Species Biological Report
for
Four Subspecies of Mazama Pocket Gopher

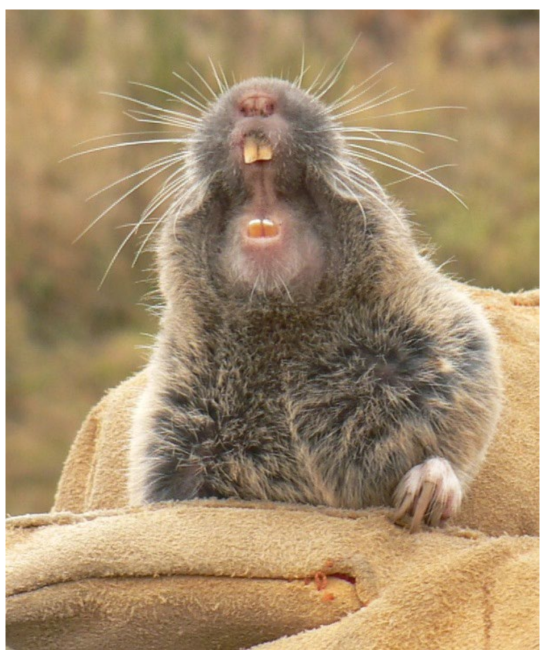
Roy Prairie Pocket Gopher
(Thomomys mazama glacialis)

Olympia Pocket Gopher
(Thomomys mazama pugetensis)

Tenino Pocket Gopher
(Thomomys mazama tumuli)

Yelm Pocket Gopher
(Thomomys mazama yelmensis)

Version 1.1



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The most recent version of this species biological report is available electronically at the Washington Fish and Wildlife Office's Mazama pocket gopher recovery web page, and on our species profile pages for the Roy Prairie, Olympia, Tenino, and Yelm pocket gophers.

*Note that underlined words throughout the document are defined in Appendix A.

EXECUTIVE SUMMARY

This Species Biological Report is a comprehensive review of the biology of the four federally listed subspecies of Mazama pocket gopher (*Thomomys mazama* ssp.) and provides a scientific assessment of the subspecies' status and viability, including those factors that impact or are likely to impact the subspecies. This report informs the final Recovery Plan for Four Subspecies of Mazama Pocket Gopher, which presents our strategy for the conservation of the four subspecies. A Recovery Implementation Strategy, which provides an expanded narrative for recovery activities and an implementation schedule, is available at the Washington Fish and Wildlife Office's Mazama pocket gopher recovery web page, and on our species profile pages for the Roy Prairie, Olympia, Tenino, and Yelm pocket gophers, and will be updated periodically. This Species Biological Report will also be updated as necessary and the most current version will be posted at these websites.

Four subspecies of Mazama pocket gopher were listed as threatened in 2014 under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.), with present ranges in Pierce and Thurston Counties, Washington (79 FR 19760; April 9, 2014): *T. m. glacialis* (Roy Prairie pocket gopher), *T. m. pugetensis* (Olympia pocket gopher), *T. m. tumuli* (Tenino pocket gopher), and *T. m. yelmensis* (Yelm pocket gopher). The U.S. Fish and Wildlife Service (Service) also published a final rule designating critical habitat for three of the four subspecies (79 FR 19712; April 9, 2014) (Olympia, Tenino, and Yelm pocket gophers).

The four subspecies of Mazama pocket gopher are associated with glacial outwash prairies, which are naturally patchy habitats that used to extend across Thurston and Pierce Counties. Soil rockiness, soil drainage, forage plant quality and availability, woody shrub and rhizomatous grass cover, and seasonal climate are the main factors influencing Mazama pocket gopher distribution on the prairie landscape in Washington. The most significant threats to the four subspecies of Mazama pocket gopher are development, loss of natural ecological processes leading to encroachment of shrubs and trees into their habitat, impacts of military training on their habitat and direct mortality and harm (Roy Prairie and Yelm pocket gophers), and small population effects (Olympia and Tenino pocket gophers). Conservation efforts at several sites in the ranges of the four subspecies of Mazama pocket gopher include the permitting of 12 Habitat Conservation Plans (HCPs), acquisition of several conservation parcels, and initiation of Department of Defense (DoD) initiatives.

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INTRODUCTION

On April 9, 2014, the U.S. Fish and Wildlife Service (Service or USFWS) published a final rule listing four subspecies of Mazama pocket gopher (MPG) (*Thomomys mazama* ssp.) as threatened species under the Act (79 FR 19760): *T. m. glacialis* (Roy Prairie pocket gopher) (RPPG), *T. m. pugetensis* (Olympia pocket gopher) (OPG), *T. m. tumuli* (Tenino pocket gopher) (TPG), and *T. m. yelmensis* (Yelm pocket gopher) (YPG). For the purposes of this report, we will refer to these four subspecies collectively as the four subspecies of MPG, or individually. At the same time, the Service also published a final rule designating critical habitat for three of the four subspecies (OPG, TPG, and YPG) (79 FR 19712; April 9, 2014). The Service subsequently published a draft recovery plan (USFWS 2020, entire) and 5-year status review (USFWS 2021) for the four subspecies of MPG.

The four subspecies of MPG are morphologically similar to other species of pocket gopher[1], all of which are fossorial (i.e., they spend most of their lives underground). Their compact, powerful bodies, long front digging claws, and ever-growing teeth help them burrow through prairie outwash soils in Pierce (RPPG) and Thurston (OPG, TPG, and YPG) Counties, Washington. The most significant threats to the four subspecies of MPG are development, loss of natural and anthropogenic ecological processes leading to encroachment of shrubs and trees into their habitat, impacts from military training on their habitat and direct mortality and harm (RPPG and YPG), and small population effects (OPG and TPG).

This Species Biological Report (SBR) is a comprehensive biological status review of the four subspecies of Mazama pocket gopher. This SBR utilizes the best available scientific and commercial data to conduct an in-depth review of these subspecies' biology and threats, evaluate their current biological status, and partially assess resources and conditions needed to maintain their long-term viability. The SBR will be a "living document" that will be updated periodically as new information becomes available and recovery needs dictate. It will eventually be transitioned into a Species Status Assessment (SSA), an analysis framework incorporating additional assessment of future scenarios that the Service now uses to support decisions under the Act. Information in this SBR will be used in the next 5-year status review for the four subspecies, which is required by section 4(c)(2) of the Act (50 CFR 424.21), and to guide any future conservation planning efforts for these subspecies. As part of the 5-year status review, the Service analyzes and documents a recommendation as to whether the listing classification of the species is currently accurate and recommends whether the species' status should be changed under the Act. The Service will decide whether to change the listing classification for these subspecies after reviewing this document, along with other relevant scientific information, and all applicable laws, regulations, and policies. A 5-year status review is a recommendation about listing status and does not in itself change the listing status of a species. However, any change in listing status would require publication of a rule in the Federal Register (FR).

Analytical Framework

In this SBR, each subspecies' viability is considered by assessing its resiliency, redundancy, and representation—the 3Rs (Smith et al. 2018, p. 304; Wolf et al. 2015, pp. 204-205). The subspecies' ecology is described in terms of the 3Rs, identifying the ecological requirements for survival and

[1] In this document, general references to "pocket gophers" are most often based on information from either T. mazama subspecies or other species in the same genus (Thomomys), or else are generalizations true for most pocket gophers in the western United States.

reproduction at the individual, local population, and subspecies (i.e., rangewide or rangewide population) levels. The Service uses these ecological requirements to determine the baseline condition for each of the four subspecies by assessing their historical and current condition in relation to the 3Rs and identifying past and ongoing factors that led to each subspecies' current condition.

To sustain itself over time, a subspecies of MPGs must have a sufficient number and distribution of healthy local populations to withstand: 1) changes in its biological (e.g., novel diseases, predators) and physical (e.g., climate change) environment, 2) environmental stochasticity (e.g., wet or dry, warm or cold years), and 3) catastrophes (e.g., severe and prolonged droughts, wildfires). As the resiliency, representation, and redundancy of a subspecies increases, the subspecies is better protected against changes in the environment, and thus can better tolerate stressors (one or more factors that may be causing a negative effect on the subspecies or its habitat). The more resiliency, redundancy, and representation a subspecies has, the more it can adapt to change, and therefore, the more viable it is.

Resiliency is the ability of a MPG subspecies to sustain local populations in the face of environmental variation and transient perturbations (Smith et al. 2018, p. 304). Environmental variation includes normal variation in weather, as well as unseasonable weather events. Perturbations are stochastic events such as wildfire, flooding, and storms. To be resilient, a species must have healthy local populations that are able to sustain themselves through conditions in good and bad years. Resiliency increases as the number of individuals in local populations increase and the amount and distribution of available medium- to high-quality habitat increases. For MPGs, resiliency is also affected by the degree of connectivity within and between local populations. For recovery, a single local population of at least 1,000 individuals must occur in each Recovery Plan Reserve (Reserve). Reserves may be Reserve Cores or Reserve Complexes. If a local population resides within a Reserve Complex, functional connectivity between Reserve Satellites will be essential. Resiliency is also affected by the diversity of occupied ecological niches within and among local populations. Diversity of climate niches improves a species' resiliency by guarding against disturbances and perturbations affecting all local populations similarly (i.e., decreases the chance of all local populations experiencing bad years simultaneously or to the same extent). For purposes of this SBR resiliency analysis, we are characterizing the current resiliency of each subspecies as they exist on the landscape today, which may or may not reflect where future Reserves will be created.

Redundancy is the ability of a MPG subspecies to withstand catastrophic events. Redundancy protects a subspecies against unpredictable and highly consequential events for which adaptation is unlikely (Smith et al. 2018, p. 304). In short, redundancy spreads the risk. Redundancy is best achieved by having multiple local populations widely distributed across each subspecies' range. For recovery, a single local population will occur within each Reserve. Having multiple local populations reduces the likelihood that all local populations will be affected simultaneously by a catastrophic event. The more widely distributed the local populations are, the less likely they are to possess similar vulnerabilities to a catastrophic event. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species. Thus, the greater redundancy a subspecies has, the more viable it will be. For purposes of this SBR redundancy analysis, we are characterizing the current redundancy of each subspecies as they exist on the landscape today, compared to the goal of a minimum number of Reserves created in each Recovery Area or Recovery Unit for each subspecies of MPG.

Representation is the ability of a MPG subspecies to adapt to short- and long-term changes in the environment over time; it is the evolutionary capacity or flexibility of a species (Smith et al. 2018, p. 3) and can be affected by genetic changes (e.g., changes in allele frequencies, or through the acquisition of novel alleles) or non-genetic changes (e.g., behavioral or physiological shifts). Representation is the amount of variation found in a species, and this variation (called adaptive diversity) is the source of species' adaptive capabilities. The greater the adaptive diversity, the more responsive and adaptable the species will be over time, thereby increasing its viability. Maintaining adaptive diversity for MPGs includes conserving the ecological and genetic diversity of a subspecies. Ecological diversity is the physiological, ecological, and behavioral variation exhibited by a subspecies across its range. For the four subspecies of MPGs, we evaluate representation based mainly on the extent and variety of soil types they inhabit, the environmental and climatic landscapes those soils occur on, and the vegetative communities those soils are capable of supporting, across each subspecies' geographical range.

Methodology

The Service used the following primary data sources, documents, and communications for this SBR: 1) our final rule to list the four subspecies of MPG as threatened under the Act and designate critical habitat for three of the four subspecies; 2) surveys and monitoring records; 3) published peer-reviewed articles on MPG habitat and population ecology; 4) final reports; and 5) expert elicitation from various conservation partners and species experts. For evaluating current conditions of MPG, presence-absence or similar screening-type survey results were retrieved from the Washington Department of Fish and Wildlife (WDFW), Joint Base Lewis-McChord (JBLM), Center for Natural Lands Management (CNLM), and from species experts. The Service requested information from parties participating in the conservation of the species, researchers who work on or have worked on the MPG, and other conservation partners who have expertise in the species.

SPECIES INFORMATION

Description

Typically adult RPPGs are yellowish brown in pelage color, OPGs are dark brown, TPGs are blackish brown, and YPGs are light brown. Soil color often affects pelage color, however, and thus coloration should not be considered a diagnostic attribute for distinguishing the subspecies. Their underparts are usually lead-colored with buff-colored tips. The lips, nose, and patches behind the ears are dark while the chin and wrists are white. Adults of these subspecies range from about 7 to 9 inches (17.8 centimeters (cm) to 22.8 cm) in total length, with light-colored tails (Verts and Carraway 2000, p. 1) that are 2 to 3 inches (5 to 7.6 cm) in length (Hall 1981, p. 465). Mazama pocket gophers are morphologically similar to other species of pocket gopher, all of which exploit a subterranean existence. They are stocky and tubular in shape, with short necks, powerful limbs, long front claws for digging, and tiny ears and eyes. Their short, nearly hairless tails are highly sensitive and probably assist in navigation in tunnels.

The "pockets" of pocket gophers are external, fur-lined cheek pouches on either side of the mouth that are used to transport nesting material and carry plant cuttings to storage chambers called food caches. As with all rodents and lagomorphs (rabbits and hares), their incisors grow continuously (Case and Jasch 1994, p. B-20). However, the rate of growth of pocket gopher incisors is higher than most rodents, perhaps to compensate for increased wear resulting from tooth-digging. Similarly, pocket gophers also have ever-growing cheek teeth (also known as aradicular hypsodont teeth).

Taxonomy

The first pocket gophers collected in western Washington were considered subspecies of the northern pocket gopher (*Thomomys talpoides*) (Goldman 1939, entire) until 1960, when a group of pocket gophers found in western Washington was determined to be more similar to the western pocket gopher (*T. mazama*) (Johnson and Benson 1960, p. 20). Fifteen subspecies of *T. mazama* occur in the States of Washington, Oregon, and California. Four of these (RPPG, OPG, TPG, and YPG) are federally listed as threatened in Washington. Of the remaining eleven subspecies, four occur in Washington (of which one is presumed extinct), five occur only in Oregon, one occurs only in California, and one has a distribution that spans the boundary between Oregon and California (Hall 1981, p. 467; USFWS 2014a, p. 19771).

Thomomys mazama is recognized as a valid species by the Integrated Taxonomic Information System (ITIS 2021, entire). We follow the subspecies designations of Verts and Carraway (2000), as this represents the definitive text for this taxon. RPPG, OPG, TPG, and YPG are recognized as separate subspecies based on morphological characteristics, distribution, and differences in numbers of chromosomes (Verts and Carraway 2000, p. 1).

While past descriptions of MPGs have focused on morphological differences in characteristics such as pelage color, skull features, and body size (Bailey 1915; Taylor 1919; Goldman 1939; Dalquest and Scheffer 1942; Dalquest and Scheffer 1944a, b; Gardner 1950; Hall 1981, pp. 465-466), recent genetic evaluations have been conducted on the MPG complex using mitochondrial deoxyribonucleic acid (mtDNA) sequencing of the cytochrome b gene (Welch 2008). From these and subsequent data, the MPG complex in Washington is spatially structured into three haplotype clades (genetic groups) representing the following three geographic areas: 1) Olympic Peninsula (Clade A, which includes the Olympic pocket gopher (*T. m. melanops*)), 2) Mason County (Clade B, which includes the Shelton pocket gopher (*T. m. couchi*)), and 3) Thurston and Pierce Counties (Clade C, which includes RPPG, OPG, and YPG) (Welch and Kenagy 2008, pp. 6-7). Although no TPG specimens were included in the mtDNA analysis, this subspecies likely belongs to Clade C, since single nucleotide polymorphisms (SNPs) indicate a close relationship between TPG and OPG (Warheit and Whitcomb 2016, p. 23). None of the haplotypes in the analyzed specimens were shared between the three clades, which supports the differentiation of the clades. The mtDNA analysis was not able to distinguish between subspecies in Clade C.

WDFW researched MPG genetic and geographic structure in the south Puget Sound area in order to relate that structure to the existing subspecific taxonomy and to provide a phylogeographic framework for the recovery of south Puget Sound MPGs (Warheit and Whitcomb 2016, entire). However, the intent of this study was not to fully describe MPG population genetics in this region, since sample sizes were generally too small to consider collection locations as local or rangewide populations. WDFW collected hair samples from over 200 pocket gophers in Thurston, Pierce, and Mason Counties, which included the Shelton pocket gopher, a subspecies of MPG that is not federally listed. WDFW scientists analyzed genomic DNA from hair samples and determined that Puget Sound MPGs had eight or nine distinct genetic groupings. Their results indicated that a high degree of genetic diversity exists across the three counties (Warheit and Whitcomb 2016, p. 19). That genetic differentiation, though it generally coincides with existing subspecific taxonomy, may be more extensive; many of the eight or nine genetic groups could be further divided into smaller, geographically congruent groups (Warheit and Whitcomb 2016, pp. 8, 21).

Many of the distinct genetic groupings were separated by creeks, rivers, and/or a lack of habitat corridors. Preliminary genetic analysis conducted by the U.S. Geological Survey to evaluate the history of evolutionary divergence (King et al. 2013, unpublished draft report) suggests that the Deschutes and Nisqually Rivers provide substantive barriers to gene flow for *Thomomys mazama*. These results are in agreement with WDFW's genetic analysis and indicate that pocket gophers found in and near the Chambers Prairie area are most closely related to YPGs found at Tenalquot. No changes to the currently accepted MPG taxonomy (Verts and Carraway 2000) have yet been proposed due to the release of the results of this study.

Life History

<u>Diet and Foraging</u>

Pocket gophers are generalist herbivores and eat a wide variety of plants, including leafy forbs, succulent roots, shoots, and tubers. All water needed for their survival is obtained from their food (Wight 1918, p. 13; Gettinger 1984a, pp. 749-750). Pocket gophers are not known to occur in areas where woody vegetation is dense and no suitable forage is available (Marsh and Steele 1992, p. 210), which includes areas invaded by the native Douglas-fir (*Pseudotsuga menziesii*) and the invasive shrub, Scotch broom (*Cytisus scoparius*). The Service considers encroachment by woody vegetation to have substantial negative impacts on suitable MPG habitat and individuals occupying such areas. Pocket gophers favor habitats dominated by early successional forbs and grasses, as well as native short-statured prairie plant communities.

Pocket gophers are likely less selective about food than surface-dwelling rodents because, similar to other subterranean rodents, burrowing to locate food is an energetically costly activity (Buffenstein 2000, pp. 64, 68, 69). As with other subterranean rodents (Buffenstein 2000, p. 69), pocket gophers tend to favor highly nutritious foods, such as starchy roots and perennial forbs, but will consume whatever is available. In Oregon, *T. mazama* pocket gophers prefer bulbs such as wild onion and wild garlic, but also eat clover, lupines, hairy cat's ear (*Hypochaeris radicata*), and grasses (Maser et al. 1981, p. 173). Additionally, their annual diet consists of above-ground parts of forbs and grasses (40 percent and 32 percent, respectively) and 24 percent roots (Burton and Black 1978, p. 387). Feeding preferences appear to change with availability, and where they are available, the most succulent plants are most preferred. In summer, when all forbs are most abundant, perennial forbs are preferred over grasses, and grasses are preferred over annual forbs. Most grasses are eaten most frequently during the dormant season (November to May), when forb availability is low or absent. Woody plants are least preferred and are a minor component of their annual diet, eaten mostly in winter.

Forbs may provide energy and nutrients that are important or essential for growth and reproduction. Keith et al. (1959, p. 139) reported that the experimental removal of forbs from an area occupied by northern pocket gophers (*T. talpoides*) in Colorado reduced the numbers of animals on that site by 87 percent. Northern pocket gophers given only grasses while in captivity lost weight and died, demonstrating that a grass-only diet would not support pocket gophers and would at most provide a marginal diet (Tietjen et al. 1967, pp. 641-642).

In summary, studies examining plant materials eaten or cached by pocket gophers, including MPGs, have documented several more or less consistent trends: 1) diets appear to include a high composition of forbs; 2) succulent vegetation is preferred (e.g., forbs, fleshy rooted grasses); 3) seasonal availability is an important determinant of diet and diet composition; 4) when available, forbs are preferred over all other types of vegetation; 5) above-ground parts are taken with greater frequency in spring and summer, while below-ground parts become more important during the dormant season; 6) grass shoots, corms, rhizomes, tubers, and roots become more important during the dormant season; and, 7) grasses provide a marginal diet, unless they bear corms or rhizomes (Philips 1936; Moore and Reid 1951; Ward 1960; Myers and Vaughan 1964; Tietjen et al. 1967; Tryon and Cunningham 1968;Barnes 1973; Turner et al. 1973; Ward 1973; Burton 1976; Burton and Black 1978; Gettinger 1984a; Cox 1989; Hunt 1992; Witmer et al. 1996; Reichman 2007).

Information from these studies has yielded the following list of forbs and grasses that MPGs are known to eat, and which occur on Thurston and Pierce County prairies. There may be others, not yet known. These are listed in alphabetical order by scientific name, not order of preference: common yarrow (*Achillea millefolium*), agoseris (*Agoseris* spp.), [non-native] thistle (*Cirsium* spp.), [native and non-native] brome (*Bromus* spp.), camas (*Camassia* spp.), willowherb (*Epilobium* spp.), woolly sunflower (*Eriophyllum lanatum*), [non-native] hairy cat's ear (*Hypochaeris radicata*), [non-native] peavine (*Lathyrus* spp.), lupine (*Lupinus* spp.), slender phlox (*Microsteris gracilis*), Gairdner's yampah (*Perideridia gairdneri*), knotweed (*Polygonum douglasii*), cinquefoil (*Potentilla* spp.), bracken fern (*Pteridium aquilinum*), [non-native] common dandelion (*Taraxacum officinale*), [native and non-native] clover (*Trifolium* spp.), and violet (*Viola* spp.).

Predators

A variety of predators eat pocket gophers, including but not limited to, long-tailed weasels (*Mustela frenata*), red foxes (*Vulpes vulpes*), skunks (*Mephitis mephitis* and *Spilogale gracilis*), bobcats (*Lynx rufus*), coyotes (*Canis latrans*), great horned owls (*Bubo virginianus*), long-eared owls (*Asio otus*), barn owls (*Tyto alba*), barred owls (*Strix varia*), spotted owls (*Strix occidentalis*), red-tailed hawks (*Buteo jamaicensis*), northern goshawk (*Accipiter gentilis*), and American kestrel (*Falco sparverius*) (Hisaw and Gloyd 1926, entire; Scheffer 1931, p. 17; Scheffer 1932, p. 54; Fichter et al. 1955, p. 13; Nussbaum and Maser 1975, p. 262; Chase et al. 1982, p. 250; Case and Jasch 1994, p. B-21; Witmer et al. 1996, p. 97; Stinson 2020, p. 14; Wiens et al. 2014, p. 25). Additionally, feral and domestic cats (*Felis catus*) and dogs (*Canis lupus familiaris*) are well known predators of pocket gophers (Scheffer 1931, p. 17; Case and Jasch 1994, p. B-21; Stinson 2020, p. 14) and are an increasing problem for the four subspecies of MPG.

Numbers of individual MPGs in local populations across the ranges of each of the four subspecies are presumed to be small based on the extent of mounding activity, extent of undeveloped MPG soils, and the solitary and territorial nature of MPGs. Small numbers of individuals often occur in a matrix of residential and agricultural development. With feral or uncontrolled domestic animals in the vicinity, MPGs are exposed to increased levels of predation in these semi-urban and rural environments. Some MPGs occur in areas where people recreate with their dogs, such as WDFW Wildlife Areas (WLAs) or expanses of prairie controlled by the DoD, bringing these potential predators into environments that may otherwise be relatively free of them and consequently, increasing the predation risks to MPGs there.

Reproduction and Development; Social Systems

Although pocket gophers are short-lived rodents, their life history is described as "K-selected" (later maturity, longer life, fewer and smaller litters, low local population densities, etc.) by comparison to most small surface-dwelling rodents (Nevo 1979, p. 283; Busch et al. 2000, pp. 202-209). Their mating system is probably polygynous (i.e., when a single male mates with multiple females) and most likely based on female choice. The adult sex ratio has been reported as biased toward females in most species of pocket gophers that have been studied, often as much as 4-to-1 (Howard and Childs 1959, p. 296; Patton and Feder 1981, p. 917). However, in Washington there was a reported sex ratio of close to 1-to-1 in MPGs (Witmer et al. 1996, p. 95). We do not know if this ratio is typical of all locations or years for the four federally listed subspecies of MPG. Sex ratio is probably equal at birth, but in older age classes, there are more females, since male survival is lower (Howard and Childs 1959, pp. 295, 302). Sex ratio may also vary with the density of animals on a site, which is often a measure of soil suitability for burrowing as well as both forage quality and forage density (Patton and Smith 1990, p. 6). Thus a sex ratio of 1:1 could indicate a low population density, and maintenance of connectivity within such populations would be important.

