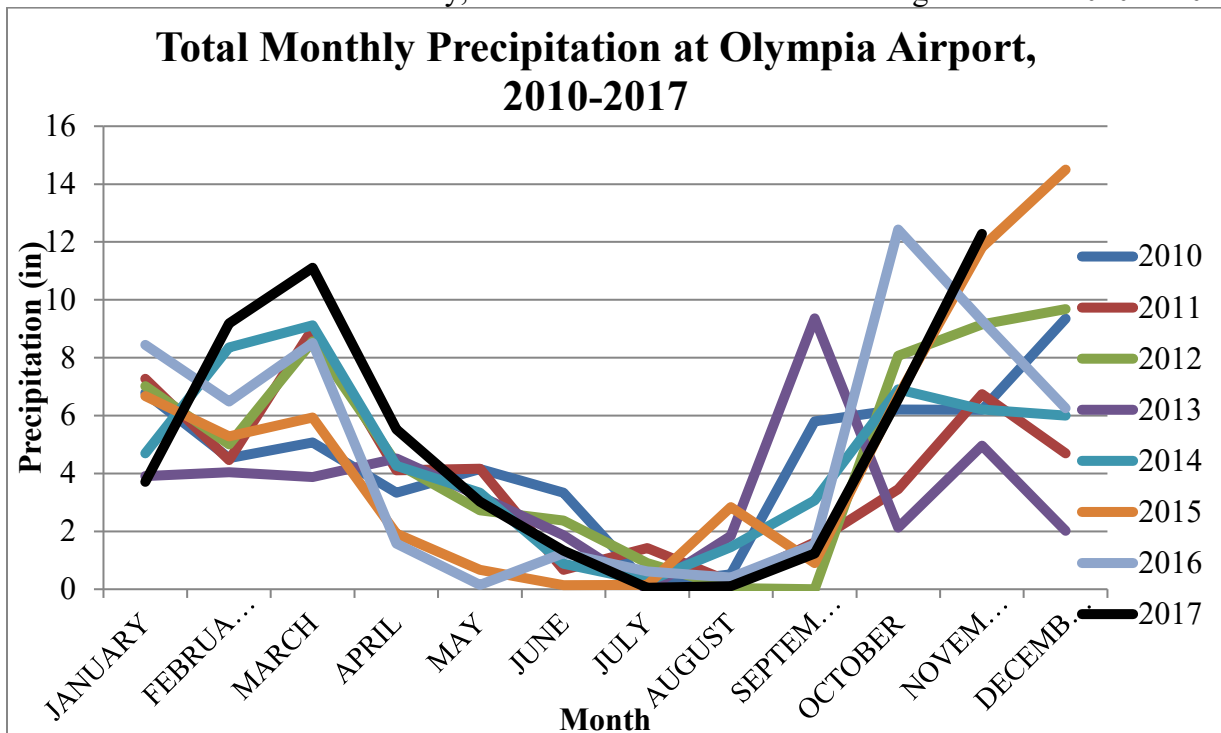


Figure 2. Total monthly precipitation as recorded by the Olympia Municipal Airport weather station in Thurston County, WA relevant to the MPG screening area from 2010 to 2017.

Field Results

In 2017, Thurston County received over 5,000 land use applications. From that set of applications, 467 permit applications were subject to County review and/or MPG screening. Thurston County conducted the preliminary assessment of applications that were flagged for prairie or MPG reviews. The County conducted field assessments for those applications that were possibly eligible for exclusion from MPG screening based on certain criteria. No MPG data were collected at these sites. In total, 152 applications were excluded due to a variety of factors. These factors included, but were not limited to, location, total woody vegetation cover, wetland conditions, existing impervious surfaces, and project type, such as the removal of underground storage tanks or replacement of structures in existing footprints.

The 315 remaining applications were then scheduled for full MPG field review by the Screen Team, per the County-adopted protocol. These applications were comprised of 322 legal tax parcels totaling approximately 2,035 acres. The 315 sites were visited up to two times each, for a total of 584 site visits over the season. MPG mounds were not detected at 267 sites, or 85 percent of all screened sites. MPG mounds were detected at 48 sites, or 15 percent of all screened sites (Table 1).

Critical Areas Ordinance

Under the current County CAO, projects within 600 feet of known MPG locations are screened. This year's screening showed that 52 percent of sites where MPG mounds were found were within 600 feet of a known/mapped MPG location, and 48 percent were not. Each additional year of data helps to further identify MPG distribution, and is thus more useful for conserving MPG across the landscape.

Soils

Of the 315 sites that were screened, 67 percent, or 211 sites, were on more preferred soils (Appendix A, Table 1). A total of 48 properties were found to have MPG mounds, of which 90 percent were found on more preferred soils. MPG mounds were also rarely found on sites screened with less preferred soils (Table 1). Figure 3 illustrates where the surveyed sites were located within Thurston County, with the Service Areas highlighted.

Table 1. Summary of all sites screened for Mazama pocket gophers in 2017, in Thurston County, WA, showing the number of sites screened, and what percentage of sites were found with gopher mounds and no gopher mounds on more and less preferred soils.

A	B	C	D
MPG Soil Preference	Sites Screened	Sites with MPG Mounds	Sites with No MPG Mounds
More-Preferred	211 (67%)	43 (90%)	168 (63%)
Less-Preferred	104 (33%)	5 (10%)	99 (37%)
-----	315	48	267

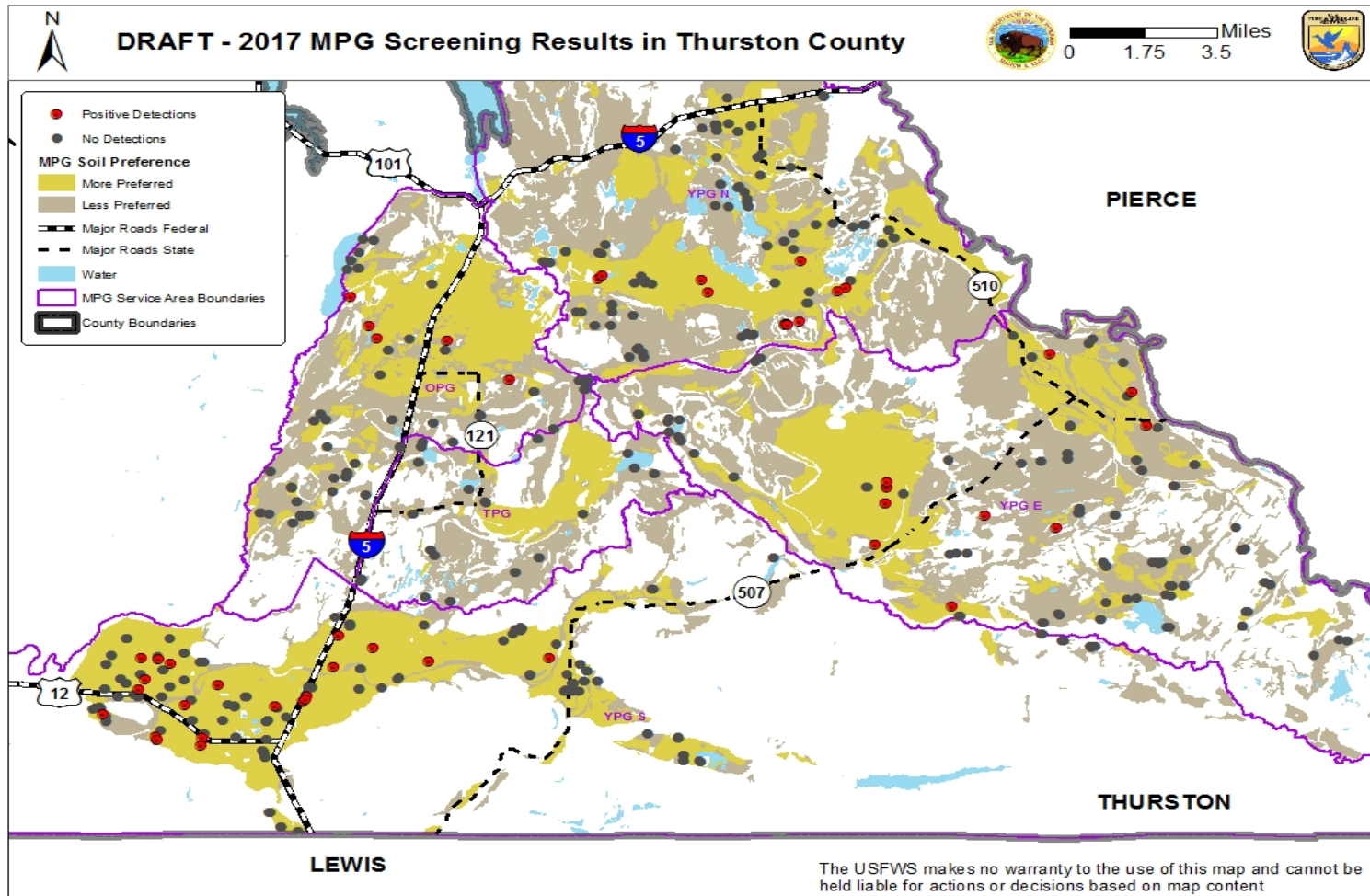


Figure 3. A map of the positive and negative detections for MPG in 2017, showing service areas where different subspecies of MPG occur in Thurston County. The map also shows areas of more preferred and less preferred soils for MPG.