Pocket gophers have been documented to reach sexual maturity during the spring of the year following their birth (Scheffer 1931, p. 13; Howard and Childs 1959, pp. 293, 302; Andersen 1978, p. 421), though timing of sexual maturity has been shown to vary with habitat quality (Patton and Brylski 1987, p. 502; Patton and Smith 1990, p. 76). This appears to be the reason for the variable timing of gestation in some *Thomomys* species, including *T. mazama* (Scheffer 1938, pp. 221-223). Gestation lasts approximately 18 days (Schramm 1961, p. 169; Andersen 1978, p. 421).

Pocket gophers generally produce one litter per year (Scheffer 1931, p. 13; Scheffer 1938, pp. 221, 223; Walker 1949, p. 58; Case and Jasch 1994, p. B-20). Young are born in the spring to early summer (Scheffer 1938, p. 222; Wight 1918, p. 13) and are reared by the female. Litter size ranges from one to nine (Wight 1918, p. 14) with an average of four or five pups (Scheffer 1938, p. 222; Verts and Carraway 2000, p. 3). Pups are born without hair, pockets, or teeth, and they must be kept warm by the mother or "packed" in dried vegetation (Wight 1918, p. 14; Case and Jasch 1994, p. B-20, Scheffer 1938, p. 222). Juvenile pelage starts growing in at just over a week (Andersen 1978, p. 420). The pups eat vegetation in the nest within 3 weeks of birth, with eyes and ears opening and pockets developing at about a month (Wight 1918, p. 14; Cahalane 1961, p. 430; Andersen 1978, p. 420).

At about 6 weeks pups are weaned, fighting with siblings, and nearly ready to disperse (Wight 1918, p. 15; Andersen 1978, p. 420), which usually occurs at about age 2 months (Cahalane 1961, p. 431; Howard and Childs 1959, p. 303). Mortality is likely to be common during juvenile dispersal (Howard and Childs 1959, p. 303); male survival appears to be density dependent, with higher numbers of males disappearing before reaching 1 year old when densities are high. Very few pups survive to breeding age (Patton 1990, p. 56). They attain their adult weight around 4 to 5 months of age (Andersen 1978, pp. 419, 421). Most pocket gophers live only 1 to 2 years, with few living to 3 or 4 years of age (Hansen 1962, pp. 152-153; Livezey and Verts 1979, p. 39; Olson 2008, p. 3; Patton 1990, p. 56), although there are data from translocated OPGs that lived to at least 4 and 5 years of age (Olson 2016, pp. 14-15).

Females live longer than males (Howard and Childs 1959, p. 302, 309); female survival rates are generally higher than for males (Olson 2016, p. 19).

Males and females remain largely segregated in their own burrow systems and they are highly asocial and intolerant of other pocket gophers. Each individual maintains its own burrow system, and occupancy of a burrow system by multiple individuals occurs only for brief periods during mating seasons and prior to weaning young (Ingles 1952, pp. 88-89; Witmer and Engeman 2007, p. 288; Marsh and Steele 1992, p. 209). Burrow systems that become vacant are quickly occupied by gophers from adjacent burrows or dispersing subadults (Witmer et al. 1996, p. 97; Engeman and Campbell 1999, p. 524).

Pocket gophers are adapted to a largely subterranean life and spend most of their time in their burrow systems. Pocket gophers are active about 36 to 50 percent of each 24-hour day (Andersen and MacMahon 1981, p. 185; Gettinger 1984b, p. 78) with the remainder spent inactive in their nest chamber. Pocket gopher activity occurs throughout the 24-hour day, with a peak in late afternoon to early evening, and the lowest activity from 12 a.m. to 4 a.m. (Gettinger 1984b, p. 79). Similarly, surface activity occurs mostly at night (Scheffer 1931, p. 16; Vaughan 1974, p. 774), but aboveground foraging occurs occasionally during the day (Maser et al. 1981, pp. 169, 173; Gettinger 1984b, p. 80). Pocket gophers rarely venture more than 12 to 18 inches (31 to 46 cm) from their foraging burrows and retreat immediately if disturbed (Marsh and Steele 1992, p. 208); however, they are still eaten by raptors, suggesting they spend more than a few minutes above ground at any given time. Pocket gophers are rarely seen feeding at the soil's surface and each bout usually does not exceed 2 minutes in duration (Gettinger 1984b, p. 80). Pocket gophers are active throughout the year, and do not hibernate in winter (Case and Jasch 1994, p. B-20).

Current Range and Distribution

The four listed subspecies of MPG occur in Pierce (RPPG) and Thurston (OPG, TPG, and YPG) Counties, Washington, as shown in Figure 1 and Appendix C. However, within the TPG Recovery Area (Map 3 in Appendix C), it is unknown if TPG occupy areas in and around Wolf Haven and West Rocky Prairie WLA. OPG and YPG individuals were translocated into these locations between 2005-2008 (Stinson 2020, p. 31), prior to the federal listing of the four subspecies of MPG. Prior to translocation, WDFW conducted presence-absence surveys, and no pocket gophers were found there. At that time (and still today), Wolf Haven and West Rocky Prairie WLA were the two largest areas of prairie habitat in this part of the Recovery Area. Forests and areas of dense woody vegetation, roads and railroad tracks, unsuitable hydric soils and wetlands, all present significant movement barriers between the three conservation sites (Rocky Prairie NAP, the WLA, and Wolf Haven). The only area where TPG are currently known to occur is on Rocky Prairie NAP and properties adjacent, and those areas appear isolated from the other two sites. Since translocation, regular presence-absence surveys show continued occupancy by MPGs in all locations. However, because no genetic studies have been conducted at the NAP, WLA, or Wolf Haven, some uncertainty remains as to which MPG subspecies or subspecies hybrid may occur at any of the sites, or if there has been any movement of individuals (TPG, OPG, YPG) between sites. This is an issue that will require research to resolve.

Habitat Characteristics

Home Range

The home range of a MPG is composed of suitable breeding and foraging habitat. Home range size varies based on factors such as soil type, climate, season, precipitation, age and gender, reproductive status, patch size, and density and type of vegetative cover (particularly foraging habitat) (Cox and Hunt 1992, p. 133; Case and Jasch 1994, p. B-21; Chase et al. 1982, p. 244; Hafner et al. 1998, p. 279, Howard and Childs 1959, pp. 329-336, Marsh and Steele 1992; p. 209; Witmer et al. 1996, p. 96). Vegetative cover (density and type) together with soil type are the two main drivers of home range size and density of animals at a site.

Little research has been conducted regarding home range size for individual MPGs. Witmer et al. (1996, p. 96) reported an average home range size of about 1,076 square feet (ft^2) (100 square meters (m^2)) for MPGs in one location in Thurston County, Washington. However, densities are likely to be higher when habitat quality is better, so the aforementioned average home range size is unlikely to represent the average density across all soil types, vegetation types, and other unique site characteristics across the ranges of the four subspecies of MPG. In other states, other species of *Thomomys* pocket gophers show a wide range of home range sizes from approximately 80 to 4,800 ft^2 (7.4 to 446 m^2) (Case and Jasch 1994, p. B20-21; Cox and Hunt 1990, p. 92; Howard and Childs 1959, p. 327; Ingles 1952, pp. 90, 92; Turner et al. 1973, p. 13). Some of these are estimates based on the density of pocket gophers trapped per acre, and some are based on measurements of individual territory sizes. Pocket gophers make only small shifts in their home range over the course of a year or longer (Andersen and MacMahon 1981, p. 191; Hansen 1962, p. 152; Olson 2015, p. 13; Tryon 1947, pp. 25-26), and they spend a large proportion of their time in a portion of their home range (Gettinger 1984b, p. 81), near the nest site (Zinnell 1992, pp. 41-42).

In the related *T. bottae* (Botta's pocket gopher), burrow length, perimeter, and home range size were all greater for reproductive males than for females and nonreproductive males, and burrow systems were more linear as well (Reichman et al. 1982, entire). However, the spacing between burrow systems did not vary by sex, reproductive condition, or study site; burrow systems consisted of basic building units with equal branch lengths and equal distances between branch points.

Prairie Ecosystems

Suitable prairie ecosystems and soils distributions are the main determinants of the subspecies' ranges. The four subspecies of MPG are associated with glacial outwash prairies in western Washington, an ecosystem of conservation concern (Hartway and Steinberg 1997, p. 1). Historically, outwash prairies naturally occurred in large patches across Thurston and Pierce Counties. However, the current prairie landscape is a small fragment of its historical distribution, and only 3 percent of what used to be highly connected prairie is considered functioning prairie today (Crawford and Hall 1997, pp. 13-14). MPGs are even further restricted in distribution, because some remnant, high-quality prairies in these counties currently do not have any pocket gophers (e.g., 13th Division Prairie on JBLM, Mima Mounds Natural Area Preserve (NAP), and Glacial Heritage Preserve) (Steinberg and Heller 1997, p. 46). This may be because within these patchily distributed prairies, there is an even patchier distribution and variability of soil rockiness. Pocket gophers generally avoid the rockiest soils (Steinberg 1996, p. 32; Olson 2011, p. 2) in all seasons, but soil drainage, forage plant type and availability, woody shrub and rhizomatous plant cover, and climate (e.g., hot dry weather, which affects ease of digging and forage plant availability) will also affect their distribution (Case and Jasch 1994, p. B-21; Kronland et al. 2018, pp. 1, 8, 14; Olson 2011, pp. 10, 12, 27; Reichman 2007, pp. 273-274; Stinson 2020, pp. 17-18) between seasons, thus further restricting the total area of a prairie that may be occupied by pocket gophers at a given time.

Soils Suitable for Mazama Pocket Gophers in Thurston and Pierce Counties

In their respective counties, the four subspecies of MPG currently occupy the following soil series and soil series complexes: Alderwood; Cagey; Everett; Everett-Spanaway complex; Everett-Spanaway-Spana complex; Indianola; Kapowsin; McKenna; Nisqually; Norma; Spana; Spana-Spanaway-Nisqually complex; Spanaway; Spanaway-Nisqually complex; and Yelm. These soil series and soil series complex names were derived from a Geographic Information System (GIS) overlay of gopher locations (as of August 1, 2017) with U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) GIS soil survey data layer (accessed June 20, 2008, for Thurston County; received from JBLM May 30, 2013, for Pierce County). Some soil series and soil series complexes occur only in one subspecies' range, while some occur in the range of two or more subspecies (Table 1). In several instances, pocket gophers are known to occur in a particular soil series in one subspecies' range but have not been found to occur in the same soil series in another subspecies' range, despite the presence of that soil series or complex occurring within the range of another subspecies. Based on an analysis performed on Thurston County soils known to be used by MPGs, we have characterized gopher soils into categories of More-Preferred and Less-Preferred (Table 1; Appendix A in USFWS 2018 in litt.).

A similar analysis has not been performed on Pierce County soils, however, we assume that soils of the same or similar name are likely to be in the same preference category, unless the subspecies has not been found in that soil type. To perform the soils preference analysis (USFWS 2018 in litt., Appendix B) MPG screenings were conducted across Thurston County, and the soil types they were found on were identified based on NRCS soils maps. We summed the available acres of each soil type in the county, i.e., acres of soils not already under buildings or pavement. A soil type was considered More-Preferred if it was used at a rate greater than its availability would indicate, based on a Manly's Alpha preference index calculation. If all MPG soils were used in direct relation to their availability (i.e., number of acres), more MPGs would be found on soil types with greater numbers of acres. However, that's not the case; MPGs are found on "More-Preferred" soils at a much higher rate than on "Less-Preferred" soils, indicating they prefer those soils more.

Table 1. MPG Soils Present in Each Subspecies' Range and Soils Known to be Inhabited[1] by Each Subspecies.

Soil Preference	MPG Soil Name	RPPG Range		OPG Range		TPG Range		YPG Range	
		Soil Present	Sub-species Present	Soil Present	Sub-species Present	Soil Present	Sub-species Present	Soil Present	Sub-species Present
	Cagey loamy sand	N	N	Y	Y	Y	N	N	N

More-Preferred	Indianola loamy sand (Thurston County: 0-3% slopes)	N	N	Y	Y	Y	N	Y	Y
	Nisqually loamy fine sand (Thurston and Pierce Counties: 0-3% slopes; Thurston County: 3-15% slopes; Pierce County: Nisqually loamy sand)	Y	Y	Y	Y	Y	Y[2]	Y	Y
	Spanaway gravelly sandy loam (0-3% slopes and 3-15% slopes)	Y	Y	Y	N	Y	Y[3]	Y	Y
	Spanaway-Nisqually complex (2-10% slopes)	N	N	Y	N	Y	Y	Y	Y
Less-Preferred	Alderwood gravelly sandy loam (Thurston County: 0-3% slopes and 3-15% slopes; Pierce County: 0-6% slopes and 6-15% slopes)	Y	N	Y	Y	Y	N	Y	Y
	Everett very gravelly sandy loam (0-3% slopes and 3-15% slopes)	N	N	N	N	Y	Y	Y	Y
	Everett-Spanaway complex (3-15% slopes)[4]	Y	Y	N	N	N	N	N	N
	Everett-Spanaway-Spana complex (0-30% slopes)[4]	Y	Y	N	N	N	N	N	N
	Indianola loamy sand (Thurston County 3-15% slopes; Pierce	Y	Y[5]	Y	Y	Y	N	Y	Y

	County: 0-3% slopes; 0-6% slopes; 6-15% slopes)								
Less-Preferred	Kapowsin silt loam (3-15% slopes)	N	N	Y	N	N	N	Y	Y
	McChord-Everett complex (0-3% and 3-15% slopes)[4]	Y	Y	N	N	N	N	N	N
	McKenna gravelly silt loam (0-5% slopes)	Y	N	Y	Y	Y	N	Y	Y
	Norma fine sandy loam	Y	Y	Y	Y	Y	N	Y	Y
	Norma silt loam	N	N	Y	Y	Y	Unknown	Y	Y
	Spana gravelly loam (Pierce County has Spana loam)	Y	N	Y	N	N	N	Y	Y
	Spana-Spanaway-Nisqually complex (0-2% slopes)[4]	Y	Y	N	N	N	N	N	N
	Spanaway stony sandy loam (0-3% slopes and 3-15% slopes)	N	N	N	N	Y[6]	N	Y	Y
Less-Preferred	Yelm fine sandy loam (0-3% slopes and 3-15% slopes)	N	N	Y	Y[7]	Y	N	Y	Y

[1]Gray highlighted cells: MPGs have not been found in this preferred soil type in this subspecies' range, but this preferred soil type occurs within this subspecies' range.
Blue-highlighted cells: Unknown subspecies of MPG occupy this soil type in the range of TPG.
[2]TPG occur on Nisqually loamy fine sand, 3-15 percent slopes
[3]TPG occur on Spanaway gravelly sandy loam, 3-15 percent slopes
[4]These soils are part of the WA-777 soil survey. For purposes of analyses in this SBR, we have only applied the results of the WA-777 soil survey to Pierce County.
[5]RPPG occur on Indianola loamy sand, 0-6 percent slopes
[6]Spanaway stony sandy loam, 0-3% slopes occurs in the range of TPG
[7]OPG occur on Yelm fine sandy loam, 0-3 percent slopes

Mapped soil survey information may be imperfect for informing pocket gopher use for a variety of reasons:

1. Maps are based on the technology, standards, and tools that were available at the time soil surveys were conducted, sometimes up to 50 years ago.
2. Maps were created for specific purposes and may not include data at a fine enough scale to answer questions about gopher use.
3. Soil survey boundaries may be adjusted in the future, and soil series names may be added or removed on the NRCS's soil survey maps database. As a result, the overlap of pocket gopher locations with soil series names may be different in the future. The soils information presented here is based on best scientific data available, and for purposes of anticipating where gophers may occur (e.g., in areas that have not been fully surveyed), we focus more on the soil series and soil series complex names, which are representative of the types of soils that the four subspecies of MPG prefer. Although some soils are loamier, sandier, gravellier, or may have more or less silt than described, most soils used by MPGs are friable (easily pulverized or crumbled), loamy, and deep, do not contain a large proportion of rocks greater than about 2 inches (5 cm) in diameter, and generally have slopes less than 15 percent.
4. Some of these soil series or soil series complexes are not typically either deep or well-drained, or for a variety of reasons, may or may not have all the characteristics of that soil type as described by NRCS. The actual soil that occurs on the ground may have characteristics that make it uninhabitable by MPGs. These reasons may include map boundary or transcription errors, map projection errors or differences, map identification or typing errors, soil or hydrological manipulations that have occurred since mapping took place, small-scale inclusions in the mapped soil type that are different from the mapped soil, and which may or may not be used by MPGs, etc.

Nevertheless, based on best available data, these are the areas where MPG locations and mapped soils have been found to overlap when mapped in GIS. Each of these soil series/complexes could potentially be suitable for any of the four listed subspecies of MPG. In addition, the four subspecies of MPG may be able to forage or burrow in soil series not on the above list. For these reasons, our list of soils may be incomplete or appear to be overly inclusive.

In 2011, there were reports of MPGs (subspecies unknown) occurring on new types of soils and on managed forest lands in Capitol State Forest (owned by Washington Department of Natural Resources (WDNR)) and Vail Forest (owned by Weyerhaeuser) in Thurston County. These were subsequently determined not to be MPGs but instead moles (*Scapanus* spp.), based on follow-up surveys and trapping conducted in these areas by WDFW in 2012 (Thompson 2012, pers. comm.). There are overlapping soil surveys in Thurston County (WA-667 and WA-777) and Pierce County (WA-653 and WA-777), conducted in different years.

<u>Minimum Recovery Plan Reserve Size</u>

To determine the appropriate size of Reserves[2], we used commercially available population viability analysis software to examine extinction probabilities under model scenarios of variable initial population

[2] See USFWS 2020, pp. 12-13 for descriptions of Reserve Cores and Reserve Complexes, which we refer to simply as Reserves in this document.

size (50 to 1,500 individuals), annual reproduction and mortality, carrying capacity (400 to 1,500 individuals), and Reserve configuration. Model simulation outputs were compared to a defined, acceptable limit on extinction probability: less than 2 percent probability of extinction (i.e., 98 percent probability of persistence) over 50 years. This defined, acceptable limit on extinction probability was selected with consideration for the thresholds widely used to conduct previous population viability analyses (Traill et al. 2007, pp. 159-166 (Supplementary Material, Table 1)), especially those examining the viability of rodent and fossorial mammal species. Modeling suggested that a single, contiguous conserved area with a minimum local population of 1,000 individuals was found to meet the overall acceptable limit on extinction (for a summary and full description of the modeling effort, see Appendix B).

Gophers are asocial and typically space themselves apart from each other on the landscape, leaving area between their individual burrow systems (Reichman et al. 1982, p. 688). Gophers occupying a site need space on the landscape to move around (Smallwood 2001, p. 256; Patton 2012, in litt.) from season to season and year to year, to take advantage of variable availability of forage resources. We estimate that approximately 40 percent of the habitat within an occupied site will be in active use by individual MPGs at any point in time (CNLM 2016, p. 3). Given that assumption, a minimum of 250 to 500 acres (ac) (101 to 202 hectares (ha)) within a conserved and managed area of medium- to high-quality habitat should support a local population of 1,000 individuals.

Density of gophers on a site is driven in large part by the type of soils they occupy (i.e., More-Preferred versus Less-Preferred) and quality of forage vegetation, as well as population demographics. Forage vegetation quality is driven by factors such as season, precipitation, land management activities, and climate. More-Preferred soils can, if appropriately managed, support higher quality forage vegetation and therefore higher densities of gophers. Density increases with increasing forage availability (Romañach et al. 2005, p. 753), a factor in habitat quality along with soil type. Given an upper and lower limit of density, assumed conservatively to be 5 to 10 gophers per acre on medium- to high-quality habitat, and a reasonable assumption that conserved and managed areas will support an approximate average of 40 percent MPG occupancy, this yields a conserved area size of about 250 to 500 ac (101 to 202 ha):

$$MPG\ population \cong\ {}^{\wedge}n^{5-10}\frac{MPG}{acre} \times\ (40\%\ occupancy)(x\ acres)$$

$$MPG\ population \cong \left(n^{5-10}\frac{MPG}{acre}\right) \times\ (0.4\ )(x\ acres)$$

$$1{,}000\ MPG\ \cong \left(5\frac{MPG}{acre}\right) \times\ (0.4\ )(500\ acres)$$

$$1{,}000\ MPG\ \cong \left(10\frac{MPG}{acre}\right) \times\ (0.4\ )(250\ acres)$$

Factors Affecting Occupancy of a Patch of Habitat

The probability of MPG occupancy is much higher in areas with less than 10 percent woody vegetation cover (Olson 2011, p. 16). It is reasonable to conclude that increasing amounts of woody vegetation will shade out the forbs, bulbs, and grasses that gophers prefer to eat, and high densities of woody plants make travel both below and above the ground difficult for gophers. Mazama pocket gophers are not known to occupy areas where woody vegetation is dense and no suitable forage is available (Marsh and Steel 1992, p. 210), which includes areas invaded by the native Douglas-fir and non-native Scotch broom. The Service considers encroachment by woody vegetation to have the potential to have substantial negative impacts on occupied MPG habitat and thus their rangewide populations.

In observations of pocket gopher distribution on JBLM, pocket gophers did not occur in areas with a high percentage of Scotch broom cover in the vegetation (Steinberg 1995, p. 26; Olson 2011, p. 12) and rhizomatous plant cover (Kronland et al. 2018, p. 14). In Thurston and Pierce Counties, there was no relationship between pocket gopher presence and mole density (Olson 2011, pp. 12-13). Another factor affecting MPG distribution and occupancy is soil depth and rockiness. At one site, there was a deep soil layer that was much less rocky that had a gopher density five times that of another site that had rocky soil (Steinberg 1996, p. 26). There was also a strong negative correlation between the proportion of medium-sized rocks in the soil and presence of MPGs in eight of nine prairies sampled (medium sized rocks were considered greater than 0.5 inches (1.27 cm) but less than 2 inches (5 cm) in diameter (Steinberg 1996, p. 32).

Burrows and Burrowing

A pocket gopher's burrow system is its home range and territory but also protection from aboveground environmental fluctuations and predators. Due to the energetic cost of burrow construction, burrows are valuable resources. The environment in a burrow is more moderate than above ground, offering protection from weather as well as from most predators. Unlike other rodents, pocket gophers maintain a sealed burrow system, plugging the entrances with a few inches to a foot of soil (Dalquest 1948, p. 303). At a depth of almost 12 inches (30.5 cm), almost all daily temperature fluctuations disappear, and a plugged burrow can quickly reach 100 percent humidity, which can be an advantage in dry environments (Reichman and Smith 1990, p. 213).

Burrows consist of a series of main runways, off which lateral tunnels lead to the surface of the ground (Wight 1918, p. 7). Many pocket gophers dig their burrows using both their sharp teeth and long front claws and then push the soil out through the lateral tunnels (Wight 1918, p. 8; Case and Jasch 1994, p. B-20), but the teeth of *T. mazama*, within the subgenus *Thomomys*, are not curved in a way that would allow for easy tooth-digging (Lessa and Patton 1989, entire). Nests containing dried vegetation are generally located near the center of each pocket gopher's home tunnel system (Wight 1918, p. 10). Food caches and store piles are usually placed near the nest, and excrement is piled into blind tunnels or loop tunnels, and then covered with dirt, leaving the nest and main runways clean (Wight 1918, p. 11). Mounding activity by MPGs in Washington appears to be highly seasonal with increased activity after the first significant fall rains, which is similar to other *Thomomys* pocket gophers that show increased activity after rain when soils are easier to dig and forage vegetation production increases (Collis-George 1959, p. 555; Cox and Hunt 1992, p. 132; Miller 1948, p. 41; Miller 1957, p. 446). The same phenomenon can occur on warm dry days in the midst of winter, when saturated soils dry out enough to allow easier digging (Olson 2017a, p. 8). Increased mounding activity can also be attributed to juvenile dispersal, which for MPGs occurs sometime between early summer and fall, and can vary between years (Olson 2015, p. 7).

Energetics and the Size of Burrows and Burrow Systems

Burrow system size is determined in part by an animal's energy needs and the energetic costs of burrowing and maintaining the system (Vleck 1981, pp. 134-135). This energy balance is affected by soil type, soil moisture and fertility, and forage plants available. Burrows that are disturbed are usually rapidly repaired or the branch is sealed off, which suggests that burrows are patrolled. There may be a theoretical maximum useful burrow system size, above which the added size is outweighed by the cost of periodic patrols or defense of the burrow system (Kennerly 1964, p. 429). There may also be a minimum burrow system size determined by food requirements. The energetic cost of burrowing likely limits how much pocket gophers can increase territory size. Balancing foraging efficiency and territoriality results in the spacing between adjacent burrow systems being highly uniform, creating a buffer zone between systems that exists regardless of site productivity (Reichman and Seabloom 2002, p. 46). The size and shape of territories are more consistent at high densities; at low densities, territory size and shape are more variable, and they tend to be clustered (Hansen and Remmenga 1961, p. 814). The persistent presence of neighbors may limit an individual's ability to expand its territory in response to reduced food availability. Pocket gopher tunnel territories shift in location in the landscape over time, presumably due to a depletion of preferred food resources (Walker 1949, p. 51). Additionally, pocket gophers tend to cluster or clump together to maintain contact with each other for breeding.

The extensive burrow systems of pocket gophers are comprised of longer main and shorter lateral, shallow feeding tunnels for foraging near the soil surface, and deeper tunnels with chambers for nests, food caches, and latrines. The foraging tunnels comprise most of the total tunnel footage (Miller 1957, p. 451). Mazama pocket gopher tunnels are 1.5 to 1.7 inches (3.8 to 4.4 cm) in diameter, which is the diameter of their bodies. Shallow tunnels are 4 to 10 inches (10 to 25 cm) below the surface (Witmer et al. 1996, p. 97; Walker 1949, p. 49), while deeper tunnels average 54 inches (137 cm) in depth (range 47 to 59 inches (119 to 151 cm)) (Witmer et al. 1996, p. 97). Nest chambers are 10 inches (25 cm) in diameter and are lined with dry grass (Witmer et al. 1996, p. 97), and their depth is determined in large part by the depth of the soil they inhabit. Nests are found at depths of 26 to 36 inches (66 to 91 cm) (Scheffer 1931, p. 13), and an average depth of about 34.8 inches (88.5 cm) with a range of 19.2 to 59 inches (48 to 150 cm) (Witmer et al. 1996, p. 97). Food caches are often located within a couple feet of a nest and are generally the same size as nest chambers, with an average depth of 20.8 inches (52.8 cm) and a range of 14.2 to 28.4 inches (36 to 72 cm) (Witmer et al. 1996, p. 97).

Pocket gophers have narrow but stout bodies, and soft fur that lies close to the skin. Their skin is loosely attached, which allows them to turn around within the diameter of the tunnel (Stein 2000, p. 22) and to run backwards almost as fast as forward (Maser et al. 1981, p. 168). When digging, MPGs loosen soil with their strong front claws (Chase et al. 1982, p. 241). They push the soil to the surface or into an unused burrow with their front feet (Cahalane 1961, p. 429; Chase et al. 1982), and occasionally use their rear paws to push the dirt backwards under their body (Cahalane 1961, p. 429; Sterner 2000, p. 392). When soil is pushed to the surface, it's pushed out in one general direction, creating the fan-shaped mounds typical of pocket gophers. When there is snow cover, excess dirt will be packed into tunnels in the snow. Due to typically mild winters in the south Puget Sound region, this is not a frequent occurrence in the ranges of the four subspecies of MPG.

Pocket Gophers as Ecosystem Engineers
In natural settings, pocket gophers play a key ecological role of aerating soils by tunneling, activating the seed bank by unearthing deeply buried seeds, and stimulating plant growth through exposure of bare soils with their mounds. Bare soils are also an important, and otherwise difficult-to-manage, breeding habitat component for grassland birds such as streaked horned larks and Oregon vesper sparrows; MPGs may play an important role on such sites. Materials such as used nest materials, unused food, and fecal matter all remain underground in abandoned, plugged burrows or unused burrow chambers (Chase et al. 1982, p. 246). Such materials decompose and feed and enrich the soil (Cahalane 1961, p. 433; Huntly and Inouye 1988, p. 790; Zinnell 1992, pp. 39, 42). Additionally, many different vertebrates and invertebrates take refuge in pocket gopher burrows, especially during inclement weather, including beetles, amphibians (such as toads, frogs, and salamanders), lizards, snakes, ground squirrels, and smaller rodents (Blume and Aga 1979, p. 131; Case and Jasch 1994, p. B-21; Stinson 2020, p. 17). As such, pocket gopher activity is important in maintaining plant and animal species richness and diversity on our prairies.

Population Dynamics and Dispersal

Density and Population Dynamics

Even though many pups do not survive to dispersal age (Patton 1990, p. 56), numbers of pocket gophers at a site can increase by as much as three to four times the number in the spring due to yearly productivity (Turner et al. 1973, p. 26). However, pocket gophers at individual locations can undergo occasional wide fluctuations within a single year (Howard 1961, entire; Tietjen et al. 1967, p. 640; Julander et al. 1969, p. 328) characterized by local extinctions and recolonizations (Baker et al. 2003, p. 284). Gopher numbers also fluctuate year-to-year due to territoriality and environmental conditions such as harsh winters or extreme drought (Aldous 1957, p. 267; Hansen 1962, p. 153; Hansen and Ward 1966, pp. 15-16). Harsh winters are known to nearly wipe out the young of the year and produce dramatic declines in numbers (Hansen 1962, p. 153; Turner et al. 1973, p. 35). In areas of low pocket gopher density and with appropriate habitat conditions, it may take 3 to 6 years to reach peak density, though high gopher densities may not be maintained for more than 3 consecutive years at a time (Hansen and Ward 1966, p. 16).

Both the area and quality of habitat and forage resources influence pocket gopher densities on a site (Keith et al. 1959, p. 143; Black and Hooven 1977, p. 126; Rezsutek and Cameron 1998, p. 546), with an upper limit determined by territoriality. The area and quality of habitat and forage resources can vary both between years and within years and is influenced by soil type, soil productivity, and climate. In general, increasing vegetative productivity decreases an individual’s total burrow length and area (Romañach et al. 2005, p. 753). However, local population numbers may vary year-to-year below the point at which pocket gopher density is limited by territorial behavior (Andersen and MacMahon 1981, p. 198). High gopher densities may depend in part on the availability of large amounts of forage, but density cannot be predicted based solely on forage availability (Hansen and Ward 1966, p. 17). Therefore, forage availability alone should not be used to determine pocket gopher density at a site.

Density also varies seasonally with reproduction and dispersal of young and may be negatively associated with female body size (Smallwood and Morrison 1999, pp. 79-80). In better-quality habitat (e.g., increased amounts and quality of forage resources, higher-quality soils), *T. bottae* exhibited greater sexual dimorphism, and the sex ratio was skewed toward females (Patton and Smith 1990, p. 81). This would affect average territory size because females have smaller territories. The difference in territory size between sexes, plus the sex ratio, would affect the maximum density at any given site. In *T. bottae*, the sex ratio is about 1:1 at low density, but skews increasingly to females with increased density (Lidicker and Patton 1987, p. 147).

Recently developed standardized survey methods allow for determination of site occupancy, estimation of site abundance, and trend monitoring (Olson 2017a, entire). Using these methods, density estimates at several sites ranged from a low of 0.5 gopher/ac (about 0.2 gophers/ha) at Lower Weir Prairie on JBLM (95 percent confidence interval = 0.07-1.4 gophers/ac (0.03-0.95 gophers/ha)) to 17 gophers/ac (6.9 gophers/ha) at Scatter Creek North WLA (95 percent confidence interval = 8.8-24 gophers/ac (about 3.6-9.7 gophers/ha)). The density at Wolf Haven was the greatest at almost 19 gophers/ac (7.7 gophers/ha).

Dispersal and Other Movements

Dispersal of juveniles may be the result of an innate drive (Chase et al. 1982, p. 244), but more likely they are driven out by the mother (Wight 1930, p. 46; Williams and Cameron 1984, p. 69). Dispersers are generally young, and dispersal peaks near the end of the reproductive season. Dispersal of young may occur in any direction and is usually only as far as necessary to find a suitable site (Vaughan 1963, p. 370; Smolen et al. 1980, p. 230; Daly and Patton 1990, p. 1291). Some subadults settle in or near the natal burrow system for a time, but others disperse to establish their own burrow system or assume ownership of one left vacant. Some young disperse by plugging off a portion of the natal burrow system and extending lateral tunnels (Scheffer 1931, p. 16).

The ability and frequency of pocket gopher dispersal affects whether groups of gophers are connected by immigration and supported demographically. Pocket gophers have low vagility, meaning they have a poor dispersal capability (Williams and Baker 1976, p. 303). Pocket gophers rarely surface completely from their burrow except as juveniles, when they often disperse above ground from spring through early fall (Ingles 1952, p. 89; Howard and Childs 1959, p. 312; Vaughan 1963, p. 369; Daly and Patton 1990, p. 1291). Adults rarely disperse (Williams and Cameron 1984, p. 68), typically staying in more-or-less one location their whole lives, aside from minor territory boundary shifts (Howard and Childs 1959, p. 316; Daly and Patton 1990, p. 1291). However, dispersal distances may vary based on surface or soil conditions, age of the animal (adult or juvenile), population density, and size of the animal. In a study on a larger *Thomomys* species, most individuals dispersed to new territories within about 131 ft (40 m) of their natal territories, but they can disperse many hundreds of feet farther (Barnes 1974, pp. 168-169; Williams and Baker 1976, p. 306; Daly and Patton 1990, pp. 1286, 1288). Another study conducted on the smaller MPGs at JBLM's Weir Prairie, found that juvenile MPGs in Washington rarely moved more than 121 ft (37 m) in a day (Olson 2012, p. 5; Olson 2015, p. 12), though these may not all have been dispersal movements. One juvenile MPG made a distinct dispersal movement of 525 ft (160 m) in 1 day (Olson 2012, p. 5) and another juvenile moved 1,345 ft (410 m) (Olson 2015, p. 12), but these were rare events.

Adult MPGs are generally sedentary, and daily movements average about 42 ft (12.7 m) with average annual movements on JBLM's Weir Prairie of 75 ft (22.8 m) (Olson 2015, p. 12), although one adult female MPG made a single movement of 1,204 ft (367 m) in a single day. These results from the large area of Weir Prairie should not be applied to smaller sites or sites with higher densities of pocket gophers, as the amount and configuration of habitat, number of and age of the animals, and population dynamics more likely influence dispersal distances.

At JBLM's Weir Prairie, many types of roads appear to be barriers to MPG movements, regardless of the type of movement. The paved road that traverses through the Weir Prairie is a busy county road linking cities; this road appears to act as a barrier to movement; however, even the gravel and dirt roads in the Weir Prairie study area were not often crossed (Olson 2015, p. 13). Studies of translocated MPGs have not shown these same results (Olson, unpublished data, as cited in Olson 2015, p. 13), which may or may not be due to their translocated status (i.e. the need to establish new territories in unfamiliar locations). Pocket gophers in areas that experience days, weeks, or months of snow may be capable of moving long distances across otherwise inhospitable habitats (Vaughan 1963, p. 369), as burrowing under or through snow is less energetically costly than burrowing in soil. However, the Puget Sound region does not have long cold winters with prolonged periods of deep snow.

Potential Dispersal Barriers

Suitable dispersal habitat is free of barriers to gopher movement and may need to contain foraging habitat if an animal is required to make a long-distance dispersal move. Potential barriers include, but are not limited to, large stands of forests or dense woody vegetation, paved and unpaved roads with high traffic volumes, abrupt elevation changes, Scotch broom thickets (Barnes 1974, pp. 168-172; Olson 2012, p. 3), highly cultivated monoculture lawns and turf farms, inhospitable soil types (Olson 2008, p. 4) or substrates, development and buildings, slopes greater than 35 percent, and open water. Barriers may be permeable, meaning that they may impede movement from place to place without completely blocking it, or they may be impermeable, meaning they cannot be crossed. Permeable barriers, as well as lower quality dispersal habitats, may present an intensified risk of mortality to animals that use them (e.g., open areas where predation risk is increased during passage or a busy road where the potential for vehicular mortality is high). We do not know all conditions that create barriers to dispersal for MPGs, but in the south Puget Sound prairie landscape, the Nisqually, Deschutes, and Black Rivers likely inhibit contact between gophers on opposite sides of them, especially if soil conditions are not suitable on the other side, while smaller rivers or streams that run through suitable habitat may not present movement barriers. Major highways such as Interstate 5 (I-5) and associated developed areas, may also isolate occupied areas or local populations (Olson 2008, p. 4; Olson 2012, p. 2).

Designated Critical Habitat

Critical habitat was designated for three of the four subspecies of MPG (OPG, TPG, and YPG) (79 FR 19712; April 9, 2014; USFWS 2014b). The Service designated three units totaling 1,607 ac (650 ha) as critical habitat. The three units are: 1) OPG Critical Habitat, Olympia Airport Unit, (676 ac (274 ha)); 2) TPG Critical Habitat, Rocky Prairie Unit (399 ac (162 ha)); and 3) YPG Critical Habitat, Tenalquot Prairie Subunit and Rock Prairie Subunit (a combined total of 532 ac (215 ha)). The approximate area and landownership for each critical habitat unit and subunit is described in Table 2. Prior to final designation of critical habitat, 6,345 ac (2,567 ha) of DoD lands were exempted under section 4(a)(3)(B)(i) of the Act, and 1,281 ac (518 ha) of State and private lands were excluded under section

4(b)(2) of the Act (79 FR 19712; April 9, 2014). These exemptions and exclusions were based on the determination that existing land management and conservation partnerships provide greater conservation benefit to the four subspecies of MPG than would inclusion in designated critical habitat.

Table 2. Designated Critical Habitat Units and Subunits for OPG, TPG, and YPG.

Critical Habitat Unit	Location Name	Subunit as Identified in Proposed Rule	Federal and State Acres (Hectares)	Private Acres (Hectares)	Other* Acres (Hectares)	Total Acres (Hectares)
OPG Designated Critical Habitat	Olympia Airport Unit	1-C	0	0	676 (274)	676 (274)
TPG Designated Critical Habitat	Rocky Prairie Unit	1-D	0	399 (162)	0	399 (162)
YPG Designated Critical Habitat	Tenalquot Prairie Subunit	1-E	0	154 (62)	135 (55)	289 (117)
	Rock Prairie Subunit	1-H	0	243 (97)	0	243 (97)
Totals			0	796 (322)	811 (328)	1,607 (650)

*Refers to local municipalities and nonprofit conservation organizations

INFLUENCES ON VIABILITY

In the final rule to list the four subspecies of Mazama pocket gopher as threatened (USFWS 2014a, entire), we identified the main threats to each of the four subspecies. They are summarized for each subspecies as: the present or threatened destruction, modification, or curtailment of its habitat or range, predation by cats and dogs, inadequacy of existing regulatory mechanisms, direct mortality and harm from military training impacts (RPPG and YPG only), direct mortality and harm from land uses and management within its habitat, control as a pest species (poisoning and trapping), and small population effects. Conservation measures to benefit the four subspecies have been implemented at sites across each subspecies' range. Examples of conservation measures include, but are not limited to: habitat conservation plans (HCPs), Integrated Natural Resource Management Plans and Sikes Act (DoD military commitments), compensatory mitigation areas, and conservation areas purchased with Section 6 and recovery funds; all of these include agreements to manage habitat to benefit MPGs. Below we summarize the information on threats and conservation actions and their effects on the viability of each of the four subspecies of Mazama pocket gopher.

Loss, Degradation, or Fragmentation of Habitat (Listing Factor A)

Historically, where preferred soils were contiguous and continuous, MPG subspecies populations likely extended across undeveloped expanses of open prairie (Dalquest and Scheffer 1942, pp. 95-96), but current populations of each of the four subspecies of MPG now either partly or largely occur in small, fragmented patches that are isolated from each other, mainly due to the loss, conversion, and degradation of habitat from residential and commercial development, loss of ecological disturbance processes in grassland habitat (i.e., fire), the spread of invasive plants, and successional changes. These are the primary long-term threats to all four subspecies of MPG. Other habitat-related threats include military training impacts to habitat and nontarget effects of restoration activities on habitat. Increased predation pressure is also closely linked to habitat degradation and discussed fully under Predation (Listing Factor C).

The prairies of south Puget Sound are part of one of the rarest ecosystems in the United States (Noss et al. 1995, p. I-2; Dunn and Ewing 1997, p. v). Dramatic changes have occurred on the landscape over the last 150 years, including a 90 to 95 percent reduction in the prairie ecosystem. Most of western Washington's prairies historically occurred in the south Puget Sound region, and less than 10 percent of the original prairie persists with only 3 percent of that original prairie dominated by native vegetation (Crawford and Hall 1997, pp. 13-14).

<u>Development (Listing Factor A and Factor D)</u>

Native prairies and grasslands have been severely reduced throughout the range of the four subspecies of MPG by conversion of habitat to residential and commercial development and agriculture. Removal and fragmentation of native vegetation, excavation and grading of surfaces, and conversion to non-habitat (buildings, pavement, and other infrastructure) renders soils unsuitable for burrowing. Residential development is associated with increased infrastructure such as new road construction, which is one of the primary causes of landscape fragmentation (Watts et al. 2007, p. 736). Activities that accompany low-density development are correlated with decreased levels of biodiversity, mortality to wildlife, and facilitated introduction of non-native invasive species (Trombulak and Frissell 2000, entire; Watts et al. 2007, p. 736). In the south Puget Sound lowlands, the glacial outwash soils and gravels underlying the prairies are deep and considered valuable for use in construction and road building, which leads to their degradation and destruction. Development is also strongly correlated with flat, open sites with rich topsoil layers that are ideal for agriculture and farming and rural residential housing near cities.

In the south Puget Sound, MPGs most commonly reside in Nisqually loamy soils, Cagey loamy sand, and Spanaway gravelly sandy loam (Appendix B in USFWS 2018). These soil types have been disproportionately subjected to development activities, as they mainly occur in developed areas of Thurston County, and within the Urban Growth Areas (UGAs) for the cities of Lacey, Olympia, Tumwater, Yelm, Rainier, Tenino, Grand Mound, and Lacey, or within the city limits of other cities that do not have UGAs such as Rochester; these are the areas where past development has already taken place, and where future development is most likely to occur (Thurston County Community Planning 2020, pp. 2-5 to 2-6, 2-20). Development often renders soils unsuitable for occupancy by pocket gophers (e.g., roads, buildings, parking lots, etc.).

The presumed extinction of the Tacoma pocket gopher (*T. m. tacomensis*) is thought to be directly linked to residential and commercial development, including a large gravel pit and golf course (Stinson 2020, p. 24; Steinberg 1996, pp. 24, 27). Such development has replaced nearly all potentially suitable gopher habitat in the historical range of the subspecies (Stinson 2020, p. 24). Gravel pit operations near the City of Roy on the type locality for the RPPG (Stinson 2020, p, 33), near the City of Tenino on Rock Prairie in the range of YPG, and on Rocky Prairie in the CHU for TPG, near its type locality, may similarly be impacting those subspecies. Development that led to the extinction of *T. m. tacomensis* in

Pierce County may also be the reason for lack of detections of *T. talpoides douglasii* (Brush Prairie pocket gopher) in Clark County since 1997 (Stinson 2020, p. 2 and p. 26).

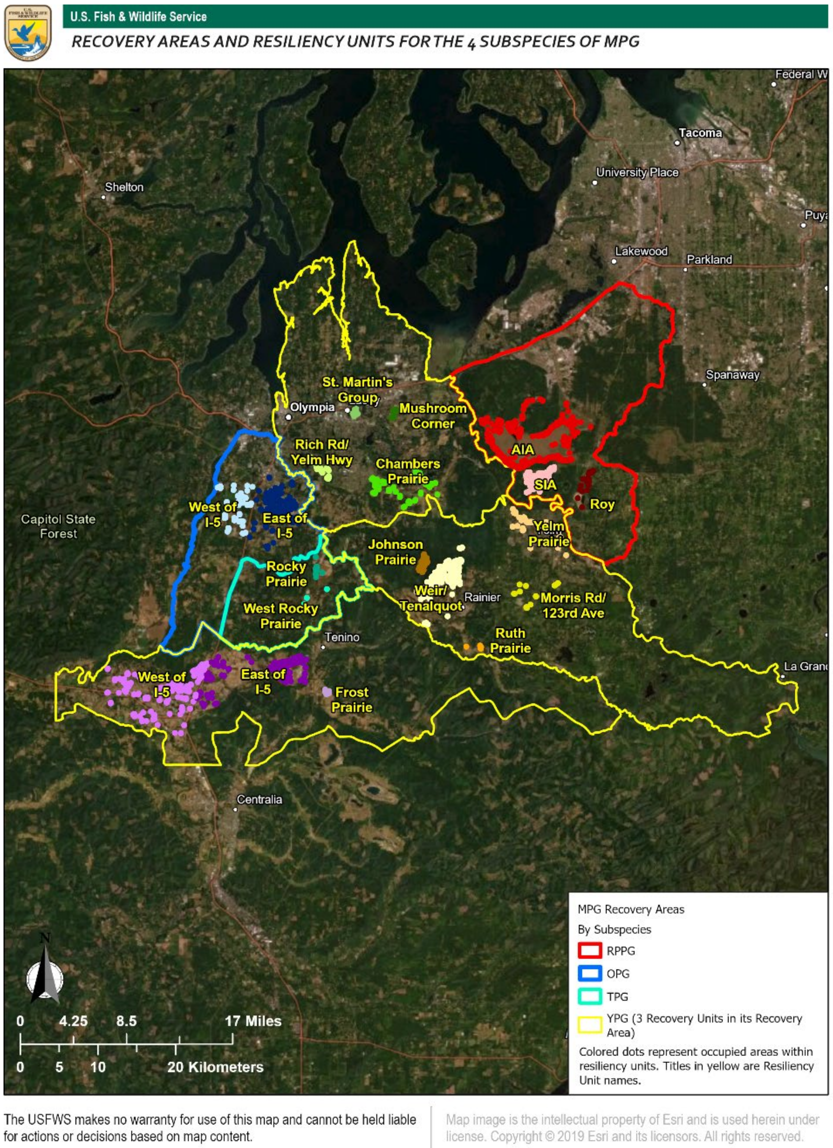

Figure 1. Recovery Areas and Resiliency Units for the Four Subspecies of MPG. The Recovery Areas for each of the four subspecies of MPG are delineated in this figure by red (RPPG), blue (OPG), turquoise (TPG), and yellow (YPG) borders. Three of the four subspecies only have a single recovery area (RPPG, OPG, and TPG), but YPG additionally has three separate Recovery Units (YPG-North (YPG-N), YPG-East (YPG-E), and YPG-South (YPG-S)) within its recovery area.

The dots in Figure 1 are confirmed MPG occupancy areas; they are colored in the same hues or tones as the subspecies‘ Recovery Areas/Units. For instance, all occupancy areas in the range of RPPG are red tones, in the range OPG they are blue tones, and in the range of TPG they are turquoise tones; the occupancy areas for YPGs are color-coded by Recovery Unit: YPG-North are green tones, YPG-East are brownish tones, and YPG-South are purple tones.

Where their properties coincide with gopher occupancy, many private lands developers and landowners in Thurston County agreed to create gopher set-aside areas in order to obtain development permits from Thurston County (Tirhi 2008, in litt.) or from City planning departments. MPG mounding was observed on eight of 15 set asides surveyed by WDFW in 2015 and/or 2016 (WDFW 2016). Such results, as well as a lack of regular monitoring; their small size, extensive grading in some areas, lack of enforcement, and lack of maintenance of the set-asides (Deffobis 2011, in litt.; WDFW 2016), as well as a lack of control of predation by domestic or feral cats or dogs, all raise questions as to the ability of these sites to support MPGs long-term.

OPGs located in the area of Port of Olympia’s Olympia Airport are currently threatened by aviation-related development on the airport itself as well as adjacent landowner development. The Port of Olympia is realigning the airport runway and has plans to develop large portions of the existing grassland that likely supports the largest number of OPG at any single site (Stinson 2020, p. 49; Port of Olympia and WDFW 2008, p. 1; Port of Olympia 2021). The Airport Master Plan was revised in 2013 and is in the process of being updated. The Port of Olympia (Olympia Airport) and City of Tumwater are working with the Service to develop a habitat conservation plan (HCP) that includes conservation measures and mitigation for impacts to OPGs and designated OPG critical habitat expected to result from planned aviation-related improvement and development projects. WDFW has also been working closely with the Port of Olympia on mitigating airport expansion activities that may impact gophers since the Mazama pocket gopher was State listed (Tirhi 2010, in litt.).

Within each subspecies’ Recovery Area, there are multiple locations that are currently secure from commercial and residential development:

RPPG Recovery Area: Most occupied areas on JBLM will not be subject to development because the open ranges and training areas are used for military training activities. Although residential and commercial development is not a major threat for pocket gophers on the installation, impacts from military training poses a threat to individual gophers and their habitat and may lead to reduced use of some areas. Occupied areas in and around the area of the City of Roy have been and continue to be subject to development pressure. There are one or two known Pierce County Critical Area Ordinance (CAO) habitat management plan set-asides in the City of Roy; their total size is approximately 5 ac (2 ha).