Subspecies of MPG

The Screen Team visited sites within the range of each of the 3 subspecies in Thurston County, and identified MPG mounds within two of the subspecies ranges. Of the total of 48 properties where MPG mounds were found, 90 percent, or 43/48 of the mounds observed, were found within the range of the Yelm pocket gopher. Ten percent of MPG mounds (5/48) were found within the range of the Olympia pocket gopher. Mounds were not detected at any site within the range of the Tenino pocket gopher.

MPG Screening Resources Expended

Implementation of the 2017 MPG screening protocol required significant time and funding. The Service hired one individual to assist with screening and provided funding to Thurston County to enable the County to employ one individual for screening assistance. Other Service and County staff were assigned to assist the Screen Team in addition to other work duties. This year utilized a new method for scheduling field teams, and included the use of up to three separate teams in the field throughout the week. The first team was comprised of a representative from both Service and the County, who went out 4 days per week to screen the majority of smaller parcels. A separate team, also comprised of several Service and County representative, went out on Mondays to screen larger properties, usually over 20 acres. A third team was utilized later in the season to meet the August 1 to October 31 screening requirement adopted by the Thurston County Board of Commissioners. The 2017 screening effort resulted in the following approximate expenditures of personnel.

- Field work lasted from June 1-October 31, 2017 for a total of 100 field days, and included 1 to 3 Service staff and 1 Thurston County staff in the field conducting surveys on three separate teams for up to 4 days per week. This effort resulted in 1,073 dedicated person hours for Service staff, and 702 person hours for Thurston County. Duties included field gear pick-up, site visits, data collection, interacting with landowners, field data form completion, data transfer between agencies, and reporting site visit information to the project manager.
- Office support for screen team activities was provided from June 1-October 31, 2017, and resulted in 960 person hours for Service staff, and approximately 1,127 person hours for Thurston County. Duties included planning, coordination, equipment preparation, data download, field form review, preparation of determination forms, database maintenance, scheduling, notifying landowners, answering correspondence, and mapping.
- Total investment of human resources to support the 2017 MPG screening effort was 2,033 person hours for the Service, and 1,829 person hours for the County. In total, this effort utilized nearly 2 person years (1.85 FTE) of human resources.

APPLICATION OF RESULTS

Screening Utility Discussion

Although screening may have short-term utility for local jurisdictions, it does not address the underlying causes of the subspecies decline, including the loss, degradation, and fragmentation of suitable habitat. Screening further exacerbates those factors identified by the Service as factors responsible for the listing of the MPG subspecies. That is, each time an individual property is identified as not having MPG mounds, the proposed project is generally allowed to proceed. There is no procedure or process in place to evaluate, account for, or offset the loss, degradation, or fragmentation of MPG habitat. Thus, impacts to the parcel's suitable habitat, adjacent habitat, and habitat at the landscape level are not addressed, which may be exacerbating threats to MPG subspecies. The Service continues to stress that screening parcels was intended to be a short-term approach. Screening is not a viable long-term solution to ensuring ESA compliance, it does not promote recovery of listed species, and it has an unsustainable cost both in the terms of dollars spent and staff time allocated. The Service continues to work with partners to develop more comprehensive solutions that do not rely on yearly screening efforts, and to promote sustained and steady economic growth, while contributing to the conservation of prairies and the recovery of listed species, including the Mazama pocket gopher.

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Appendix A

2017 MPG Screening Protocol

Summary Table of Site Visits by Soil Type Needed for the 2017 Mazama Pocket Gopher Review
Process for Permit Applications in Thurston County as adopted by the Thurston County Commissioners.