OPG Recovery Area: There are a few small set-asides and/or mitigation sites (from as small as 1 ac (0.4 ha) to about 40 ac (16 ha)) east of I-5, adjacent to and south of the Olympia Airport as the result of various single-landowner HCPs and Thurston County CAO habitat management plans. West of I-5, there are two HCP mitigation parcels (5 ac (2 ha) and 68 ac (27.5 ha)).

TPG Recovery Area: The Rocky Prairie NAP, Wolf Haven, and West Rocky WLA are not subject to development because they are owned or managed by WDFW (West Rocky Prairie), WDNR (Rocky

Prairie NAP), or conservation organizations (Wolf Haven International). It is not known if Wolf Haven or West Rocky Prairie WLA are occupied by TPG: individuals from YPG-North and OPG-East of I-5 were translocated to Wolf Haven, and individuals from the OPG-East of I-5 were translocated to the West Rocky Prairie WLA (Linders 2008, p. 5). These OPG and YPG individuals were translocated prior to the federal listing. Although surveys have been consistently performed at both sites, no genetic work has been conducted to determine what subspecies or subspecies hybrids may occur at each of these sites since the translocations.

YPG Recovery Area:

YPG-North Recovery Unit:

- There are two MPG set asides in this Recovery Unit, but they are both very small (0.2 and 1.2 ac (0.08 and 0.49 ha)).

YPG-East Recovery Unit:

- CNLM owns two conservation properties in this recovery unit that are occupied by YPGs: Tenalquot Prairie Preserve and Deschutes River Preserve.
- JBLM's Rainier Training Areas are also not likely to be subject to any significant amount of development in comparison to the total occupied area.

YPG-South Recovery Unit

- There are several areas in this Recovery Unit that are not subject to development: Both the North and South units of the Scatter Creek WLA (a combined amount of open grassland area of approximately 700 ac (283 ha); a couple small (<20 ac (<8 ha)) mitigation sites east of I-5; a moderately-sized (140 ac (57 ha)) mitigation bank east of I-5; a seed nursery and adjacent lands owned by CNLM (about 75 ac (30 ha) of which are not under woody plant cover) on Violet Prairie; private property under an NRCS grassland reserve program management plan (620 ac (251 ha) on Rock Prairie; 330 ac (135 ha) of a larger site recently purchased by WDFW on Rock Prairie; and a 70-ac (28-ha) WDFW conservation easement on Frost Prairie, of which about 60 ac (24 ha) are not under woody cover. Most of these sites are or will be managed for MPGs or are managed in ways expected to retain MPG occupancy onsite.

Washington's State Endangered Species Act regulations protect individuals of the subspecies from direct or malicious take, but MPG habitat is not protected (RCW 77.15.120). As a Priority Species under WDFW's Priority Habitats and Species (PHS) program (WDFW 2021, pp. 212-213), *T. mazama* pocket gophers benefit from some protection of their habitats under environmental reviews of applications for county or municipal development permits (Stinson 2020, p. 44). As part of the PHS program, WDFW provides management recommendations to local government permit reviewers, applicants, consultants, and landowners in order to avoid, minimize, and mitigate impacts to *T. mazama* pocket gophers and their habitats due to development (WDFW 2011, p. 1). These recommendations are not regulatory but are based on best available science.

Habitat receives protection through county or municipal CAOs. CAOs require environmental review and habitat management plans for development proposals that affect State-listed species. Washington's Growth Management Act requires counties to develop CAOs that address development impacts to important wildlife habitats. However, the specifics and implementation of CAOs vary by county and city jurisdictions. City and County CAOs are crafted to preserve the maximum amount of biodiversity while at the same time encouraging high density development within their respective UGAs. Both Thurston and Pierce County have CAO regulations, and within the ranges of the four subspecies of MPG, the following cities have CAO regulations: Olympia (partly in OPG range, partly in YPG range), Lacey (partly in OPG range, partly in YPG range), Tumwater (OPG range), Yelm (YPG range), Tenino (YPG range), Rainier (YPG range), Bucoda (YPG range), and Roy (RPPG range). The vast majority of CAOs are tied to streams, wetlands, shorelines, landslide-prone, flood or hazardous areas, aquifers, or other sensitive areas tied to aquatic resources.

City and County CAOs require presence-absence or similar screening-type surveys be conducted on potential fish and wildlife habitat (e.g., for MPG presence-absence surveys in Thurston County, see Thurston County Government 2021, entire) by qualified professional habitat biologists as development is proposed except Rainier, where a qualified city staffer may complete the survey. A Habitat Conservation Area (HCA) is determined according to the WDFW PHS list, which is associated with WDFW management recommendations for each habitat and species. If an HCA is identified at a site, the development of the parcel is then subject to the CAO regulations. Mitigation required by each City or County CAO prioritizes reconsideration of the proposed development action in order to avoid the impact to the HCA.

Different CAO requirements among the multiple authorities, together with jurisdictional limitations, results in uneven and non-coordinated application of mitigation measures intended to benefit the listed MPGs. In the patchwork regulatory framework, inconsistent assessment and application of mitigation measures that could be beneficial have not prevented the isolation of areas occupied by MPGs; increased habitat fragmentation, degradation, decreased connectivity, and pressure from onsite and offsite factors are not fully taken into consideration in the establishment of these mitigation sites.

Based on our review of the Washington County and State regulatory mechanisms, these measures are currently inadequate to protect the four subspecies of MPG from further rangewide population declines associated with habitat loss, inappropriate management, and loss of connectivity due to development.

<u>Loss of Natural and Anthropogenic Ecological Disturbance Processes, Invasive Species, and Succession</u>

Historically, the prairies and meadows of the south Puget Sound region of Washington are thought to have been actively maintained by the native peoples of the region, who lived here for at least 10,000 years before the arrival of Euro-American settlers (Boyd 1986, entire; Christy and Alverson 2011, p. 93). Frequent burning reduced the encroachment and spread of shrubs and trees (Boyd 1986, entire; Chappell and Kagan 2001, p. 42), and favored open grasslands with a rich variety of native plants and animals important as food resources or which had cultural significance. The suppression and loss of natural and anthropogenic ecological disturbance regimes, such as fire, has altered vegetation structure in south Puget Sound prairies, and led to an invasion by native and non-native woody vegetation rendering formerly suitable habitat unusable for the four subspecies of MPG. The basic ecological processes that maintain prairies and meadows have disappeared from, or have been altered on, all but a few protected and managed sites. The loss of natural and anthropogenic ecological disturbance processes, subsequent invasion by non-native grasses and forbs, and succession of prairie ecosystems to shrubs and forested areas by both native and non-native species are considered population-level threats for all four subspecies of Mazama pocket gopher.

Fires on the prairie create a mosaic of vegetation conditions, which serve to maintain native prairie plant communities. In some prairie patches, fires will kill encroaching woody vegetation and reset succession back to bare ground, creating early successional vegetation conditions suitable for many native prairie species. Early succession forbs and grasses are favored by MPGs. The historical fire frequency on prairies is estimated to have been 3 to 5 years (Foster 2005, p. 8). Following Euro-American settlement of the region in the mid-19th century, fire was actively suppressed on grasslands and allowed encroachment of native and non-native woody vegetation such as the Douglas-fir and Scotch broom, respectively, into the remaining prairie habitat and oak woodlands (Franklin and Dyrness 1973 p. 122; Boyd 1986, entire; Kruckeberg 1991, p. 287; Agee 1993, p. 360; Dunn and Ewing 1997, p. v; Altman et al. 2001, p. 262; Foster 2005, p. 8). This increase and succession of open prairies and grasslands to forests and areas dominated by woody vegetation has resulted in a significant loss of prairie and grassland habitat overall and led to an increase in the number of acres that are unsuitable for and avoided by many native prairie species, including the MPG (Tveten and Fonda 1999, p. 155; Pearson and Hopey 2005, pp. 2, 27; Olson 2011, pp. 12, 16).

The four subspecies occur on remnant or former prairies, many of which, if not actively managed to maintain vegetation in an early-successional state, have been invaded by shrubs and trees. Mazama pocket gophers prefer early successional vegetation as forage (Witmer et al 1996, p. 96) and occupancy by MPGs is negatively associated with Scotch broom cover (Olson 2011, pp. 12-13, 16) and rhizomatous plant cover (Kronland et al. 2018, p. 14), and they are not commonly found in areas colonized by Douglas-fir (Steinberg 1995, p. 26). In fact, Mazama pocket gopher occupancy is higher in areas with less than 10 percent woody vegetation cover (Olson 2011, p. 16). Some MPG subspecies may disperse through small patches of forest or may temporarily establish territories on forest edges, but trees and other woody plants shade out forage plants and high densities of woody plants make travel below (i.e., burrowing) and above ground difficult for gophers. In locations with poor forage, pocket gophers tend to have larger territories, which may be difficult to establish in forested areas.

On JBLM, over 16,000 ac (6,477 ha) of prairies have been colonized by and/or converted to Douglas-fir forests since the mid-19th century (Foster and Shaff 2003, p. 284). Where controlled burns or direct tree removal are not used as management tools, the encroachment of woody vegetation will continue to cause the loss of open grassland habitats for MPGs and represents an ongoing threat for the four subspecies. Restoration in some south Puget Sound prairies and grasslands has resulted in temporary control of Scotch broom and other invasive plants through the careful and judicious use of herbicides, mowing, grazing, and prescribed burns. Fire has been used as a vegetation management tool to maintain native prairie composition and structure and is generally acknowledged to improve the health and composition of grassland habitat by providing a short-term nitrogen addition, which results in a fertilizer effect to vegetation, thus aiding grasses and forbs as they resprout. Due to concerns about air quality and risk of escaped fires, the ability to use fire as a method of prairie restoration has become increasingly difficult as development density increases around conservation sites.

Live fire training, which is the use of small arms, artillery weapons, and detonations, at JBLM ignites unintentional fires (wildfires) that burn large patches of prairie grasses and forbs on an annual basis. These light ground fires create a mosaic of conditions within the grassland, maintaining a low vegetative structure of native and non-native plant composition and patches of bare soil. Because of the topography of the landscape, fires often cause a patchy mosaic of vegetated areas that burn completely, do not burn, or a combination of both. One of the benefits to fire in grasslands is that it tends to kill regenerating conifers and reduces the cover of non-native shrubs such as Scotch broom, although Scotch broom seed stored in the soil can be stimulated by fire (Agee 1993, p. 367). Fire also improves conditions for many native bulb-forming plants, such as *Camassia* sp. (camas) (Agee and Dunwiddie 1984, p. 367), which pocket gophers eat. In prairie areas where regular, low-intensity fires occur, there is a high complement of native plants and fewer invasive species. These types of fires promote the maintenance of the native short-statured, early successional plant communities favored by pocket gophers. Excessive and high intensity burning can result in a lack of native vegetation or encourage regrowth to non-native grasses. Where such burning has occurred over a period of more than 50 years on the artillery ranges of the JBLM, portions of these historic prairies are covered by non-native forbs and grasses instead of native perennial bunchgrasses (Tveten and Fonda 1999, pp. 154-155).

<u>Military Training (Listing Factor A and Factor D)</u>

Local populations of RPPG and YPG occurring on JBLM in Pierce and Thurston Counties, respectively, are exposed to differing levels of military training activities. No military training occurs in the ranges of OPG or TPG. In 2017, the Service completed a program-level consultation evaluating the effects of military training, maintenance, recreation, and resource management activities on pocket gophers at JBLM and assisted the installation with the completion of their Integrated Natural Resource Management Plan (INRMP). Several moderate- to large-sized areas occupied by MPGs occur on JBLM, and these areas are exposed to varying levels of training use. In fact, military training occurs across all areas occupied by RPPG and YPG on JBLM's installation. Within the South Impact Area (SIA; a.k.a. Marion Prairie), live fire training, and unexploded ordnance detonation are allowed. Within the Johnson/Weir/Tenalquot Prairie area (a.k.a. Rainier Training Areas), parachute drops, heavy drops and sling load operations, and mounted maneuver training activities occur, along with other training-related activities. The Artillery Impact Area (AIA) is exposed to live fire training, mortar and heavy artillery firing (bombardment), off-road vehicle use, bivouacking, excavation, high mobility artillery rocket system testing, and unexploded ordnance detonations, chaff deployment, and a suite of other types of training or training-related activities. Military training infrastructure such as roads, firing ranges, and bunkers degrade habitat and may lead to reduced use of some of these areas by pocket gophers. Infrastructure development projects that have been initiated since the subspecies were listed include creation of runways for remotely operated aircraft in the AIA and expansion of the main runway at Gray Army Airfield. These areas may no longer be usable by gophers or when completed because these projects may result in removal of forage vegetation and burrowing habitat and result in direct mortality of gophers through crushing of burrows.

Although military training in the AIA and SIA results in repeated damage and ground-disturbance from mortar fire, there is a large amount of habitat remaining in the area. Gophers occur around most of the perimeter of the both areas, and presence-absence surveys consistently detect them there. Similarly, there are large areas of More-Preferred soils (Table 1) that are occupied by YPGs at the Rainier Training Areas in the YPG-East Recovery Unit, despite training activities that occur there. Vegetation on many of these areas is actively managed and maintained by JBLM for open grassland/prairie characteristics. There are few or no local population abundance or trend data (Appendix 1; Olson 2017a, pp. 10, 12-13) for these areas.

Conservation measures to minimize impacts to pocket gophers are outlined in the biological opinion (USFWS 2017, pp. 27-30) and the Endangered Species Management Component (ESMC) of the INRMP (JBLM 2017) and include: 1) conducting pocket gopher surveys once every 3 years, 2) buffering occupied areas to protect against damage from heavy vehicle maneuvers, 3) avoiding placement of large troop assembly areas in locations occupied by gophers when feasible, 4) scheduling and rotating prescribed burns to maintain adequate forage and refugia around treatment plots, 5) conducting maintenance activities from existing roads and not staging or storing equipment in occupied gopher habitat, and 6) minimizing or avoiding work that involves digging or ground-disturbance in areas occupied by gophers during the mating season (April, May, and June) to avoid damaging burrows with young. Deviating from these conservation measures may require the development of adaptive management plans or strategies and approval from the Director of Public Works – Department of Fish and Wildlife. While some of the training areas on the base have degraded habitat for these species, these areas still provide habitat for the MPG with implementation of conservation measures. As result of training activities, RPPGs on thousands of acres within the AIA and SIA and YPGs on hundreds of acres within the Rainier Training Areas (Johnson/Weir/Tenalquot Prairie area) will be harmed or killed over a period of 5 years (USFWS 2017, pp. 309-310). Since 2017, there have been multiple unauthorized incursions (i.e., not covered by the biological opinion) by vehicles and troops into areas occupied by gophers habitat each year on the installation, though the yearly amount of damage is typically less than 10 ac (4 ha) total (JBLM 2018, 2019, JBLM 2020, entire). Authorized and unauthorized damages resulting from training are repaired by the Integrated Training Area Management program (ITAM) as soon as possible after detection if they are outside the dudded area of the AIA. ITAM's repairs typically include seeding or planting on the damaged soils to encourage regrowth of native grasses and forbs and to suppress non-native plant species (USFWS 2017, p. 15). The 2017 programmatic consultation was due to expire in 2021 and was extended another year; it will eventually be replaced by a broader framework programmatic consultation.

JBLM has authority and capacity to conserve MPG subspecies outside of the boundary of the installation through the Readiness and Environmental Protection Integration Program (REPI), the Army Compatible Use Buffer (ACUB) Program, and Sentinel Landscapes Partnership. Sentinel Landscapes Partnership is a partnership between DoD, the Department of the Interior (DoI), and the Department of Agriculture that catalyzes shared goals in the vicinity of military installations. JBLM previously provided significant conservation investments for YPG off of JBLM lands under these programs, but many of the efforts and funds were paused in the mid-2010s as the DoD reconsidered their return on investment.

In 2021, the Service completed a framework biological opinion for JBLM's proposed Conservation Crediting Program. In conjunction with a revised ACUB Plan, the Conservation Crediting Program will incentivize JBLM and DoD to invest in the conservation of RPPG, YPG, and other listed species outside of the boundary of the installation. However, the Recovery and Sustainment Partnership Initiative Memorandum of Understanding (MOU) (DoD and DoI 2018) and the Conservation Policy Initiative provided a new direction for the Service and JBLM in 2020. The Service is now working closely with JBLM and the DoD on a "Pilot Project" for the Conservation Policy Initiative. As currently envisioned, the JBLM Pilot Project would set "defined conservation commitments" for several listed and unlisted prairie species, including the RPPG and YPG, beyond which the Service would ask no further commitments from JBLM under section 7(a)(2) of the Act and provide broad authorization for training flexibility. The Conservation Crediting Program, the Conservation Policy Initiative JBLM Pilot Project, and the revised ACUB Plan are expected to secure conservation for pocket gophers and other prairie species in a large buffer zone around the boundaries of the installation and the greater Sentinel Landscape, which includes much of the south Puget Sound lowlands geographic area of flat low elevation glacial outwash areas in Pierce, Thurston, Grays Harbor, and Lewis Counties. The revised ACUB Plan and the programmatic biological opinion for the Pilot Project are currently expected to be completed by early 2023.

In summary, military training activities cause mortality and direct and indirect harm to RPPGs on thousands of acres in their Recovery Area and to YPGs on hundreds of acres in the YPG-East Recovery Unit. Large portions of the base's training areas are being managed for maintenance of open grassland/prairie habitat, even as training still occurs in those areas. Overall, we believe military training is a population-level threat to RPPG and YPG due to the overall extent of the training, and the types of impacts (mortality and harm) that occur as a result. Presence-absence surveys show individual animals continue to persist in these training areas, despite a long history of military training. However, due to a lack of monitoring data that would inform population trend, there remains some level of uncertainty.

Restoration Activities

Restoration activities designed to control weedy and invasive plant species and remove encroaching woody native and non-native plants may have negative impacts on the four subspecies of MPG as they require the use of various types of mechanical equipment and vehicles, the use of prescribed fire, and other similar activities. The application of pesticides and herbicides can also have negative impacts and is discussed in the Pesticides and Herbicides section, below. While restoration has conservation value for the four subspecies, management actions to implement restoration may also have direct negative impacts to the subspecies or their habitat, particularly if best management practices are not followed. Overall, however, we anticipate this is a threat to individuals of the four subspecies of MPG, rather than a population-level threat.

MPG habitat in the south Puget Sound has been degraded and encroached upon by native and non-native woody plants, as well as several Washington State-listed noxious weeds, such as *Euphorbia esula* (leafy spurge) and *Centaurea* sp. (knapweed) (Dunn and Ewing 1997, p. v; Buschmann 1997, p. 163). Controlling Scotch broom and other invasive plants for purposes of restoration may be achieved through careful use of mowing, grazing, fire, and herbicides. These activities promote the maintenance of the native short-statured, early successional prairie or grassland plant communities where MPGs typically occur, but they also have the potential to be ineffective or detrimental when applied incorrectly, not frequently enough, or injudiciously. For example, regular use of heavy vehicles or other equipment in the loamy soils gophers prefer can compact soils and collapse tunnel systems, particularly when soils are wet (see also Use of Heavy Equipment section, below). Fire applied at the wrong season, frequency, or scale can result in a lack of vegetation that can decrease forage availability, increase predation, encourage regrowth of non-native plants that decrease habitat quality or amount for MPGs, or be ineffective at controlling Scotch broom if not conducted at the correct frequency (see Prescribed Fire and Wildfire section, below). While prairie restoration activities may be aimed at enhancing and maintaining habitat for MPGs, when best management practices are not followed, direct and indirect mortality and harm may occur (see sections regarding Direct Mortality and Harm, below).

At the time the four subspecies of MPG were listed, the Service issued a 4(d) rule which exempts certain agricultural and restoration-type activities on civilian airports and other non-federal lands, including control or other management of noxious weeds and invasive plants through mowing, discing, herbicide and fungicide application, fumigation, or burning. Use of herbicides, fungicides, fumigation, and burning must occur in such a way that non-target plants are avoided to the maximum extent practicable. Planting, harvest, fertilization, harrowing, tilling, or rotation of crops are exempted on non-federal lands, so long as disturbance to soils does not exceed 12 inches (30.5 cm) in depth, though deep tillage for compaction reduction purposes may occur not more than once in 10 years (USFWS 2014a, p. 19795). Many of these actions are part of a typical prairie restoration program. While these activities may cause some level of harm to individuals of the four subspecies of MPG, the Service determined that they may create and improve habitat for the subspecies, create or foster conservation partnerships with landowners, and are important elements in the subspecies' conservation and recovery efforts (USFWS 2014a, p. 19794). Restoration activities are a threat to individuals of each of the four subspecies of Mazama pocket gopher, but not a population-level threat.

Predation by Cats and Dogs (Listing Factor C)

Predation is a process of major importance that influences the distribution, abundance, and diversity of species in ecological communities. Generally, predation leads to changes in the population size of both the predator and the prey. In unfavorable environments, prey species are stressed or living at low population densities such that predation is likely to have negative effects on all prey species, thus lowering species richness. Natural levels of predation do not appear to affect established pocket gopher local populations as much as other factors, such as habitat quality and food availability (Baker et al. 2003, p. 283), which is likely a result of their subterranean life history (Busch et al. 2000, p. 5-18; Cameron 2000, p. 237). There is a positive correlation between pocket gophers that spend more time on the surface and likelihood of predation (Busch et al. 2000, p. 5-18).

When a non-native predator is introduced to the ecosystem, such as feral and/or free-roaming domestic cats and dogs, negative effects on the prey population may be higher than those from co-evolved native predators. The effect of predation may be magnified when populations are small, and the disproportionate effect of predation on declining populations has been shown to drive rare species even further towards extinction (Woodworth 1999, pp. 74-75). Exposure to feral and domestic cats and dogs, coupled with declining local population sizes, has caused predation to negatively impact local populations of MPGs. Urbanization and development, particularly in the south Puget Sound area around the cities of Lacey, Olympia, Tumwater, Yelm, Rainier, Tenino, Grand Mound, and Rochester, has resulted in not only habitat loss for MPGs but the increased exposure to feral and domestic cats and dogs. Domestic cats are known to have serious impacts on small mammals and birds and have been implicated in the decline of several endangered and threatened mammals, including marsh rabbits (*Sylvilagus palustris*) in Florida and the salt-marsh harvest mouse (*Reithrodontomys raviventris*) in California (Ogan and Jurek 1997, p. 89). Domestic cats and dogs have been specifically identified as common predators of pocket gophers (Wight 1918, p. 21; Henderson 1981, p. 233; Case and Jasch 1994, p. B-21) and at least two MPG locations were found as a result of house cats bringing home pocket gopher carcasses (WDFW 2001, entire). In addition, the last specimens and last known individuals of the now-extinct Tacoma pocket gopher were carcasses brought home by cats (Stinson 2020, p. 48). There are also recorded instances of a WDFW biologist being presented with a dead MPG by a dog during an East Olympia, Washington, site visit in 2006 (Burke Museum 2012), a dog killing a gopher during a pheasant release event at Scatter Creek WLA (Linders 2012, in litt.), a dog killing a gopher on JBLM lands in Thurston County (Miller 2012, in litt.), and cats killing gophers in local area yards and farms (Skriletz 2013, pers. comm.; Wood 2013, in litt.), or in other states (Chan 2013, in litt.).

The four subspecies of MPG occur in rapidly developing areas, and gophers that survive commercial and residential development are vulnerable to predation by domestic and feral cats and dogs (Henderson 1981, p. 233; Case and Jasch 1994, p. B-21, Loss et al. 2013, pp. 2-4). Feral cats are particularly effective predators of small mammals (Loss et al. 2013, p. 3). Predation is a natural part of the MPG's life history; however, the effect of predation may be magnified when there are a small number of gophers at a site. Predation by feral and domestic dogs and cats will likely continue to be a threat to the four subspecies of MPG where they occur in small sites abutting development. In such areas, this additional predation pressure (above natural levels of predation) is expected to impact numbers of individuals at these small sites. But there are several larger undeveloped areas of occupied gopher soils within each of the ranges of the four subspecies of MPG, and in those areas predation due to feral and domestic dogs and cats is expected to be low. Therefore, predation is not considered to be a population-level threat for any of the four subspecies of MPG.

Direct Mortality and Harm from Military Training Impacts (RPPG and YPG only) (Listing Factor E)

A suite of military training and related activities may result in direct mortality or harm to RPPG and YPG. These include, but are not limited to, the following: removal and/or destruction of unexploded ordnances, weapons and gunnery training, live-fire maneuver training, aerial gunnery, mounted off-road maneuvers, bivouacking/digging/fighting positions, storage and assembly areas, forward arming and refueling, heavy drops and sling load operations, recovery of unmanned aerial vehicles, maintenance and repair of existing infrastructure, and road and trail repair (USFWS 2017, pp. 265-266). Many of these activities require the use of heavy equipment, grading, excavation, or placement of fill material. Direct mortality or harm to MPGs may occur as a result of damage and destruction of occupied burrows, nest chambers, and tunnel systems, and explosive detonations resulting in blast or shock waves. Such impacts are anticipated to occur on thousands of acres over a 5-year period (USFWS 2017, pp. 309-310). Mortality events are difficult to impossible to detect for several reasons: pocket gophers are small prey animals that could be eaten or decompose before they are found; pocket gophers are fossorial and live most of their life underground and may not be visible after they die; vegetation may obscure them from detection if they are at the soil surface; and many thousands of acres are unsafe to monitor (e.g., the center of the AIA). Trend monitoring is one way to assess the stability of a local or rangewide population, but no such data are available for RPPG and YPG on the installation. Tying trend information to JBLM's ongoing training monitoring (type, intensity, area affected) would better inform which types and intensities of training are most impactful to the subspecies.

Military training activities cause mortality to RPPGs on thousands of acres in their Recovery Area, and to YPGs on hundreds of acres in the YPG-East Recovery Unit. Large portions of the base's training areas are being managed for maintenance of open grassland/prairie habitat, even as training still occurs in those areas. Overall, we believe direct mortality and harm from military training is a population-level threat to RPPG and YPG due to the areal extent of the training in relation to the range of the subspecies in their Recovery Area (RPPG) or Recovery Unit (YPG-East), and the types of impacts (mortality and harm) that occur as a result. Presence-absence surveys show individual animals continue to persist in these training areas, despite a long history of military training. However, due to a lack of monitoring data that would provide information on population trend over time, there remains uncertainty regarding the impact(s) military training is having on these populations.

Direct Mortality and Harm from Land Uses and Management (Listing Factor E)

Application of Pesticides and Herbicides

Mazama pocket gophers may be impacted by the equipment used to dispense pesticides and herbicides or when there is a significant loss of suitable gopher forage plants at a site. The habitat-related effects of equipment impacts are covered under Factor A. Direct mortality and harm from the application of pesticides and herbicides is a threat to individuals of each of the four subspecies of MPG but is not a population-level threat.

The widespread use of herbicides on agricultural lands and farms (working lands) to favor certain crops can result in monocultures of unsuitable vegetation (such as turf grass) in areas where soil and conditions would otherwise be highly suitable for pocket gophers. Turf farms and intensively managed row crops (e.g., corn, produce, or berries) have a lower potential to support pocket gophers due to a lack of forage resources (due to use of herbicides) and/or frequent tilling compared to less intensively managed fields or pastures, nursery operations, and native seed production sites. Agricultural fields that are frequently tilled tend not to support consistent or high-density populations in the centers.

Broadcast spraying of certain herbicides can have detrimental effects to forage plants in areas occupied by gophers, even when used for purposes of prairie restoration. Timing, amount, and type of herbicide used will influence the severity of the impact to gophers. Broadcast spraying may be used immediately following a fall burn to kill non-native vegetation that emerges before native plants. The herbicide used is typically glyphosate, which targets non-native grasses, herbs, and forbs. Glyphosate disrupts photosynthesis, so only actively growing plants are killed and are killed down through the root. Seeds are not affected, and neither are plants that do not have growing parts above ground. Prior to glyphosate application, the burned area is surveyed to determine the density of non-native versus native plants. If too many native plants would be affected, spot spraying is utilized. If only a few or no native plants would be harmed, herbicides may be applied using a broadcast spray. If there are just a few places with native plants, the areas would be covered for protection prior to broadcast spraying.

Herbicides do not kill everything they target. There are multiple "flushes" of growth after a burn, and both non-natives and natives will come in with that second flush of growth or even later. Non-natives and natives may be covered by duff or other cover during herbicide application and will be protected from the herbicide’s effects; therefore, it is anticipated that some non-natives will remain on-site, which means future treatments may be needed. In very degraded prairie sites, especially areas with abundant tall oat grass or Scotch broom, there are minimal native plants left on the site or within the seed bank. Therefore, these areas often need to be seeded after herbicide treatment. Areas may need repeated seeding in successive years to fully establish a native plant community at a site.

In degraded prairie sites that are occupied by gophers, the only food available to the gophers is often non-native plants. Broadcast application of glyphosate in such areas will kill the photosynthesizing (green, growing) non-native plants the gophers eat. Food remaining for gophers will be the individual non-native plants that did not have green parts above ground (i.e., either already dead, senesced, or covered by duff) and any food stored in underground caches. An individual underground cache is estimated to provide enough food for about 2 weeks (Andersen and MacMahon 1981, p. 195). Because newly seeded natives will not have a well-developed root system for perhaps a year, gophers will be reliant on any remaining non-native plants for food.

At the time the four subspecies of MPG were listed, the Service issued a 4(d) rule which exempts certain agricultural activities on civilian airports and other non-federal lands, including control or other management of noxious weeds and invasive plants through herbicide and fungicide application or fumigation. While application of herbicides and pesticides may cause some level of harm to individuals of the four subspecies of MPG, the Service determined that they may create and improve habitat for the subspecies, create or foster conservation partnerships with landowners, and are important elements in the subspecies' conservation and recovery efforts (USFWS 2014, p. 19794). Application of herbicides and pesticides is a threat to individuals of each of the four subspecies of Mazama pocket gopher, but not a population-level threat.

Prescribed Fire or Wildfire

Prescribed fires are used today to achieve the short-statured, early successional prairie and grassland vegetation to restore prairie ecosystems that include pocket gophers. When prescribed fires are well executed using best management practices (timing, size, placement, post-fire management), there are few or no negative outcomes for pocket gophers. But if best management practices are not followed or if best management practices fail, there can be negative outcomes for pocket gophers. The same is true in cases of wildfire. Historical fire frequency at JBLM is estimated to have been every 3-5 years prior to the listing of the MPG (Foster 2005, p. 8). Fires occurring at such frequencies typically resulted in low intensity, low severity burns with a patchy mosaic of burned and unburned areas. Areas managed using best management practices can mimic the outcomes of historic, low intensity/low severity fires. However, longer fire return intervals (frequency) or certain weather and dense vegetation conditions (e.g., drought, wind and high fuel loading) can create high severity fires where the result is not a patchy mosaic of burned and unburned areas, but a solid burned area. The result can be significant loss of above-ground vegetation, and consequently, negative impacts to MPGs due to predation (Olson 2017b, p. 8) or reduction in forage resources. Extremely severe fires that sterilize the soil and kill the roots of forage plants can occur, but typically do not occur on a large scale in the south Puget Sound area. Exceptions may be areas in the center of the AIA that experience repeat wildfires and/or bombardment.

If the fire is not too intense and is followed by a rainy period, new above-ground forage vegetation can resprout relatively quickly. During the time between the fire and the resprouting, however, MPGs that venture above ground during mounding activity or attempt to forage will be exposed to increased predation rate as cover will not be available. Additionally, fire suppression and control activities can cause the collapse, damage, or destruction of occupied burrows or nest chambers when conducted in occupied habitat and can result in the mortality or harm of individuals.

At the time the four subspecies of MPG were listed, the Service issued a 4(d) rule which exempts certain agricultural activities on civilian airports and other non-federal lands, including burning to control noxious weeds and invasive plants. While burning may cause some level of harm to individuals of the four subspecies of MPG, the Service determined that it may create and improve habitat for the four subspecies, create or foster conservation partnerships with landowners, and is an important element in the subspecies' conservation and recovery efforts (USFWS 2014, p. 19794). Prescribed fire and wildfire are a threat to individuals of each of the four subspecies of Mazama pocket gopher, but do not pose a population-level threat.

Use of Heavy Equipment

Heavy equipment is often used in occupied areas during restoration actions or other types of land management actions, such as mowing, planting, haying, fire suppression and control, herbicide and pesticide application, etc. External loads can compress, collapse, and/or destabilize soil profile structure. Heavier equipment tends to rut and compact soils (Ampoorter et al. 2010, pp. 1-3, 22), while more frequently or intensively trafficked areas become more compacted, and/or compacted at greater depth (Schaffer et al. 2008, pp. 776, 778; Ampoorter et al. 2010, pp. 1-3, 19). Wet soils in particular, wet, fine-grained soils, are more vulnerable to rutting and compaction than dry soils (Miller et al. 1996, pp. 226-229, 235) or sandy, gravelly soils, and previously disturbed soils are more vulnerable to compaction (Schaffer et al. 2008, pp. 771-773).

Mazama pocket gophers occupy a variety of soil types (Table 1). Fine-grained Nisqually and Spanaway-Nisqually complex soils, as opposed to other preferred soils, are more vulnerable and susceptible to damage from the use of heavy equipment at most times of year, especially when they are wet; conversely, gravellier soils are more resilient and less susceptible to damage, except when particularly wet or saturated. Site-specific soil properties, soil disturbance history, and climatic factors all substantially influence vulnerability to compaction, shrinkage, loss of porosity, and structural destabilization (Climo and Richardson 1984, p. 252; Rab 2004, p. 337; Schaffer et al. 2008, pp. 771-773). Fine-grained soils containing substantial clay or silt fractions are particularly vulnerable, especially when wet (Collis-George 1959, p. 556; Climo and Richardson 1984, p. 248; Ampoorter et al. 2010, pp. 2, 17). Alternatively, coarse-grained gravelly or sandy loams are not particularly vulnerable to effects resulting from the use or trafficking of mechanized equipment (Wass and Smith 1997, pp. v, 1, 4, 6, 12). Gravelly loam to sandy loam soils derived from glacial till are resilient and exhibited little evidence of damage resulting from conventional forestry operations conducted with a heavy excavator (Wass and Smith 1997, pp. 11-12).

Based on the above discussion of soil properties, disturbance, climatic factors, and vulnerability to structural destabilization, the Service expects and assumes that sites and soils vary in their susceptibility to damage from use of heavy equipment. The potential for direct mortality or harm to MPGs as a result of such activities depends on local population density, the weather (wet or dry), and the size of the area impacted. If gophers are in their foraging tunnels near the soil surface when soils are damaged, there is a risk of mortality or injury. There is also an energetic cost to the animal when they are required to reconstruct their burrows, especially if the animal is a female that is pregnant or lactating. Most land managers strive not to damage large areas of soil while using heavy equipment, as doing so would also damage their ability to grow vegetation on those areas. Overall, we anticipate that the use of heavy equipment is a threat to individuals of each of the four subspecies of MPG, but not a population-level threat.

Recreation (Listing Factor E)

Direct impacts from predation by domestic dogs associated with recreational activities does occur (see Predation (Listing Factor C) section above). We anticipate predation by dogs associated with recreational activities is a threat to individuals of each of the four subspecies of MPG but not a population-level threat.

Control as a Pest Species (Listing Factor E)

Pocket gophers are often considered a pest because they sometimes damage crops and seedling trees, and their mounds can create a nuisance. Several site locations were found as a result of trapping on Christmas tree farms, a nursery, and in a livestock pasture (WDFW 2001). Mazama pocket gophers in Washington were used in a rodenticide experiment as recently as 1995 (Witmer et al. 1996, p. 97). Because Mazama pocket gophers are State-listed as threatened in Washington, without a permit it is currently illegal under State law to trap or poison them or to trap or poison moles where they overlap MPG occupied areas. Using traps other than live traps, such as body-gripping traps, also requires a special State trapping permit. However, not all property owners are cognizant of these laws, and differentiating between mole and pocket gopher mounds can be difficult. MPGs that survive commercial and residential development (adjacent to and within MPG habitat) may be subsequently extirpated by trapping or poisoning by humans. Lethal control by trapping or poisoning is most likely a threat to individuals of each of the four subspecies of MPG, where they overlap residential properties, but is not a population-level threat.

Small or Isolated Populations (Listing Factor E)

Most species' populations fluctuate naturally and respond to various factors such as weather events, disease, and predation. However, these factors have less impact on a species with a wide and continuous distribution (Johnson (1977, p. 3). Populations that are small, fragmented, or isolated by habitat loss or modification of naturally patchy habitat, and other human-related factors are more vulnerable to extirpation by natural randomly occurring events, cumulative effects, and to genetic effects that plague small populations (collectively known as small population effects). These effects can include genetic drift (loss of alleles), founder effects (over time, an increasing percentage of the population inheriting a narrow range of traits), and genetic bottlenecks (increasingly lower genetic diversity if bottlenecks are long-term), with consequent negative effects on evolutionary potential.

All four subspecies of MPG have occupied areas that are small, fragmented, and physically isolated from one another and continue to face threats from further loss or fragmentation of habitat. However, the location, size, and resiliency of the four subspecies' rangewide populations influence their vulnerability to small population effects at the rangewide population scale. Historically, if local, small-scale extinctions occurred, MPGs likely persisted by continually recolonizing patches of habitat either within a larger patch, or in separate patches linking occupied sites across permeable or semipermeable landscapes. This process, in concert with widespread development and conversion of habitat, has resulted in widely separated areas of occupancy, since intervening habitat corridors are largely gone, preventing much of the natural recolonization that historically occurred (Stinson 2020, p. 46).

Roy Prairie Pocket Gopher:

Within the RPPG Recovery Area, in the area around the City of Roy, occupied areas are scattered and isolated from each other by development and gravel pits. Although no abundance or trend surveys have been conducted, most occupied areas are likely to have low abundance due to low habitat quality and quantity (Table 3). In contrast, in areas around the AIA and SIA, there are large (>500 ac (202 ha) to several thousands of acres) patches of habitat. The majority of those acres are subject to various types of military training and accidental wildfires that can result in mortality or harm to MPGs. Active vegetation management activities in areas around the AIA and SIA maintain prairie habitat characteristics, and development does not pose a significant threat in these areas. No abundance or trend data are available within the Recovery Area, but the large prairie areas (hundreds to thousands of acres) on the AIA and SIA are known to support gopher occupancy. Therefore, small population effects are not a population-level threat for RPPG.

Olympia Pocket Gopher:

Within the OPG Recovery Area, that portion west of I-5 is characterized by scattered occupied areas that are isolated from each other by forests or dense development between them. One larger parcel (over 60 ac (24 ha)) along 93rd Avenue SW as well as another smaller (about 10 ac (4 ha)) conservation property just off Littlerock Road was recently acquired for OPG conservation in the area west of I-5, as part of the Tumwater East/Puget Western Inc. HCP. The remainder of the occupied areas are small and not managed for OPG conservation. No abundance or trend surveys have been conducted, but most occupied areas are likely to have low abundance due to low habitat quantity and quality in the occupied areas.

That portion of the OPG Recovery Area that is east of I-5 contains a large, occupied area on the Olympia Airport, with several smaller mitigation sites and set-asides that are either adjacent to or disjunct from the habitat at the Airport. The largest conservation parcel adjacent to the airport is a 45 ac (18 ha) parcel between Old Highway 99 and the Deschutes River, and is part of the Kaufman HCP. Habitat on and off the Airport is threatened by development, as most of this portion of the Recovery Area occurs in the UGA for Tumwater. There are two other smaller conservation parcels located south of the Olympia Airport that are being managed for OPG and which associated with recently completed HCPs, including a 38 ac (15 ha) parcel east of Case Road along Salmon Creek (pat of The Preserve HCP) and a smaller (5 ac (2 ha)) parcel between Case Rd and I-5 (part of the McLain HCP).

OPG recovery relies on the establishment of at least three Reserves, with at least one west of I-5 and one east of I-5. Remaining areas of habitat west of I-5 are limited to small and isolated patches that are threatened by development. Similarly, remaining habitat east of I-5 is also threatened by development. Thus, small population effects are a population-level threat for OPG.

Tenino Pocket Gopher:

Within the TPG Recovery Area, the area around Rocky Prairie NAP is characterized by known MPG occupancy with small, scattered areas of occupancy surrounding it. The TPG critical habitat unit (CHU) to the east of the NAP is presumed to be occupied due to connectivity with the NAP, presence of More-Preferred soils, and suitable vegetative habitat, but there are no local population abundance or trend data for either the NAP or the CHU. Approximately 40 ac (16 ha) of habitat on the NAP are managed for purposes of achieving prairie characteristics and are not threatened by development. However, the CHU and other occupied areas around the NAP are not managed for TPG conservation and are threatened by development, which leads to isolation of occupied areas, particularly small areas of occupancy.

The area in and around the West Rocky Prairie WLA includes a large, occupied area on and immediately adjacent to the WLA, and a smaller occupied area on Wolf Haven. Wolf Haven, which is less than 50 ac (20.2 ha) in size, and the WLA are not threatened by development and contain about 230 ac (93 ha) of habitat combined. There is also a small (approximately 5 ac (2 ha)) conservation parcel adjacent to the WLA that will be managed for purposes of MPG conservation (part of the Puget Sound Energy HCP). However, TPG recovery relies on establishment of a minimum of two Reserves, with a minimum of one on Rocky Prairie. Because establishment of a Reserve on Rocky Prairie is necessary for recovery, and occupied areas there are small and threatened by development, small population effects are a population-level threat to TPG.

Yelm Pocket Gopher:

There are three Recovery Units in the YPG Recovery Area: YPG-North, YPG-East, and YPG-South.

YPG-North Recovery Unit

In the YPG-North Recovery Unit, most of the occupied areas are either very small or both small and isolated from each other. In the Chambers Prairie area, there are some better-connected, larger areas that are known to be occupied and one 10-acre (4 ha) conservation parcel set aside under the PSE HCP. There are a few other set asides in the Recovery Unit, but they are even smaller (5 ac (2 ha) or less). Most of the Recovery Unit is within a UGA for the cities of Lacey or Olympia, and therefore are subject to development, which has already served to isolate occupied areas from each other. Two exceptions are the Chambers Prairie area, and some areas on Less-Preferred soils north of I-5. The area north of I-5 in this Recovery Unit is not identified as an area expected to contribute to recovery of YPGs. The Chambers Prairie area has a moderate amount of habitat and moderate levels of connectivity between occupied areas. Much of the More-Preferred soils in this area are managed as turf farms, agricultural lands, or single-family homes. While not currently located in the Lacey UGA, development is still a threat in this portion of the Recovery Area.

YPG-East Recovery Unit

In the YPG-East Recovery Unit, JBLM owns large areas of habitat that are occupied by YPG and are managed in part for prairie characteristics. These include Johnson Prairie and the Weir/Tenalquot Prairie on the Rainier Training Areas 21 and 22. Military training does occur in these areas, but development is not likely to occur on these training areas. Additional conservation properties owned by CNLM (Deschutes River Preserve, Tenalquot Preserve) located adjacent to JBLM lands, are known to be occupied, are managed for purposes of prairie species conservation, and are not threatened by development.

Ruth Prairie, to the southwest of JBLM's lands, has one large, presumed-occupied area (>250 ac [>101 ha]) with moderate connectivity, mostly on More-Preferred soils. But a group of moderately sized and -

connected occupied areas located several miles to the northeast of Ruth Prairie occur mostly on Less-Preferred soils. None of the occupied areas are managed specifically for YPG conservation. Their rural locations mean development is not an imminent threat in either location.

On Yelm Prairie, nearly all of the More-Preferred soils are within the City of Yelm's UGA, and thus threatened by development. There are a handful of moderately sized areas of habitat that are presumed to be occupied, which are surrounded by areas of moderate to dense development. Habitat quantity and connectivity are moderate, but none of the areas are managed for YPG conservation. Overall, in this portion of the Recovery Area, development is not a threat.

YPG-South Recovery Unit

Within the YPG-South Recovery Unit, in the area west of I-5, the two units of the Scatter Creek WLA combined contain approximately 700 ac (283 ha) of habitat that are managed in part for prairie characteristics, and gophers are distributed across large portions of the WLA. Other occupied areas west of I-5 occur in more widely scattered, small to moderately sized amounts of habitat. Habitat in these smaller areas is not managed for YPG conservation. Except for on the WLA, development pressure is high.

In the area east of I-5, between I-5 and the City of Tenino, there are several small to moderately sized mitigation banks and set asides that are managed for YPG conservation but are separated from each other by areas of moderately dense rural residential development. There is also a small, conserved property owned by CNLM that is partly managed for YPG conservation. In contrast, there are two private properties adjacent to each other on Rock Prairie that are or will be managed for YPG conservation or are managed in a manner compatible with YPG conservation. These two properties support a combined total of more than 800 ac (324 ha) of land that support an unknown number of YPGs. Habitat quantity and connectivity in the Rock Prairie area are considered high, though overall connectivity between I-5 and the City of Tenino is moderate. Development pressure is not as great in this portion of the Recovery Unit since most of it is not within a UGA or city boundary.

In the Frost Prairie area, south of the City of Tenino, WDFW has an easement on a moderately sized area (70 ac (28 ha)), which is currently known to have gophers. Within it, there are about 60 ac (24 ha) of habitat . These acres will be managed for YPG conservation. There are open agricultural fields adjacent to this property that are also at least partially occupied by YPGs, so the habitat amount and connectivity are considered to be moderate. Development pressure is currently low in the Frost Prairie area of this Recovery Unit. Overall, in this portion of the Recovery Area, development is not a threat.

Summary of Small Population Effects for YPG

Small population effects are acting on a large portion of the YPG-North Recovery Unit, but not to as great an extent in the other two Recovery Units (YPG-East and YPG-South). There remains a sufficient amount of undeveloped acreage on preferred soils in the areas needed to establish all seven Reserves necessary for YPG recovery, although development is an imminent threat in many areas. Overall, small population effects are not considered to be a population-level threat for YPG.

PAST AND ONGOING CONSERVATION EFFORTS

Several actions have been completed or initiated since the listing to address recovery activities in the Recovery Implementation Strategy (RIS) (USFWS 2022b, entire). These include the permitting of 12 HCPs in the ranges of OPG and YPG, planning of several other HCPs, provisioning of recovery land acquisition grants in the range of YPG, and initiation of several DoD-related conservation actions.

Habitat Conservation Plans

The following HCPs have been completed since 2014 to manage habitat in the OPG and YPG ranges: Kaufman HCP 2016, Meier HCP 2016, McLain HCP 2017, Tveten HCP 2018 and 2021, Preserve HCP 2018, Capitol Boulevard Infrastructure Improvement 2019, DeChaux HCP 2020, M-Gopher 2020, Puget Sound Energy HCP 2020, and the Tumwater East Distribution Center (Puget West Inc.) HCP 2021, and the Thurston County HCP 2022. As of July 2022, the Bush Prairie HCP for OPG habitat near the Olympia Regional Airport is under development. Two other HCPs are currently undergoing internal review for publication and consultation.

Recovery Land Acquisition Grants

Section 6 of the Act offers four grant programs through the Cooperative Endangered Species Conservation Fund, which provides funding to States and Territories for species and habitat conservation activities on non-federal lands. Recovery Land Acquisition Grants provide financial assistance to State projects that acquire habitat for the purpose of conserving threatened and endangered species. In Washington State, the Service has awarded Recovery Land Acquisition grants to assist in funding the purchase of a 71-ac (29-ha) conservation easement in the YPG-South Recovery Unit on Frost Prairie, as well as 330 ac (135 ha) of habitat within a larger site on Rock Prairie. Grants have also been awarded by the Service to help fund the initiation of 150 ac (61 ha) of conservation lands or easements in the YPG-South Recovery Unit near the Scatter Creek WLA (WDFW 2019, p. 1).

Department of Defense

Coordination between the DoI and DoD, and/or the Service and JBLM to promote the conservation of the four subspecies of MPG and other prairie-dependent species has resulted in the development of multiple MOUs, section 7 consultations, and policy initiatives. These actions are aimed at increasing military mission flexibility through the conservation (recovery) of MPG and other prairie species' habitats to enhance the JBLM ACUB Program and south Puget Sound Sentinel Landscapes Partnership program, while the Conservation Policy Initiative supports the initiation of the DoD and Service Conservation Pilot Project. Additional information on these actions is included in the Military Training section, above.

SPECIES VIABILITY

Shaffer and Stein (2000, p. 307) stated, "Successful biodiversity conservation comes down to this: *Save some of everything, save enough to last*." In recovery planning, the Service uses the conservation principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 307, 309-310; Wolf et al. 2015, pp. 204-205; Smith et al. 2018, entire) to inform our approach in assessing the viability of threatened and endangered species. Viability is gauged by the ability to withstand disturbances of varying magnitude and duration (resiliency), the ability to withstand catastrophic events (redundancy), and the ability to adapt to changing environmental conditions (representation). The viability of a species is also dependent on the influence of new or continued stressors now and in the future that act to reduce the species' redundancy, representation, and resiliency.