Mazama Pocket Gopher Preference	Soil Type	Site Visits & Timing
More preferred	<ul style="list-style-type: none">• Nisqually loamy fine sand, 0 to 3 percent slopes• Nisqually loamy fine sand, 3 to 15 percent slopes• Spanaway-Nisqually complex, 2 to 10 percent slopes• Cagey loamy sand• Indianola loamy sand, 0 to 3 percent slopes• Spanaway gravelly sandy loam, 0 to 3 percent slopes• Spanaway gravelly sandy loam, 3 to 15 percent slopes	<p>For property more than 600 feet from a gopher occurrence:</p> <ul style="list-style-type: none">• 2 site visits at least 30 days apart, 2nd visit after Aug. 1st• At least one site must occur after August 1• 1st visit must occur by September 30
Less preferred	<ul style="list-style-type: none">• Alderwood gravelly sandy loam, 0 to 3 percent slopes• Alderwood gravelly sandy loam, 3 to 15 percent slopes• Everett very gravelly sandy loam, 0 to 3 percent slopes• Everett very gravelly sandy loam, 3 to 15 percent slopes• Indianola loamy sand, 3 to 15 percent slopes• Kapowsin silt loam, 3 to 15 percent slopes• McKenna gravelly silt loam, 0 to 5 percent slopes• Norma fine sandy loam• Norma silt loam• Spana gravelly loam• Spanaway stony sandy loam, 0 to 3 percent slopes• Spanaway stony sandy loam, 3 to 15 percent slopes• Yelm fine sandy loam, 0 to 3 percent slopes• Yelm fine sandy loam, 3 to 15 percent slopes	<p>For property more than 600 feet from a gopher occurrence:</p> <ul style="list-style-type: none">• 2 site visits at least 30 days apart• 1st visit must occur by September 30

Appendix B

MPG SOIL PREFERENCE* ANALYSIS	A	B	C	D	E	F	G	H	I
	MPG Soils in County			Occupied Soils in County		Preference Indices			
	Total Thurston ² MPG Soils Acres	Total Pervious ³ Thurston County MPG Soils Acres	Percent ⁴ Pervious MPG Soils in the County (n _i)	MPG Acres ⁵ Pervious	Percent Pervious MPG Soils Used ⁶ (r _i)	MPG Pervious Index ⁷ r _i /n	Manly's Alpha -- MPG Soil Preference Index ⁸	1/m - Manly's Alpha ⁹	
All Thurston County Soils With Confirmed Gopher Occupancy¹									
Nisqually loamy fine sand, 0 to 3 percent slopes	9,308	4,239	3.6%	1,098.2	14.5%	4.07	0.200	0.152	
Spanaway-Nisqually complex, 2 to 10 percent slopes	6,959	6,424	5.4%	1,397.4	18.5%	3.42	0.168	0.120	
Nisqually loamy fine sand, 3 to 15 percent slopes	3,711	2,813	2.4%	555.4	7.3%	3.10	0.152	0.104	
Cagey loamy sand	5,344	4,229	3.6%	611.2	8.1%	2.27	0.111	0.064	
Spanaway gravelly sandy loam, 0 to 3 percent slopes	27,975	21,613	18.2%	2,298.8	30.4%	1.67	0.082	0.034	
Indianola loamy sand, 0 to 3 percent slopes	5,628	4,189	3.5%	362.5	4.8%	1.36	0.067	0.019	
Spanaway gravelly sandy loam, 3 to 15 percent slopes	4,596	4,224	3.5%	295.5	3.9%	1.10	0.054	0.006	
Norma silt loam	6,805	6,415	5.4%	199.4	2.6%	0.49	0.024	-0.024	
Spana gravelly loam	1,364	897	0.8%	27.7	0.4%	0.49	0.024	-0.024	
Spanaway stony sandy loam, 3 to 15 percent slopes	1,093	902	0.8%	24.6	0.3%	0.43	0.021	-0.027	
Everett very gravelly sandy loam, 0 to 3 percent slopes	10,772	9,435	7.9%	218.4	2.9%	0.36	0.018	-0.030	
McKenna gravelly silt loam, 0 to 5 percent slopes	3,361	3,135	2.6%	52.5	0.7%	0.26	0.013	-0.035	
Spanaway stony sandy loam, 0 to 3 percent slopes	1,926	1,456	1.2%	22.2	0.3%	0.24	0.012	-0.036	
Yelm fine sandy loam, 0 to 3 percent slopes	7,342	4,904	4.1%	69.0	0.9%	0.22	0.011	-0.037	
Yelm fine sandy loam, 3 to 15 percent slopes	4,388	2,728	2.3%	33.6	0.4%	0.19	0.009	-0.038	
Indianola loamy sand, 3 to 15 percent slopes	4,839	4,031	3.4%	44.6	0.6%	0.17	0.009	-0.039	
Alderwood gravelly sandy loam, 0 to 3 percent slopes	3,010	2,061	1.7%	21.4	0.3%	0.16	0.008	-0.040	
Everett very gravelly sandy loam, 3 to 15 percent slopes	17,916	14,671	12.3%	134.9	1.8%	0.14	0.007	-0.041	
Norma fine sandy loam	2,341	2,260	1.9%	18.1	0.2%	0.13	0.006	-0.041	
Alderwood gravelly sandy loam, 3 to 15 percent slopes	16,106	13,588	11.4%	78.2	1.0%	0.09	0.004	-0.043	
Kapowsin silt loam, 3 to 15 percent slopes	5,151	4,775	4.0%	7.6	0.1%	0.02	0.001	-0.046	
Totals	149,935	118,990		7,571		20.4			