Resiliency

Resiliency is the ability of a MPG subspecies to sustain local populations in the face of environmental variation and transient perturbations (Smith et al. 2018, p. 304). To be resilient, a subspecies must have healthy local populations with a degree of connectivity that are able to sustain themselves in good and bad years. We have delineated resiliency units for the four subspecies that are groups of potentially interbreeding individuals within a defined area (Figure 1 and Appendix C). Barriers to movement between groups often drove the delineation of separate resiliency units within a recovery area or recovery unit (see Dispersal Habitat section for more information on dispersal barriers). These groups may not interbreed within a single season or year, but over the course of two or more years due to the distances between the groups. But there are no impermeable barriers between the groups. This analysis of current resiliency is not intended to be reflect the expected locations of Reserves as recommended in the USFWS's recovery plan for the four subspecies of MPG, but rather how resilient the four subspecies are currently. For recovery, a minimum number of Reserves in specific areas will need to be created and maintained. The locations of those Reserves may or may not exactly coincide with the resiliency units described below. Reserves will each contain one local population as defined and described in the recovery plan (USFWS 2022a).

To evaluate the current condition within each resiliency unit, we defined High, Moderate, and Low conditions for each demographic and habitat parameter (Table 3). Condition categories were defined using the best available science and expert elicitation.

Redundancy

Redundancy is the ability of a MPG subspecies to withstand catastrophic events. Redundancy protects a subspecies against the unpredictable and highly consequential events for which adaptation is unlikely (Smith et al. 2018, p. 304). In short, it is about spreading the risk. Redundancy is best achieved through the establishment and maintenance of a minimum number of widely distributed Reserves (as defined and described in the MPG Recovery Plan (USFWS 2022a), within each subspecies' recovery area or recovery unit (Table 5). Having multiple Reserves reduces the likelihood that all local populations will be affected simultaneously. The more widely distributed the Reserves are, the less likely they are to possess similar vulnerabilities to a catastrophic event. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species. Thus, the greater redundancy a subspecies has, the more viable it will be. Furthermore, the greater number of Reserves and the greater diversity and distribution of those Reserves, the more likely it is that a subspecies' adaptive diversity and evolutionary flexibility will preserve the subspecies. Currently, no Reserves (USFWS 2020, pp. 12-13) have been established in any of the MPG subspecies Recovery Areas or Units.

Representation

Representation is the ability of a species to adapt to short- and long-term changes in its physical (climate and habitat conditions, habitat structure, etc.) and biological (pathogens, competitors, predators, etc.) environments over time; it is the evolutionary capacity or flexibility of a species (Smith et al. 2018, p. 304), and can be affected by genetic changes (e.g., changes in allele frequencies, or through the acquisition of novel alleles) or non-genetic changes (e.g., behavioral or physiological shifts). Representation is the amount of variation found in a species, and this variation (called adaptive diversity) is the source of species' adaptive capabilities. The greater the adaptive diversity, the more responsive and adaptable the species will be over time, thereby increasing its viability. Representation can be measured by examining the breadth of genetic and ecological diversity found within a species, i.e., the number and frequency of unique alleles within and among populations, which may reflect the physiological, ecological, and behavioral variation exhibited by a subspecies across its range. The greater representation, or diversity, a species has, the more it can adapt to changes (natural or human-caused) in its environment. Some genetic analyses have been performed on MPG specimens (Warheit and Whitcomb 2016, entire; King et al. 2013, entire), but most sample sizes were too small to provide site-specific genetic information. Research has shown genetic differences across the range of YPGs (Warheit and Whitcomb 2016, pp. 19), which informed our delineation of three Recovery Units (YPG-North, YPG-East, and YPG-South) within the YPG Recovery Area.

Within these recovery units, and for the three other subspecies of MPG, in the absence of site-specific genetic information, we evaluate representation based on the extent and variety of mapped soil types that each subspecies inhabits, which reflect the variety of environmental and climatic landscapes and vegetative communities across each subspecies' geographical range. The four subspecies of MPG each occupy a variety of soil types in differing landscapes and past and current management regimes. The types of soils present in each subspecies' range are a function of the geologic history of the area. The size, shape, and configuration of each soil type is similarly a function of the geologic history of the area. The different soil properties (e.g., depth, drainage, rockiness, sand, silt, loam, or clay content, geography NRCS 2022), combined with past and current management (e.g., if a naturally wet soil has been drained, if a lot of woody vegetation is present on the site) make them either easier or more difficult to burrow in, and lead to different vegetative communities these soils support or are capable of supporting. Occupied areas for each subspecies differ in terms of the amount and types of soils (Table 1) and subsequent vegetative communities within them, but because we don't have detailed and/or summarized vegetative community characteristics associated with every occupied area, we are limiting this discussion of representation to soil types only. This represents our best available science.

Resiliency, Redundancy, and Representation is presented for each subspecies, below.

Table 3. Matrix for Evaluating Current Condition within Each Resiliency Unit.

Demographic and Habitat Parameters Within Each Resiliency Unit	High Condition	Moderate Condition	Low Condition
Abundance	Abundance monitoring* indicates that abundance is high (>1,000 individuals)	Abundance monitoring indicates that abundance is moderate (50-1,000 individuals)	Abundance monitoring indicates that abundance is low (<50 individuals) or zero or abundance is unknown.
Trend	Trend monitoring shows a stable or increasing population trend		Little or no trend data are available **OR** trend monitoring shows a declining trend
Connectivity Between Occupied Areas	Most or all occupied areas** are connected by Protected Matrix-or-better quality habitat	Most of the occupied areas are connected by permeable dispersal habitat but not all are Protected Matrix-or-better quality habitat	Very few or none of the occupied areas are connected by Protected Matrix or permeable dispersal habitat
Medium- to High-Quality Habitat	Amount of medium- to high-quality habitat totals ≥500 ac (>202 ha). Soils at most or all occupied areas are More-Preferred	Amount of medium- to high-quality habitat totals 250-500 ac (101-202 ha). Soils at most occupied areas are More-Preferred, though some may be Less-Preferred.	Amount of medium- or high-quality habitat totals <250 ac (<101 ha). Soils may be More-Preferred or Less-Preferred.
Management	Management maintains the majority (>50%) of habitat in a medium- to high-quality condition.	Management maintains 25-50% of habitat in a medium- to high-quality condition	Management maintains 0-25% of the habitat in a medium- to high-quality condition

*See Olson 2017a, entire.

**Per the recovery plan, Reserves will be created from many of the occupied areas.

Table 4. Current Condition of the Resiliency Units for the Four Subspecies of Mazama Pocket Gopher.

			Demographic and Habitat Parameters					
RECOVERY AREA or RECOVERY UNIT		RESILIENCY UNITS	Abundance	Trend	Connectivity	Medium-or High- Quality Habitat	Management	Resiliency Level
RPPG RECOVERY AREA		AIA	HIGH	LOW	HIGH	HIGH	HIGH	HIGH
		SIA	HIGH	LOW	HIGH	HIGH	MODERATE	HIGH
		Roy	LOW	LOW	MODERATE	LOW	LOW	LOW
OPG RECOVERY AREA		East of I-5	HIGH	LOW	HIGH	MODERATE	MODERATE	MODERATE
		West of I-5	LOW	LOW	LOW	LOW	LOW	LOW
TPG RECOVERY AREA		West Rocky Prairie*	LOW*	LOW *	HIGH	MODERATE	HIGH	LOW*
		Rocky Prairie	LOW	LOW	MODERATE	MODERATE	LOW	LOW
YPG RECOVERY AREA	YPG-NORTH RECOVERY UNIT	Chambers Prairie	LOW	LOW	MODERATE	MODERATE	LOW	LOW
		St. Martin's	LOW	LOW	MODERATE	LOW	LOW	LOW
		Mushroom Corner	LOW	LOW	MODERATE	LOW	LOW	LOW
		Rich Rd/Yelm Hwy	LOW	LOW	LOW	LOW	LOW	LOW
	YPG-EAST RECOVERY UNIT	Weir/Tenalquot Prairies	HIGH	LOW	HIGH	HIGH	HIGH	HIGH
		Johnson Prairie	HIGH	LOW	HIGH	LOW	HIGH	MODERATE
		Yelm Prairie	LOW	LOW	MODERATE	MODERATE	LOW	LOW
		Morris Rd./ 123rd Ave.	LOW	LOW	MODERATE	MODERATE	LOW	LOW
		Ruth Prairie	LOW	LOW	MODERATE	LOW	LOW	LOW
	YPG-SOUTH RECOVERY UNIT	East of I-5	HIGH	LOW	MODERATE	HIGH	MODERATE	MODERATE
		West of I-5	HIGH	LOW	MODERATE	HIGH	MODERATE	MODERATE
		Frost Prairie	LOW	LOW	MODERATE	MODERATE	LOW	LOW

*Unknown if TPG occur in this resiliency unit, therefore the overall score was determined to be low for TPG, despite the high and moderate scores for habitat-related parameters. We did not rank this resiliency unit for the benefit of YPG (which occur on Wolf Haven) or OPG (which likely occur on both Wolf Haven and the West Rocky Prairie WLA).

Roy Prairie Pocket Gopher

RPPG Resiliency

There are three resiliency units in the RPPG Recovery Area: AIA, SIA, and Roy.

AIA Resiliency Unit: Approximately 4,000 ac (1,619 ha) in the center of the AIA Resiliency Unit (part of the 91st Division Prairie Training Area (TA)) is regularly bombarded and subject to wildfires associated with live fire training. Hundreds to thousands of acres around the perimeter of the AIA are actively managed to support prairie species and habitat, including habitat for RPPG (JBLM 2021, entire). Presence-absence or similar-type surveys for RPPG are conducted at several TAs north (TAs1-5) and east (TA6) of the AIA, the Central Impact Area, and surrounding TAs. There are a number of small, isolated training areas north of the AIA and in and around the Central Impact Area (northeast of the AIA) where RPPG are occasionally detected (. The majority of these occupied areas are considered too small and fragmented to persist on their own or to significantly contribute to the resiliency of the AIA Resiliency Unit. No pocket gophers have been detected at any of the military airfields (McChord and Gray Army, north of the AIA) or the 13th Division Prairie (TA14) east of the AIA (between SR 7 and SR 507). Although there are no trend data for this resiliency unit, the overall current condition of this unit is high due to assumed high abundance (based on survey results conducted or funded by JBLM), connectivity, habitat quality, and management (Table 4).

SIA Resiliency Unit: The SIA (a.k.a. Marion Prairie) Resiliency Unit (part of the SIA Training Area) contains hundreds of acres of preferred soils, although the central portion of the resiliency unit consists of multiple firing ranges. Vegetation is kept low for purposes of fire prevention and visibility, which allows RPPGs to occupy the area (e.g., Olson 2017, p. 41). Vegetation management occurs on areas around the perimeter of the firing ranges to achieve prairie habitat benchmarks (JBLM 2021, entire). Overall, resiliency of this unit is high due to high abundance and management, a lack of trend data, but high connectivity and amount of habitat (Table 4).

Roy Resiliency Unit: The Roy Resiliency Unit occurs on private properties around the town of Roy, and past survey efforts in that area are limited. The Biological Assessment for the JBLM Credit-Debit Framework Programmatic states: “Suitable sites for compensatory mitigation will be found only in Pierce County, which, having less area of preferred soils and a higher proportion of these soils already developed, has fewer opportunities for conservation. Potential sites with preferred soils have been identified by Dunn and Treadwell (2017); of these, four properties have high suitability for gopher; three of these properties have the same landowner and are currently occupied by gophers. Thirteen other properties (one occupied) might potentially support gopher[s]” (JBLM, BA p. 26). Despite some patches of More-Preferred soil types and open areas in and around the town of Roy, there are very few occupied areas in the resiliency unit, and they are isolated and separated from each other. Overall, the current condition of this resiliency unit is low due to moderate connectivity, low amount of habitat and management, and a lack of abundance and trend data (Table 4).

RPPG Redundancy

Of the three resiliency units in the RPPG Recovery Area, the AIA is in highly resilient, SIA is moderately resilient, and Roy has low resilience (Table 6). Catastrophic events are unlikely to cause the

RPPG subspecies to become extinct because of the current distribution of occupied areas within the Recovery Area and because there are multiple resiliency units in high to moderate condition across the subspecies' range.

RPPG Representation

RPPG are currently known to occur in three resiliency units (AIA, SIA, and Roy) within their range (Map 1 in Appendix C), on eight different soil types (Table 1). Two are More-Preferred soils (Nisqually loamy fine sand (0-3% slopes)/Nisqually loamy sand and Spanaway gravelly sandy loam (0-3% slopes and 3-15% slopes)), and six are Less-Preferred soils (Everett-Spanaway complex (3-15% slopes), Everett-Spanaway-Spana complex (0-30% slopes [though they are not as likely to occupy slopes greater than 15%]), Indianola loamy sand (0-6% slopes), McChord-Everett complex (0-3% and 3-15% slopes), Norma fine sandy loam, and Spana-Spanaway-Nisqually complex (0-2% slopes)). The vast majority of the occupied areas (hundreds to thousands of acres) within the range of this subspecies occur on Nisqually and Spanaway soils, on the AIA and SIA, which coincide with the majority of open prairies/grasslands within the range of the species, and which are managed to maintain prairie characteristics. RPPG occur in three resiliency units (AIA, SIA, and Roy), but the majority of occupied habitat occurs in two of the three (AIA and SIA) resiliency units. Therefore, we consider RPPG to have a moderate level of representation.

Olympia Pocket Gopher

OPG Resiliency

There are two resiliency units in the OPG Recovery Area: West of I-5 and East of I-5.

- *West of I-5 Resiliency Unit:* The West of I-5 Resiliency Unit includes that portion of the Recovery Area that is west of I-5 but centered on the More-Preferred soils in the northern portion of the OPG Recovery Area. Abundance, connectivity, habitat quantity, and management in this unit are low, due to the isolated nature of occupied areas that have not been monitored and which mostly are not managed for OPG conservation. There is one 70-ac (28 ha) mitigation parcel that is mowed, which may in future by managed for prairie characteristics. There are no trend data for this unit. Overall, the resiliency of this unit is low (Table 4).

- *East of I-5 Resiliency Unit:* The East of I-5 Resiliency Unit includes that portion of the Recovery Area that is east of I-5. The number of OPGs at the Olympia Airport is likely the largest at a single site for this subspecies. There are no trend data for this occupied area. Although this site is not managed to completely reduce threats to OPGs, the Airport's wildlife hazard management program limits the numbers of predators on the airport, which likely benefits OPG, as does their mowing regime, which prevents shrubs and trees from encroaching on the airfield. Based on its size and past area-wide surveys, we assume abundance is high. The amount of habitat in the resilient unit is high, but connectivity moderate, due to poor connectivity between the airport area and other occupied areas in the unit. Management is moderate; the largest area of habitat is at the airport, and it is likely that some habitat at the Olympia Airport will be permanently lost in the future to accommodate aviation-related development needs. The 20-Year Master Plan for the Olympia Regional Airport (Port of Olympia 2013) is currently in the process of being updated and will be addressed in an HCP they are forming with the

City of Tumwater. Proposed alternatives considered in the 2021 Master Plan approval process and HCP include the potential construction of new taxiways, general aviation facilities, additional aircraft hangers, and other aviation-related industries that could cause the permanent loss of up to 340 ac (138 ha) of occupied gopher habitat on the airfield over the next 30 years (Port of Olympia 2021). This represents nearly half of the occupied grassland habitat on the airfield, which is also designated critical habitat for the OPG.

There are several small mitigation parcels in the unit, many of which are only mowed to remove woody vegetation but are not otherwise managed to maintain prairie characteristics. There is at least one slightly larger mitigation parcel in the southern portion of this unit that will be managed for prairie characteristics, but it is not well connected to the airport. Overall, the resiliency of this unit is moderate (Table 4).

Individuals of OPG from this resiliency unit were translocated to Wolf Haven and West Rocky Prairie WLA prior to the federal listing of the four subspecies of MPG. Although regular surveys have been conducted in these areas since translocation (e.g., Olson 2017, p. 41), no genetics studies have been conducted to determine which subspecies or subspecies hybrid may occur at these sites, or if there has been any movement of individuals (TPG, OPG, YPG) between sites. Any OPGs that may occur on West Rocky Prairie WLA or Wolf Haven are not able to contribute to the current condition of the OPG East of I-5 Resiliency Unit because the translocation sites are too far away and there is no connectivity.

OPG Redundancy

Of the two resiliency units in the OPG Recovery Area, the West of I-5 Resiliency Unit has low resiliency, and the East of I-5 Resiliency Unit is moderately resilient (Table 6). Catastrophic events are somewhat unlikely to cause the OPG subspecies to become extinct because of the current distribution of occupied areas within the Recovery Area and because there are two resiliency units, even if only one is currently in moderate condition.

OPG Representation

OPG are currently known to occur in two resiliency units (West of I-5 and East of I-5) within their range (Map 2 in Appendix C), on 10 different soil types (Table 1). Three are More-Preferred soils (Cagey loamy sand, Indianola loamy sand (0-3% slopes), and Nisqually loamy fine sand (0-3% and 3-15% slopes)), and seven are Less-Preferred soils (Alderwood gravelly sandy loam (0-3% and 3-15% slopes), Everett very gravelly sandy loam (0-3% and 3-15% slopes), Indianola loamy sand (3-15% slopes), McKenna gravelly silt loam (0-5% slopes), Norma fine sandy loam and silt loam [usually found on this soil type if it has been drained], and Yelm fine sandy loam (0-3% slopes). Occupied areas within the range of this subspecies occur mainly on the More-Preferred Nisqually, Cagey, and Indianola soil types. The largest occupied area, at the Olympia Airport in the OPG East of I-5 Resiliency Unit, is approximately 600 ac (242 ha) in size and occurs on the More-Preferred Nisqually and Indianola soils. In the OPG West of I-5 Resiliency Unit, occupied areas are smaller and more isolated from each other. These occupied areas occur mainly on the More-Preferred Nisqually and Cagey soil types. OPG occur in two resiliency units (West of I-5 and East of I-5) and reside mostly on three More-Preferred soil types. Only one resiliency unit (East of I-5) has a large, occupied area. We consider OPG to have a moderate level of representation.

Tenino Pocket Gopher

TPG Resiliency

There are two resiliency units in the TPG Recovery Area: Rocky Prairie and West Rocky Prairie.

- *Rocky Prairie Resiliency Unit:* The Rocky Prairie Resiliency Unit is located north of Offut Lake Road SE, on both sides of Old Highway 99 SE. The Rocky Prairie NAP is in this resiliency unit and is the only occupied area within the resiliency unit with more than years of presence-absence or similar screening-type surveys, i.e., where enough years of surveys have been conducted to show site persistence. However, the amount of managed prairie habitat on the NAP is less than 40 ac (16 ha). Properties surrounding the NAP include private agricultural lands and designated critical habitat on an adjacent parcel that is partly being managed as a gravel pit. Only the NAP is being managed to maintain prairie characteristics, and other properties in the unit have varying levels and types of management, many which are not compatible with TPG conservation. There are no trend data for this resiliency unit, and abundance is assumed to be low since the amount of and density of mounding on the NAP is low based on repeat years of presence-absence surveys, and year-to-year occupancy on the NAP has at times been sporadic (Stinson 2020, p. 30). It is possible that TPGs on the NAP are part of a larger source population, perhaps on the CHU to the east or other properties nearby. Habitat quantity and connectivity in the unit are moderate, and management across the unit is low. Overall, the resiliency of this unit is low (Table 4).

- *West Rocky Prairie Resiliency Unit:* The West Rocky Prairie Resiliency Unit is located south of Offut Lake Road SE, on both sides of Old Highway 99 SE. The unit includes the West Rocky Prairie WLA and Wolf Haven, both of which are occupied by pocket gophers, but it is not known if TPG occur there; they were not historically known to occur on this area prior to translocation of individuals of OPG and YPG onto Wolf Haven, and OPG onto West Rocky Prairie WLA. Both the WLA and Wolf Haven are managed to maintain prairie species. Properties on gopher soils surrounding and between these two areas are not managed for pocket gopher conservation, and include areas of trees, shrubs, agricultural lands, and neighborhoods. Habitat connectivity and management are high in the unit, due to the amount of habitat managed by WDFW on the WLA (about 200 ac (81 ha)); Wolf Haven manages about 30 ac (12 ha). Quantity of habitat is moderate, while abundance of TPG in the unit is low because it is unknown if there are TPG in the unit. See write-up in the O*PG East of I-5 Resiliency Unit* section, above, for more information. Overall, the resiliency of this unit is low (Table 4).

TPG Redundancy

Both resiliency units in the TPG Recovery Area (Rocky Prairie and West Rocky Prairie) have low resiliency (Table 6). Catastrophic events could cause the TPG subspecies to become extinct due to the current distribution of TPG-occupied areas within the Recovery Area and because there are two resiliency units, but both are currently in a low condition.

TPG Representation

TPG are currently known to occur on one (Rocky Prairie) of two Resiliency Units (Rocky Prairie and West Rocky Prairie) within their range (Map 3 of Appendix C), on four different soil types (Table 1). It is unknown if TPG occur in the West Rocky Prairie Resiliency Unit

- *Rocky Prairie Resiliency Unit*: TPG are currently known to occur on four different soil types (Table 1) in this Resiliency Unit. Three are More-Preferred soils (Nisqually loamy fine sand (3-15% slopes), Spanaway gravelly sandy loam (3-15% slopes), and Spanaway-Nisqually complex (2-10% slopes), and one is a Less-Preferred soil (Everett very gravelly sandy loam (0-3% and 3-15% slopes). The largest area of preferred soils in this resiliency unit are the More-Preferred Nisqually and Spanaway-Nisqually complex soils. TPG are known to occur on the Rocky Prairie NAP, which contains less than 40 ac (16 ha) of habitat, and on smaller isolated patches of habitat nearby in the resiliency unit. Areas adjacent to the NAP, including the TPG CHU, have >500 ac (202 ha) of preferred soils and are presumed occupied due to connectivity with the NAP and suitable vegetative cover.

- *West Rocky Prairie Resiliency Unit*: It is unknown if TPG occupy this resiliency unit, however, pocket gophers here occur on five different soil types. Three are More-Preferred soils (Nisqually loamy fine sand (3-15% slopes), Spanaway gravelly sandy loam (0-3% slopes), and Spanaway-Nisqually complex (2-10% slopes)), and two are Less-preferred soils (Everett very gravelly sandy loam (3-15% slopes) and Norma silt loam). The largest area of occupancy (about 240 ac (97 ha)) is on the West Rocky WLA on the More-Preferred Spanaway-Nisqually complex.

While there are two resiliency units (Rocky Prairie and West Rocky Prairie) in the range of TPG, only one is known for certain to be occupied by TPG; it is unknown if TPG occupy the other resiliency unit. TPG are known to occur mainly on two More-Preferred soil types in the Rocky Prairie resiliency unit, and MPG occur mainly on a single More-Preferred soil type in the West Rocky Prairie resiliency unit. We consider TPG to have a low level of representation.

Yelm Pocket Gopher

YPG Resiliency

There are three Recovery Units within the YPG Recovery Area: YPG-North, YPG-East, and YPG-South.

YPG-North Recovery Unit

Within the YPG-North Recovery Unit, there are four Resiliency Units: Rich Rd/Yelm Hwy, St. Martin's, Mushroom Corner, and Chambers Prairie.

- *Rich Rd/Yelm Hwy Resiliency Unit:* This resiliency unit is centered on its named intersection. There are three occupied areas in the vicinity that are each 50 ac (12 ha) or less in size. They are isolated from each other by developed neighborhoods. On one site, gophers are known to only occur on the outer perimeter of the area due to past removal of all topsoil in the center. There are two small set asides in this area (0.2 and 1.2 ac [0.08 and 0.49 ha]) that are regularly mowed. There are no local population abundance or trend data for this Resiliency Unit. Abundance, trend, connectivity, amount of habitat, and management are all low, and so the resiliency of this unit is low (Table 4).

Individuals of YPG from this resiliency unit were translocated to Wolf Haven prior to the federal listing of the four subspecies of MPG. Although regular surveys show continued MPG occupancy of this area since translocation, no genetics studies have been conducted to determine which subspecies or subspecies hybrid may occur at this, or if there has been any movement of individuals (TPG, OPG, YPG) between this and other sites in the TPG Recovery Area. Any YPGs that may occur on Wolf Haven are not able to contribute to the current condition of the YPG Rich Rd/Yelm Hwy Resiliency Unit because Wolf Haven is too far away and there is no connectivity.

- *St. Martin's Resiliency Unit:* This resiliency unit is centered around St. Martin's University. Most of the occupied areas in this unit are on Less-Preferred soils. There are fewer than 50 ac (12 ha) of open (free of trees, undeveloped, and on gopher soils) areas in this unit, and there are no local population trend or abundance data for occupied areas. Connectivity between the various occupied areas is moderate. Twenty-six acres of grassland on St. Martin's University campus will be maintained for the next 20 years, as part of their HCP agreement (Krippner Consulting 2021, pp. 30-31). Overall, the resiliency of this unit is low (Table 4).

- *Mushroom Corner Resiliency Unit:* The Mushroom Corner Resiliency Unit is centered on the intersection of SR-510 (Pacific Ave. SE) and Marvin Road SE, in Lacey. There is one occupied area about 45 ac (18 ha) in size, but it is not managed for YPG conservation. Connectivity in the area is moderate, as there is only one area of occupancy. There are no local population abundance or trend data for this unit. Habitat amount and management are low. Overall, the resiliency of this unit is low (Table 4).

- *Chambers Prairie Resiliency Unit:* The Chambers Prairie Resiliency Unit is located around Kelly's Corner in Lacey. There are multiple occupied areas in the unit, largely on agricultural lands and on large single-family parcels. The several occupied areas are separated from each other by turf farms, trees and shrubs, row crop farms, tree farms, and neighborhoods. None of the areas are managed specifically for YPG conservation, and there are no abundance or trend data for the unit. Habitat amount and connectivity are moderate, but overall resiliency of this unit is low (Table 4).

YPG-East Recovery Unit

Within the YPG-East Recovery Unit there are five resiliency units: Johnson Prairie, Weir/Tenalquot Prairies, Ruth Prairie, Morris Rd/123rd Ave, and Yelm Prairie.

- *Johnson Prairie Resiliency Unit:* The Johnson Prairie Resiliency Unit is located on JBLM; it is part of Rainier Training Area 22. The unit contains <250 ac (101 ha) of habitat that is managed for prairie characteristics, and although the habitat quality is high, the amount of habitat is considered to be low, because it is smaller than what is expected to be able to support a self-sustaining local population (i.e., >1,000 individuals (see Appendix B)). There are no local population abundance and trend data for this unit, but based on JBLM presence-absence surveys (Hill et al. 2017, p. 16), we assume abundance is high, and management of habitat within the unit is high. Overall, the resiliency of this unit is moderate (Table 4).

- *Weir/Tenalquot Prairies Resiliency Unit:* The Weir/Tenalquot Prairies Resiliency Unit is located largely on Rainier Training Areas 21, 22, and 23 on JBLM, and includes private lands, as well as conservation properties owned and managed by CNLM. The amount of habitat (>1,500 ac (607 ha)), management, and connectivity in the unit are high. JBLM manages most of their lands in this unit for purposes of maintaining prairie characteristics, although military training does occur here. Based on surveys by JBLM on Training Areas 21, 22, and 23 (Hill et al. 2017, p. 16), and by WDFW on Tenalquot Preserve (Olson 2017, p. 41), we assume abundance is high. Adjacent conservation parcels (Deschutes River Preserve and Tenalquot Prairie Preserve are similarly managed, although the Deschutes River Preserve is newer and has more years to go before it achieves its goals. Overall, the resiliency of this unit is high (Table 4).

- *Ruth Prairie Resiliency Unit:* The Ruth Prairie Resiliency Unit is situated on Ruth Prairie, northeast of the town of Vail. There are >300 ac (>121 ha) of open agricultural lands in the area that are at least partially occupied. There are no local population abundance or trend data for this unit, and occupied areas in this unit are not managed for purposes of YPG conservation. Connectivity in the unit is moderate, but habitat amount and management are low. Overall, the resiliency of this unit is low (Table 4).

- *Morris Rd/123rd Ave Resiliency Unit:* This resiliency unit is more-or-less centered over the crossroads of Morris Road SE and 123rd Ave. SE, south of the City of Yelm. There are multiple occupied areas on large areas of open agricultural lands (>500 ac (>202 ha)). Almost all the soils in the unit are Less-Preferred, meaning if a Reserve were to be established here, it would likely take more acres of lands than if they were all More-Preferred soils. Connectivity in the unit is moderate, since development in the unit is not very dense. There are no local population abundance or trend data for this unit, and occupied areas in this unit are not managed for purposes of YPG conservation. Habitat amount is moderate, but management is low. Overall, the resiliency of this unit is low (Table 4).

- *Yelm Prairie Resiliency Unit:* The Yelm Prairie Resiliency Unit is centered on the City of Yelm and the historic Yelm Prairie, which is a large area of More-Preferred soils. There are a handful of moderately sized areas of habitat that are presumed to be occupied, surrounded by areas of moderately dense development. There are additional open lands (no development, no trees) where occupancy is unknown. Connectivity and habitat amount are moderate in this unit. There are no local population abundance or trend data for this unit, and occupied areas are not managed for purposes of YPG conservation. Overall, the resiliency of this unit is low (Table 4).

YPG-South Recovery Unit

Within the YPG-South Recovery Unit there are three resiliency units: West of I-5, East of I-5, and Frost Prairie.

- *West of I-5 Resiliency Unit:* The West of I-5 Resiliency Unit extends from the Black River, east to I-5 across Baker and Grand Mound Prairies. The two units of the Scatter Creek WLA occur in this unit and, when combined, contain approximately 700 ac (283 ha) of habitat that are managed in part for prairie characteristics. YPGs are distributed across large portions of both WLA units. Other occupied areas in the resiliency unit occur in more widely scattered, small to moderately sized amounts of open agricultural lands. These smaller occupied areas are not managed for YPG conservation. Based on presence-absence surveys conducted on the WLA by WDFW (Olson 2017, p. 41), abundance is considered to be high. There are no trend data for this site, although gophers have been known to occupy the site for several years. Connectivity and management across the unit are considered moderate, while the amount of habitat is considered high. Overall, the resiliency of this unit is moderate (Table 4).

- *East of I-5 Resiliency Unit:* In the East of I-5 Resiliency Unit, there are several small (~10 ac (4 ha) to moderately sized (140 ac (57 ha)) occupied mitigation parcels, set asides, and a CNLM-owned future mitigation bank, all of which are managed for YPG conservation, but which are separated from each other by areas of moderately dense development. Some presence-absence surveys have been conducted on the mitigation bank, which is still in the process of being stood up. Current abundance on the bank is unknown, but has been moderate in the past, based on the size of area occupied. There are also two conserved properties on Violet Prairie either owned or managed by CNLM, of which about 90 ac (36 ha) are partially occupied by YPG and managed in part for YPG conservation. In contrast, there are two private properties adjacent to each other on Rock Prairie (west of the City of Tenino) that are being or will be managed either for YPG conservation or in a manner compatible with YPG conservation. These two properties support a combined total of more than 800 ac (324 ha) of land, that have some number of YPGs on them; one is in an NRCS grassland reserve program easement, and the other is owned by WDFW. There are no local population abundance or trend data for this large area, although abundance on Rock Prairie (both properties) and CNLM's managed mitigation property appears to be high based on results of presence-absence surveys. There are no local population abundance or trend data available for other areas in the unit. Overall abundance for the unit is considered high as is habitat amount. Connectivity and management across the unit are considered moderate. Overall, the resiliency of this unit is moderate (Table 4).

- Frost Prairie Resiliency Unit: In the Frost Prairie Resiliency Unit, there is only one moderately sized area (about 70 ac (28 ha)) which has gophers at least on a portion of it. About 60 ac (24 ha) of this area is habitat under a recently acquired conservation easement with WDFW and will be managed for YPG conservation. There are open agricultural fields adjacent to this property that may support some number of gophers, but there are no presence-absence or screening-type survey data available. There is a conservation easement owned by CNLM on a property to the west of SR-507 that sits on More-Preferred soils, but years of presence-absence or opportunistic surveys in this area have found no evidence of occupancy by YPGs. CNLM will continue to manage this property with the goal of supporting multiple prairie species, hopefully including YPG one day. Abundance and management on the currently occupied areas is low, while the amount of habitat and connectivity is moderate. Overall, the resiliency of this unit is low (Table 4).

<u>YPG Redundancy</u>

There are 12 resiliency units across the subspecies' range. One out of the 12 resiliency units is highly resilient, 3 are moderately resilient, and the remaining 8 have a low resiliency (Table 6). Catastrophic events are unlikely to cause the YPG subspecies to become extinct because of the current distribution of occupied areas within the Recovery Area and because there are four resiliency units in high to moderate condition across the subspecies' range.

YPG Representation

YPG are currently known to occur in three Recovery Units (YPG-North, YPG-East, and YPG-South) and 12 resiliency units (Map 4 in Appendix C) within their range, on 15 different soil types (Table 1). Five are More-Preferred soils (Cagey loamy sand, Indianola loamy sand (0-3% slopes), Nisqually loamy fine sand (0-3% and 3-15% slopes), Spanaway gravelly sandy loam (0-3% and 3-15% slopes), and Spanaway-Nisqually complex (2-10% slopes)), and 10 are Less-Preferred soils (Alderwood gravelly sandy loam (0-3% and 3-15% slopes), Everett very gravelly sandy loam (0-3% and 3-15% slopes), Indianola loamy sand (3-15% slopes), Kapowsin silt loam (3-15% slopes), McKenna gravelly silt loam (0-5% slopes), Norma fine sandy loam and silt loam [usually found on this soil type if it has been drained], Spana gravelly loam, Spanaway stony sandy loam (0-3% and 3-15% slopes), and Yelm fine sandy loam (0-3% and 3-15% slopes). Occupied areas within the range of this subspecies occur mainly on the More-Preferred Spanaway and Spanaway-Nisqually soil types. The largest occupied areas occur at the Weir/Tenalquot Prairie on JBLM (approximately 1,500 ac (607 ha)) in the YPG-East Weir/Tenalquot Prairie Resiliency Unit, Johnson Prairie (approximately 200 ac (81 ha)) in the YPG-East Johnson Prairie Resiliency Unit, Rock Prairie (approximately 900 ac (364 ha)) in the YPG-South, East of I-5 Resiliency Unit, and Scatter Creek WLA proximity (approximately 800 ac (324 ha)) in the YPG-South, West of I-5 Resiliency Unit. These large, occupied areas occur on the More-Preferred Nisqually, Spanaway, and Spanaway-Nisqually soils. Other YPG resiliency units have smaller occupied areas that are more isolated from each other. These occupied areas occur mainly on the More-Preferred Spanaway, Nisqually, Spanaway-Nisqually, and Cagey soil types. YPG occur in 12 resiliency units (Map 4 in Appendix C) and reside mostly on three More-Preferred soil types. Four of the 12 resiliency units have large, occupied areas. Genetic analyses by WDFW (Warheit and Whitcomb 2016, p. 19) have shown genetic differences within this subspecies, between YPGs at Chambers Prairie (YPG-North Recovery Unit), Yelm Prairie (YPG-East Yelm Prairie Resiliency Unit), Tenalquot Prairie (YPG-East Johnson Prairie and YPG-East Weir/Tenalquot Prairies Resiliency Units), Frost Prairie (YPG-South Frost Prairie Resiliency Unit), and Baker/Grand Mound/Rock Prairies (YPG-South, West of I-5 and YPG-South, East of I-5 Resiliency Units). We consider YPG to have a moderate level of representation.

Table 5. Minimum Number of Reserves Required for Recovery of Each of the Four Subspecies of MPG.

RECOVERY AREA or RECOVERY UNIT		Minimum Number of Reserves Needed
RPPG RECOVERY AREA		3
OPG RECOVERY AREA		3
TPG RECOVERY AREA		2
YPG RECOVERY AREA	YPG-NORTH RECOVERY UNIT	2
	YPG-EAST RECOVERY UNIT	2
	YPG-SOUTH RECOVERY UNIT	3

Table 6. Current Condition of Recovery Areas/Recovery Units for the Four Subspecies of MPG.

RECOVERY AREA or RECOVERYUNIT		RESILIENCY UNIT	CURRENT CONDITION
RPPG RECOVERY AREA		AIA	HIGH
		SIA	HIGH
		Roy	LOW
OPG RECOVERY AREA		East of I-5	MODERATE
		West of I-5	LOW
TPG RECOVERY AREA		West Rocky Prairie	LOW
		Rocky Prairie	LOW
YPG RECOVERY AREA	YPG-NORTH RECOVERY UNIT	Chambers Prairie	LOW
		St. Martin's	LOW
		Mushroom Corner	LOW
		Rich Rd/Yelm Hwy	LOW
	YPG-EAST RECOVERY UNIT	Weir/Tenalquot Prairies	HIGH
		Johnson Prairie	MODERATE
		Yelm Prairie	LOW
		Morris Rd./ 123rd Ave.	LOW
		Ruth Prairie	LOW
	YPG-SOUTH RECOVERY UNIT	East of I-5	MODERATE
		West of I-5	MODERATE
		Frost Prairie	LOW

Summary (see Table 7)
We conclude that the current condition of:

- RPPG is characterized by three resiliency units, two with high resiliency and one with low resiliency. RPPG have moderate levels of redundancy and representation;
- OPG is characterized by two resiliency units with moderate and low resiliency. OPG have moderate levels of redundancy and representation;
- TPG is characterized by two resiliency units, each with low resiliency. TPG have low levels of redundancy and representation; and,
- YPG is characterized by 12 resiliency units with one high, three moderate, and eight low resiliency. YPG have a moderate levels of redundancy and representation.

Table 7. Summary of Current Viability of the Four Subspecies of MPG

Viability Component	Needs	Current Condition			
		RPPG	OPG	TPG	YPG
Resiliency *Ability to withstand demographic and environmental disturbances (i.e., stochastic events)*	▪Large areas of medium- to high quality habitat ▪Appropriate management over the long-term for MPGs ▪Habitat connectivity within and/or between occupied areas	**High**	**Low**	**Low**	**Low**
Redundancy *Ability to withstand catastrophic events*	Multiple resilient populations in the subspecies' range	**Moderate**	**Moderate**	**Low**	**Moderate**
Representation *Sufficient genetic and ecological diversity to maintain adaptive potential in a changing environment*	Occupancy in a variety of soil types and associated landscapes distributed across the subspecies' range*	**Moderate**	**Moderate**	**Low**	**Moderate**

*Some genetic differences known for YPG

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APPENDIX A. Glossary

<u>Abundance and abundance monitoring</u>: The number of animals for a resiliency unit is measured as a collective score of abundance across all occupied areas within a unit. The total number of mounds in an occupied area is not directly equivalent to the abundance (number) of individual animals at a site. An estimate of abundance can be accurately determined using Olson (2017, pp. 10, 12-13). This paper also discusses methodologies or guidelines for general occupancy surveys, plot-based surveys, and transect surveys. Multiple years of abundance estimation surveys at a site can be used to determine local population trend (Olson 2017, p. 10). Screening-type surveys, whose purpose is to determine presence only, and which are typically conducted over a 1-2-year time frame, are not adequate to determine abundance for purposes of this analysis. The number of mounds in an area do not directly equate to the number of individuals at a site, since a single gopher may produce dozens of mounds in a season (Richens 1966, entire). GIS maps of screening results often display repeat years of mounding data, which may overestimate the number of mounds at a site. Not all areas screened include GPS data for each mound, which may underestimate the number of mounds at a site. For these reasons, we do not use screening survey data to determine abundance. Areas with no survey information are assumed to be unoccupied for purposes of this analysis.

<u>Less-Preferred soils</u>: Soil types that MPGs use relatively less than those that are More-Preferred, considering how many accessible acres of each gopher soil type exist on the landscape.

<u>Local population</u>: An occupied area within a subspecies' range containing a group of interbreeding individuals. There are typically multiple local populations within the range of a subspecies of MPG. A Reserve, once established, will contain a single local population.

<u>Management appropriate for MPG conservation</u>: Land management activities whose purpose is to improve and maintain habitat for MPGs. Appropriate management for MPG conservation includes areas protected from further development or conversion and managed for MPGs over the long term with the goal of maintaining medium- or high-quality habitat sufficient to support a self-sustaining local population of MPGs.

<u>Medium- to high-quality habitat</u>:

> **<u>High-quality habitat</u>** meets the following minimum requirements: 1) consists of More-Preferred and/or Less-Preferred soils, with mapped More-Preferred soils making up greater than or equal to 50 percent by area; 2) native soil profile and structure is unaltered; 3) there is less than 5 percent cover in the form of trees, and less than 10 percent cover in the form of woody shrubs; 4) there is greater than 85 percent herbaceous cover; 5) there is 10 percent or greater native herbaceous cover by area; and 6) there is less than or equal to 5 percent invasive herbaceous plant species cover by area, focusing on those plants which negatively impact MPG habitat.

Medium-quality habitat meets the following minimum requirements: 1) consists of More-Preferred and/or Less-Preferred soils (Appendix A in USFWS 2018), with mapped More-Preferred soils making up less than 50 percent by area; 2) native soil profile and structure is mostly unaltered, or has been restored; 3) there is less than 5 percent cover in the form of trees (unless native oak savanna, with less than 25 percent cover of oaks [*Quercus garryana*]), and less than 25 percent cover in the form of woody shrubs (other than native oak and kinnikinnick [*Arctostaphylos uva-ursi*]); 4) there is greater than 70 percent herbaceous cover; 5) there is 10 percent or greater native herbaceous cover by area; and 6) there is greater than 5 percent but less than or equal to 10 percent invasive herbaceous plant species cover by area, focusing on those plants that negatively impact MPG foraging or burrowing habitat.

Limiting the cover of invasive trees and woody shrubs and managing for increased herbaceous cover within suitable MPG habitat will improve foraging habitat for MPGs. Managing towards more native vegetative cover will improve overall heterogeneity on each reserve. At a landscape scale, environmental heterogeneity across locations has been shown to increase the stability of ecosystem functions (Wang and Loreau 2014, p. 898). Ecosystem stability (either an ecosystem's ability to endure perturbations and return to equilibrium, or its ability to resist perturbations altogether), is another term for resilience (Connell and Sousa 1983, p. 790). Invasive species cover of greater than 5 but less than 10 percent is approximately equivalent to a rating of "Fair," while cover of less than 5 percent is approximately equivalent to a rating of "Good" in Rocchio et al. (2018, p. 49).

More-Preferred soil: More-Preferred soil types are those that MPGs use relatively more than those that are Less-Preferred, considering how many accessible acres of each gopher soil type exist on the landscape.

Occupied areas: Areas of contiguous habitat that are occupied by gophers, regardless of ownership. Also known as "local populations."

Permeable dispersal habitat: Dispersal habitat has that has few or no barriers to gopher movement. Dispersal habitat may occur within an occupied area, or between occupied areas. Barriers may be permeable, meaning that they may impede movement from place to place without completely blocking it, or they may be impermeable, meaning they cannot be crossed. Permeable barriers, as well as lower quality dispersal habitats, may present an intensified risk of mortality to animals that use them (e.g., open areas where predation risk is increased during passage or a paved area where vehicular mortality is high). Potential barriers include, but are not limited to, forest edges, roads (paved and unpaved), abrupt elevation changes, Scotch broom thickets, highly cultivated lawns, impervious surfaces, inhospitable soil types or substrates, development and buildings, slopes greater than 35 percent, and open water. At this point in time, most paved and unpaved roads do not appear to be impermeable barriers, aside from highways such as I-5. Smaller roads and highways may impede movement (as mentioned above) but are not known at this time to fully preclude movement.

Population: The term **population** is generally accepted to mean a group of potentially interbreeding individuals within a defined area. We use the term "population" in two specific contexts in this document:

- When discussing all individuals in a subspecies across its range, we use the term "**rangewide population**" or "**subspecies population**."
- Within each subspecies' range, there are numerous occupied areas that we may also refer to as "**local populations**." Local populations are groupings of occupied areas connected to each other across a permeable or semipermeable landscape (no barriers) allowing movement, genetic exchange, and interbreeding.

Population dynamics: For purposes of this discussion, this term is intended to include the birth rate, death rate, immigration rate, and emigration rate within populations.

Population-level threat: Any alteration of a species' physical, chemical, genetic, or biological resources that can induce an adverse response at the scale of the entire population of a species. This can include, but is not limited, to lower reproductive rates, reduced rangewide population growth rates, or changes in rangewide distribution. Population-level threats can act directly on the species (e.g., to a significant proportion of individuals within the rangewide population), or indirectly, through impacts to a species' resources.

Preferred soil: A soil type known to be used by MPGs (see definitions of More-Preferred soil and Less-Preferred soil, above).

Protected matrix: Habitat that allows dispersal, connectivity, and recolonization among Reserve Satellites that is protected under compatible long-term management (USFWS 2020, p. xi). Protected Matrix areas are typically used to connect Reserve Satellites within a Reserve Complex (USFWS 2020, p. xi).

Rangewide population (also known as "subspecies population"): a group of potentially interbreeding individuals across a subspecies range.

Reserves: To meet the recovery criteria in the Recovery Plan for Four Subspecies of MPG, Reserves with viable populations occupying protected habitat should be established within Reserve Priority Areas, designated MPG critical habitat, or proposed MPG critical habitat that was exempted or excluded. Depending on their spatial configuration, Reserves may be:

- **Reserve Core** areas (250 to 500 acres of medium- and high-quality habitat in a single block), or
- **Reserve Complex** areas (250 to 500 acres of medium- and high-quality habitat comprised of two or more **Reserve Satellite** areas, functionally connected to each other by Protected Matrix.)

Reserves must be managed for MPGs over the long-term. Reserve Complexes are comprised of two or more Reserve Satellites (contiguous polygons of suitable MPG habitat, smaller than Reserve Cores) connected to each other by Protected Matrix (contiguous polygons of lands not solely managed for MPGs). Reserves must support a minimum local population size of 1,000 individuals.

The Service's final MPG Recovery Plan (USFWS 2022a), as well as the WDFW's final MPG Recovery Plan (Stinson 2020), define Reserves with the assumption that they are distinct areas that are not contiguous with one another. Because most existing or potential Reserves are permanently separated from one another by areas of developed or otherwise unsuitable habitat, direct contact or connectivity among Reserves is unlikely.

Reserve Satellites: Two or more Reserve Satellites will make up a single Reserve Complex. Habitat quality and management requirements are the same as for Reserve Cores. Medium- and high-quality habitat acreage within Reserve Satellites makes up the total acreage requirement within a Reserve Complex. Reserve Satellites are functionally connected to each other by Protected Matrix. Each individual Reserve Satellite area must be 10 acres or more.

Resiliency Units: Resiliency units are groups of potentially interbreeding individuals within a defined area. These groups may not interbreed within a single season or year, but over the course of two or more years due to the distances between the groups. But there are no impermeable barriers between the groups. Barriers to movement between groups usually drove the delineation of separate resiliency units. Resiliency units represent the current distribution of MPGs within each subspecies' range, and in this document, we assess the current resiliency of occupied areas within each unit.

3Rs - Components of Viability (See Table 7):

Resiliency: Resiliency is the ability of a species or subspecies to sustain local populations in the face of environmental variation, demographic, environmental disturbances (stochastic events), and transient perturbations. To be resilient, a subspecies must have healthy local populations with a degree of connectivity that are able to sustain themselves in good and bad years. We have evaluated **Resiliency Units** for the four subspecies of MPGs based on clusters of occupied sites of potentially interbreeding individuals in variably permeable landscapes and isolated small patches. These geographic areas are described in the SBR for each subspecies and are shown as clusters of occupied areas (based on recent surveys) that are color-coded in the same hues or tones in the legend for Figure 1 and in the maps in Appendix C.

Redundancy: Redundancy is the ability of a species or subspecies to withstand catastrophic events. Redundancy protects a subspecies against the unpredictable and highly consequential events (i.e., catastrophic events) for which adaptation is unlikely (Smith et al. 2018, p. 304). Redundancy is best achieved through the establishment and maintenance of a minimum number of widely-distributed Reserves within each subspecies' recovery area or recovery unit. Having Reserves reduces the likelihood that all local populations will be affected simultaneously. The more widely distributed the Reserves are, the less likely they are to possess similar vulnerabilities and be lost during a catastrophic event.

Representation: Representation is the ability of a species to adapt to short- and long-term changes in its physical (climate and habitat conditions, habitat structure, etc.) and biological (pathogens, competitors, predators, etc.) environments over time; it is the evolutionary capacity or flexibility of a species (Smith et al. 2018., p. 304), and can be affected by genetic changes (e.g., changes in allele frequencies or the acquisition of novel alleles) or non-genetic changes (e.g., behavioral or physiological shifts).

Representation is the amount of variation found in a species, and this variation (also called adaptive diversity) is source of species' adaptive capabilities. The greater the adaptive diversity, the more responsive and adaptable the species will be over time, thereby increasing its viability.

Territoriality: The ways in which an animal defines and defends its territory.

Trend monitoring: Estimates of rangewide or local population trend based on a minimum of 5 years of monitoring over a 10-year period (USFWS 2021, p. v). Trend may be determined by using methods described in Olson (2017, entire).

Vagility: The degree to which an animal can or does move or disperse within its environment.

Viability: The viability ratings for the four subspecies of MPGs are shown in Table 7. The combination of each subspecies' 3Rs ranks are used to determine its overall viability.