¹ **Column A:** Soil types in which MPG are known to occur within Thurston County, Washington, east of the Black River.

² **Column B:** Total acres of each soil type within Thurston County, Washington, east of the Black River.

³ **Column C:** Pervious soils are 0-80% pervious; soils acres that are >80% impervious have been removed from Column B to create the values in this column. The layer for this is imperfect: it overestimates the amount of impervious surface on the landscape in some locations, but underestimates it in others.

⁴ **Column D:** Pervious acres of each soil type in Column C are divided by the Total at the bottom of Column C to yield the percents (%) in this column. In other words, of all the pervious soils in the County, east of the Black River, what percent is THIS soil type?

⁵ **Column E:** Points and polygons of MPG occupancy were used to populate this column. Points are buffered by 200 m, but polygons are unbuffered. Where points and polygons intersect, their boundaries are dissolved. Occupancy data were obtained from WDFW PHS database and USFWS2014, 2015, 2016 screening results.

⁶ **Column F:** Occupied pervious acres of each soil type in Column E are divided by the Total at the bottom of Column E to yield the percents in this column. This is a measure of the percent (%) of each soil type in the County, east of the Black River, that was found to be occupied by MPGs.

⁷ **Column G:** Percents from Column F are divided by percents (%) in Column D to yield the values in this column. This is an intermediate step to calculate Manly's Alpha.

⁸ **Column H:** Manly's Alpha Index: Values for each soil type in Column G are divided by the Total for Column G to yield the number in this column. If this index value is >1/21 (0.0476), then the soil type is more preferred, whereas if it is <1/21, the soil type is less preferred. This is a measure of soil use by MPGs compared to soil availability in the County, east of the Black River, and assumes all soils are equally accessible by MPGs. See Figure 1.

⁹ **Column I:** ($1/m$ - Manly's Alpha) Using Manly's alpha index of preference (Manly 1974), we calculated MPG preference for each soil type. If the index value in each row is greater than 0, it indicates this soil type is more preferred by MPGs. See Figure 2.

**Preference* is a term used to describe the amount of use by MPG of habitat - in this case, soils - relative to the availability of that habitat type.

"More Preferred" indicates that MPG use such soils relatively more than those that are "Less Preferred", when considering how many acres of each soil exist in the County.

More Preferred Soils

Less Preferred Soils

Figure 1. MPG Soil Preference Index

Manly's alpha

More Preferred

1/m = 0.0476

Less Preferred

MPG Soil

MPG Soil	Manly's alpha
Nisqually loamy fine sand, 0 to 3 percent slopes	0.20
Spanaway-Nisqually complex, 2 to 10 percent slopes	0.165
Nisqually loamy fine sand, 3 to 15 percent slopes	0.15
Cagey loamy sand	0.11
Spanaway gravelly sandy loam, 0 to 3 percent slopes	0.08
Indianola loamy sand, 0 to 3 percent slopes	0.065
Spanaway gravelly sandy loam, 3 to 15 percent slopes	0.055
Norma silt loam	0.025
Spanaway stony sandy loam, 3 to 15 percent slopes	0.025
Everett very gravelly sandy loam, 0 to 3 percent slopes	0.02
McKenna gravelly silt loam, 0 to 5 percent slopes	0.018
Spanaway stony sandy loam, 0 to 3 percent slopes	0.015
Yelm fine sandy loam, 0 to 3 percent slopes	0.012
Yelm fine sandy loam, 3 to 15 percent slopes	0.01
Indianola loamy sand, 3 to 15 percent slopes	0.008
Alderwood gravelly sandy loam, 0 to 3 percent slopes	0.007
Everett very gravelly sandy loam, 3 to 15 percent slopes	0.006
Alderwood gravelly sandy loam, 3 to 15 percent slopes	0.005
Norma fine sandy loam	0.004
Kapowsin silt loam, 3 to 15 percent slopes	0.003
	0.002
	0.001

Figure 2.