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APPENDIX B. Population Modeling for Recovery Criteria Development

Citations
The *VORTEX* 10 program should be cited as:

Lacy, R.C., and J.P. Pollak. 2018. Vortex: A Stochastic Simulation of the Extinction Process. Version 10.3.1. Chicago Zoological Society, Brookfield, Illinois, USA.

The *VORTEX* 10 manual should be cited as:

Lacy, R.C., P.S. Miller, and K. Traylor-Holzer. 2018. Vortex Manual. 1 June 2018 update. IUCN SSC Conservation Breeding Specialist Group, and Chicago Zoological Society, Apple Valley, Minnesota, USA. Available On-Line at Vortex 10 Manual; Accessed 3 August 2018.

Methods
Free, publicly available population viability analysis software (*VORTEX* 10; Lacy and Pollak 2018) was used to examine extinction probabilities under model scenarios of variable initial population size, annual reproduction and mortality, carrying capacity, and Reserve configuration. Model simulation outputs/outcomes were compared to a defined, acceptable limit on extinction probability: less than 2% probability of extinction over 50 years.

"*VORTEX* is an individual-based simulation of deterministic forces as well as demographic, environmental, and genetic stochastic events on wildlife populations. It can model many of the extinction vortices [(forces or scenarios)] that can threaten persistence of small populations. *VORTEX* models population dynamics as discrete, sequential events that occur according to probabilities that are random variables following user-specified distributions. *VORTEX* simulates a population by stepping through a series of events that describe an annual cycle of a typical sexually reproducing, diploid organism: mate selection, reproduction, mortality, increment of age by one year, dispersal among populations, removals, supplementation, and then truncation (if necessary) to the carrying capacity. The simulation of the population is iterated many times to generate the distribution of fates that the population might experience." (link to Vortex 10)

Model simulations included relevant portions of the *VORTEX* 10 "Annual Sequence" (*e.g.*, breeding, mortality, aging), but did not use portions of the sequence regarded as irrelevant to the Reserve design and management scenarios under consideration (*e.g.*, harvest, supplementation) (Lacy *et al.* 2018, p. 23).

Simulations were run as individual-based models, not population-based models, allowing for demographic stochasticity. (Lacy *et al.* 2018, p. 21) "Demographic stochasticity is the variation in an observed vital rate due to the sampling variation that is inherent because each individual (an observation) is an independent and random sample from a population with a given mean or probability" (Lacy *et al.* 2018, p. 29).

"Variation across years in the frequencies of births and deaths—both in real populations and in simulated *VORTEX* populations—will have two components: the demographic variation resulting from binomial sampling around the mean for each year, and additional fluctuations due to environmental variability. Catastrophic events…also contribute to the overall observed variation across many years of data, but they are treated separately from standard annual environmental variability" (Lacy *et al.* 2018, p. 30).

"Environmental Variation is the annual fluctuation in probabilities of birth and death arising from random fluctuations in the environment (*e.g.*, weather, abundance of prey or predators, etc.). Annual fluctuations in the probabilities of reproduction and mortality are modeled in *VORTEX* 10 as binomial…distributions" (Lacy *et al.* 2018, p. 29).

Environmental Variation in survival rates was modeled by entering a mean and standard deviation for adult (age 1+) and juvenile (age 0-1) survival. "Environmental Variation in reproduction [was] modeled by…entering a standard deviation for the percent females producing litters of offspring [PBreed, mean and standard deviation]. *VORTEX* determines the percent breeding for a given year by sampling from a binomial distribution with the specified mean and standard deviation" (Lacy *et al.* 2018, p. 45).

"EV correlation between reproduction and survival…Sources of this environmental variation are outside the population; examples include weather, predator and prey population densities, and parasite loads…These factors can affect reproduction and survival independently or simultaneously. If this value is set to 0.0, then EV in reproduction will be independent from EV in mortality. If this value is set to 1.0, then EV in reproduction and EV in survival will be completely synchronized…If this correlation is set to an intermediate value, then EV in reproduction will be partly correlated with EV in survival" (Lacy *et al.* 2018, p. 29). Similarly, where EV correlation between populations is set to an intermediate value, the extrinsic environmental factors that influence annual variation in reproduction and survival will be partly correlated.

Simulations were run for one or more local populations, but not a complex meta-population (*i.e.*, variably interacting group of populations). Meta-population models require the resolution of "added complexities" (Lacy *et al.* 2018, p. 22). It is assumed that most or all of the likely Reserve configurations will place these local populations in relatively close proximity, EV correlation between populations was generally set to an intermediate value.

Modeling effort did not resolve an important set of questions relevant to Reserve design scenarios that involve groupings of smaller Reserve Satellites surrounded and functionally linked or connected by Protected Matrix (*i.e.*, a Reserve Complex). Modeling effort did not resolve questions about expected variable rates of dispersal and/or exchange across the many forms/configurations that a Reserve Complex could take, nor did it resolve questions about the likely role or function of colonization and re-colonization within Reserve Complexes. The basic science to reliably inform the selection of input parameter values specific to these populations of Mazama pocket gopher is incomplete (*e.g.*, spatial and temporal aspects of demography across habitats of variable quality and function). A more robust evaluation of meta-population extinction probabilities was deemed not possible at this time.

Model Development, Refinement, and Application

First Runs/Simulations explored model sensitivity to input values for the following:
Environmental Variation (EV)

- EV correlation between reproduction and survival [0.00, 0.25, 0.50, 0.75, 1.00]
- EV correlation between populations [0.00, 0.25, 0.50, 0.75, 1.00]

Lifespan (0-7), Broods Per Year (1)
Progeny per Brood/Litter Size (mean 4, standard deviation 1)
Density-Dependent Reproduction (tested and discounted)
Percent Females Breeding (PBreed) (40% to 90%)

Mortality Rate, as a function of age (age 0-1, age 1+)
Annual Adult Survival (20% to 80%)
Annual Juvenile Survival (20% to 80%)

First runs/simulations informed the selection of input values for further model development and refinement. The inputs identified below are within the range of credible values based on review of relevant literature for these and related species. Based on first run simulations in the absence of "catastrophes", the inputs identified below result in intrinsic growth rates (lambda; λ) that approximate 1.0:

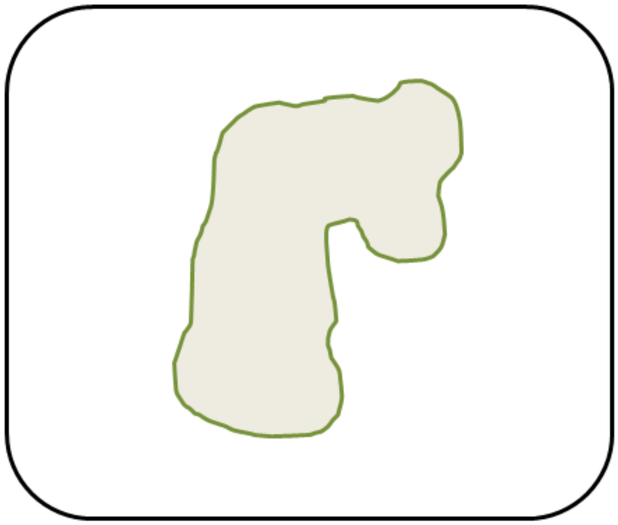
EV correlation between reproduction and survival (0.25)
EV correlation between populations (0.50, 0.75)

Base Value Set 1	Adult Survival (65%, standard deviation 3)
	Juvenile Survival (30%, standard deviation 5)
	Percent Females Breeding (PBreed) (65%, standard deviation 5)
Base Value Set 2	Adult Survival (70%, standard deviation 3)
	Juvenile Survival (25%, standard deviation 5)
	Percent Females Breeding (PBreed) (70%, standard deviation 5)

Second runs/simulations explored model sensitivity to event scenarios ("catastrophes") that result in substantial annual declines in reproduction, survival, or both. These included:

Events with a year-to-year probability, or annual occurrence rate, of 5% to 20%
Events with variable, moderate severity of impact to reproduction, 0.2 to 0.7
(80% to 30% of normal PBreed retained)
Events with variable, moderate severity of impact to survival, 0.2 to 0.7
(80% to 30% of normal survival retained; all sex and age classes)

Rare events with a year-to-year probability, or annual occurrence rate, of 1% or 2%
Rare events with extreme severity of impact to survival, 0.9
(10% of normal survival retained; all sex and age classes)



Runs/simulations, generating predicted extinction probabilities, were applied to Reserve design scenarios involving a **single contiguous Reserve Core**, with a single local population.

Question: How many individuals, what minimum population size, results in acceptable extinction probabilities?

Finding(s): On balance, with consideration for a large number of runs/simulations including medium probability/moderate severity "catastrophes", and low probability/extreme severity "catastrophes", modeling showed that a minimum population size of 1,000 individuals generally and consistently achieved acceptable extinction probabilities.

Application: If a Reserve Core managed for good habitat condition will support <40% pocket gopher occupancy by area[3], and 5 to 10 pocket gophers per acre represents a reasonable, conservative, range of average densities, how many acres of contiguous Reserve Core are necessary to achieve acceptable extinction probabilities? It was determined that a single contiguous Reserve Core should fall in the size range of 250 to 500 ac (101 to 202 ha) to ensure acceptable extinction probabilities.

Runs/simulations generating predicted extinction probabilities were applied to Reserve design scenarios involving **two or three contiguous Reserve Cores**, each with a single, **isolated**, local population (*i.e.*, no dispersal, translocation, or exchange between Reserve Cores; not a meta-population or "variably interacting group of populations").

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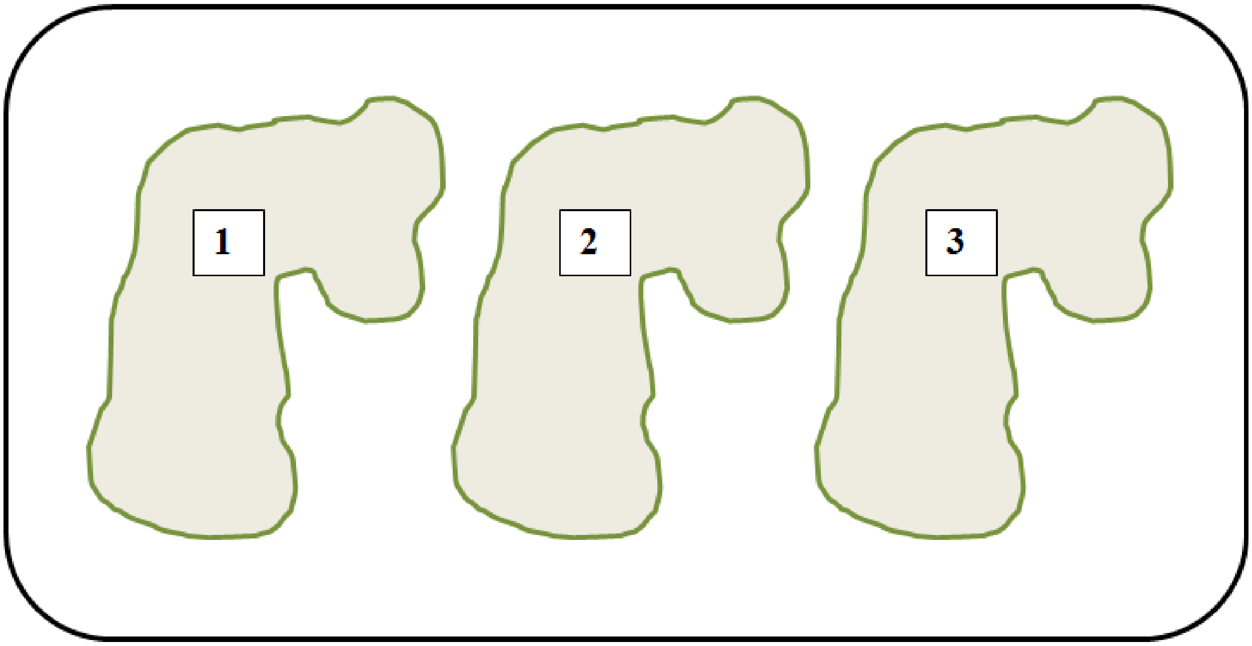
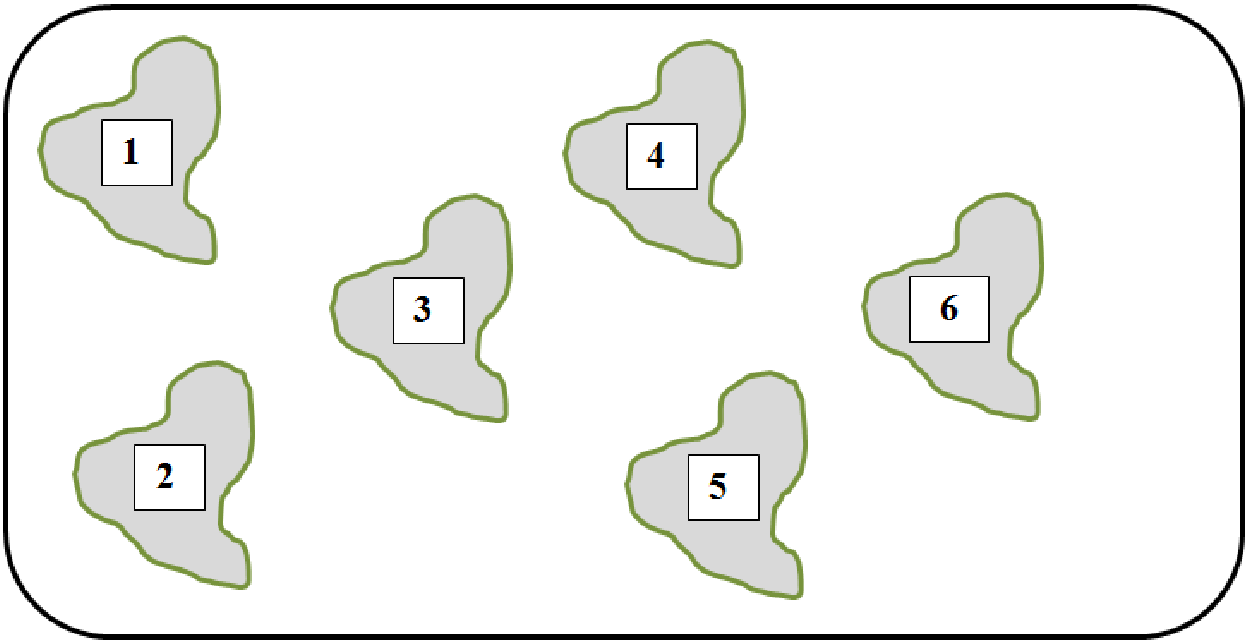
[3] This is an average value in a given year. Gophers are asocial and typically space themselves apart from each other on the landscape, leaving area between their individual burrow systems (Reichman *et al*. 1982, p. 688). Also, local gopher populations as a whole often move around on the landscape (Klaas *et al*. 2000, p. 254; Smallwood 2001, p. 256; Patton *in litt*. 2012) from season to season and year to year, to take advantage of variable availability of forage resources. Based on research (conducted by WDFW on a translocated group of Olympia pocket gophers in Thurston County (reported in CNLM 2016, p. 3) and by Reichman *et al*. (1982, p. 688; *Thomomys bottae* in Arizona), we reasonably estimate that approximately 40 percent of the habitat within a Reserve would be occupied at any point in time.



Question: If the reserve configuration consists of multiple Reserve Cores (1, 2, or 3), meeting the above description, how do the multiple Reserve Cores change modeled extinction probabilities?

Finding(s): Modeling showed that where scenarios include low probability/extreme severity "catastrophes" (year-to-year probability of 1%, 10% of normal survival retained), a third Reserve Core reduces or lowers extinction probabilities by 1.2% to 2.5%. Modeling showed that where scenarios include low probability/extreme severity "catastrophes" (year-to-year probability of 2%, 10% of normal survival retained), a third Reserve Core reduces or lowers extinction probabilities by 8.1% to 11.2%.

Runs/simulations generating predicted extinction probabilities were applied to Reserve design scenarios involving **1 to 6 smaller, contiguous Reserve Satellites**, each with a single, **isolated**, local population (*i.e.*, no dispersal, translocation, or exchange between Reserve Satellites; not a meta-population or "variably interacting group of populations").



Question(s): If the reserve configuration consists of 4, 5, or 6 smaller, isolated, Reserve Satellites, each supporting an initial local population of 50 to 500 individuals, (**1**) What is the predicted range of extinction probabilities for the local populations (*i.e.*, for each Reserve Satellite), and, (**2**) What is the combined probability that at least one of the local populations will persist for 50 years, for 100 years?

And if the Reserve configuration consists of 1, 2, 3, 4, 5, or 6 smaller, isolated, Reserve Satellites, each apportioned an equal share of the combined total initial population (300, 600, 900, or 1,200 individuals), (**3**) What is the combined probability that at least one of the local populations will persist for 50 years, for 100 years?

Finding(s): Where scenarios include low probability/extreme severity "catastrophes" (year-to-year probability of 1% or 2%, 10% of normal survival retained), modeling showed the following:

(**1**) The predicted range of extinction probabilities for the local populations (*i.e.*, for each Reserve Satellite) is 0.205 (20.5%) to 0.879 (87.9%); and, (**2a**) The combined probabilities that at least one of the local populations will persist for 50 years range from 0.871 (87.1%; Case = 4 Reserve Satellites, each with an initial local population of 50 individuals; a year-to-year "catastrophe" probability of 2%) to 1.0 (100%; more than Ten Cases); and, (**2b**) The combined probabilities that at least one of the local populations will persist for 100 years range from 0.465 (46.5%; Case = 4 Reserve Satellites, each with an initial local population of 50 individuals; a year-to-year "catastrophe" probability of 2%) to 1.0 (100%; Two Cases; Case = 6 Reserve Satellites, each with an initial local population of 400 individuals; a year-to-year "catastrophe" probability of 1%; Case = 6 Reserve Satellites, each with an initial local population of 500 individuals; a year-to-year "catastrophe" probability of 1%).

(**3a**) The combined probabilities that at least one of the local populations will persist for 50 years range from 0.732 (73.2%; Case = 1 Reserve Satellite, with an initial local population of 300 individuals; a year-to-year "catastrophe" probability of 2%) to 1.0 (100%; Six Cases); and, (**3b**) The combined probabilities that at least one of the local populations will persist for 100 years range from 0.400 (40.0%;

Case = 1 Reserve Satellite, with an initial local population of 300 individuals; a year-to-year "catastrophe" probability of 2%) to 0.997 (99.7%; Case = 6 Reserve Satellites, each with an initial local population of 200 individuals; a year-to-year "catastrophe" probability of 1%).

Application: When the same total number of individuals, the combined total initial population (300, 600, 900, or 1,200 individuals with carrying capacity K = 450, 800, 1200, and 1800, respectively), is apportioned equally across 1, 2, 3, 4, 5, or 6 isolated Reserve Satellites, the combined probabilities of persistence (*i.e.*, probability that at least one of the local populations will persist) are always, under all scenarios, greater for multiple, smaller local populations than for one or two, larger local populations.

These model results were not completely unexpected, but did prompt a set of follow-up comparisons:

> If the reserve configuration consists of 1, 2, 3, 4, 5, or 6 smaller, isolated, Reserve Satellites, each apportioned an equal share of the combined total initial population (300, 600, 900, or 1,200 individuals), (**1**) What is the combined probability that at least one of the local populations will persist for 50 years? (Same Question posed above, Item (3a)); **and**, (**2**) What is the mean population size (*i.e.*, number of individuals; proportion of initial) for local populations still persisting after 50 years?
>
> For combined total initial populations of 300, 600, 900, or 1,200 individuals, these model results and comparisons reveal a consistent pattern of trade-offs between combined persistence probabilities and mean population size (*i.e.*, number of individuals; proportion of initial) persisting after 50 years.

Under all scenarios, combined probabilities of persistence approach 1.00 (100%) when the combined total initial populations (300 or 600 individuals) are apportioned equally across more than 2 Reserve Satellites, or when the combined total initial populations (900 or 1,200 individuals) are apportioned equally across more than 1 Reserve Satellite. **But**, when the combined total initial populations (300 or 600 individuals) are apportioned equally across more than 1 Reserve Satellite, there is a projected steep decline in mean population size (*i.e.*, number of individuals; proportion of initial) for local populations still persisting after 50 years. **And**, when the combined total initial populations (900 or 1,200 individuals) are apportioned equally across more than 1 Reserve Satellite, there is a projected shallower but still steady decline in mean population size (*i.e.*, number of individuals; proportion of initial) for local populations still persisting after 50 years.

These model simulations and comparisons suggest the following: multiple smaller (and isolated) Reserve Satellites do increase combined probabilities of persistence, but those combined probabilities of persistence become negligibly greater (or larger) for Reserve configurations that include more than 3 Reserve Satellites; and, for Reserve configurations that apportion a combined total initial population across more than 3 smaller (and isolated) Reserve Satellites, mean population size (*i.e.*, number of individuals; proportion of initial) persisting after 50 years becomes increasingly smaller.

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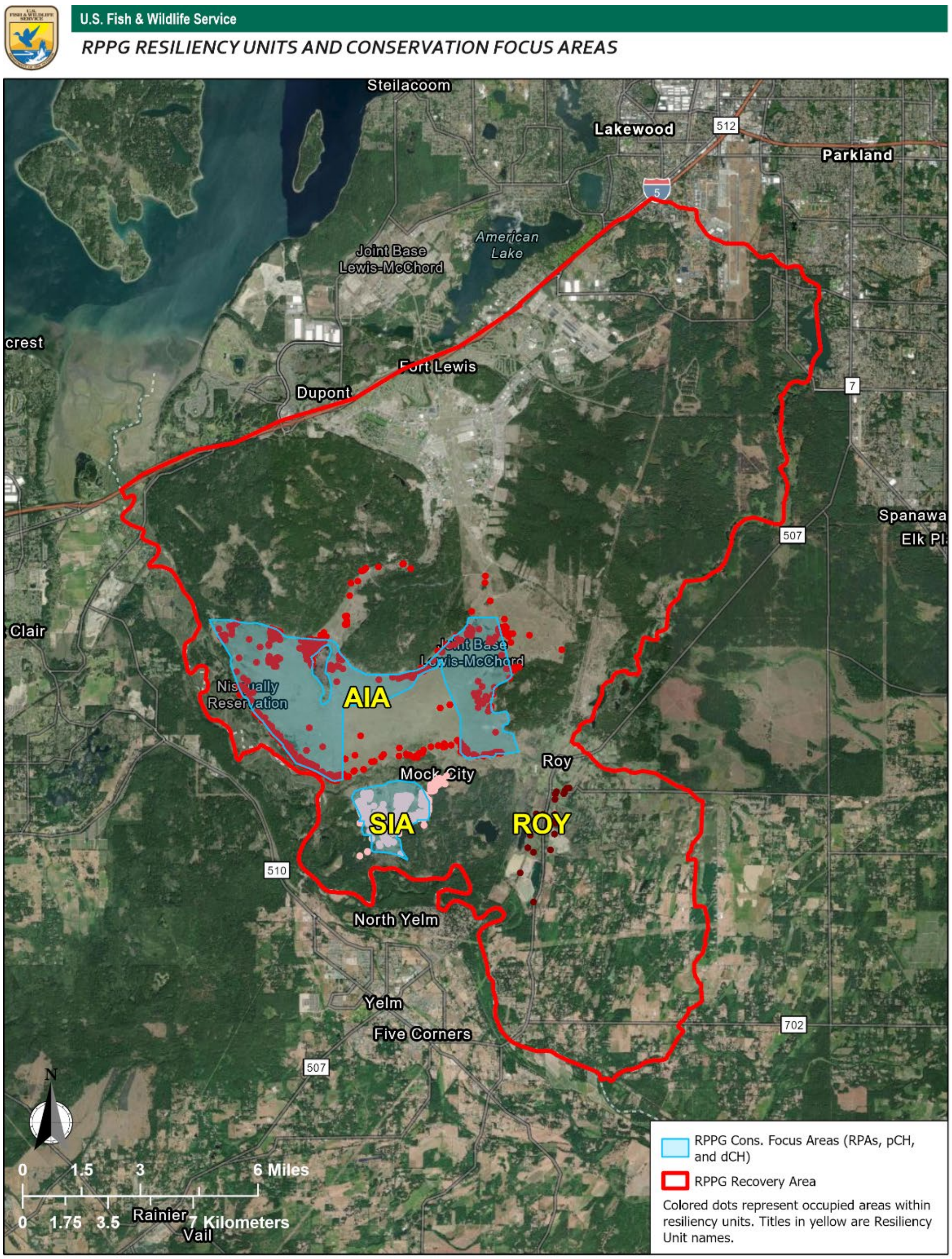
APPENDIX C. Maps

Map 1. RPPG Recovery Area, Reserve Priority Areas, and Resiliency Units



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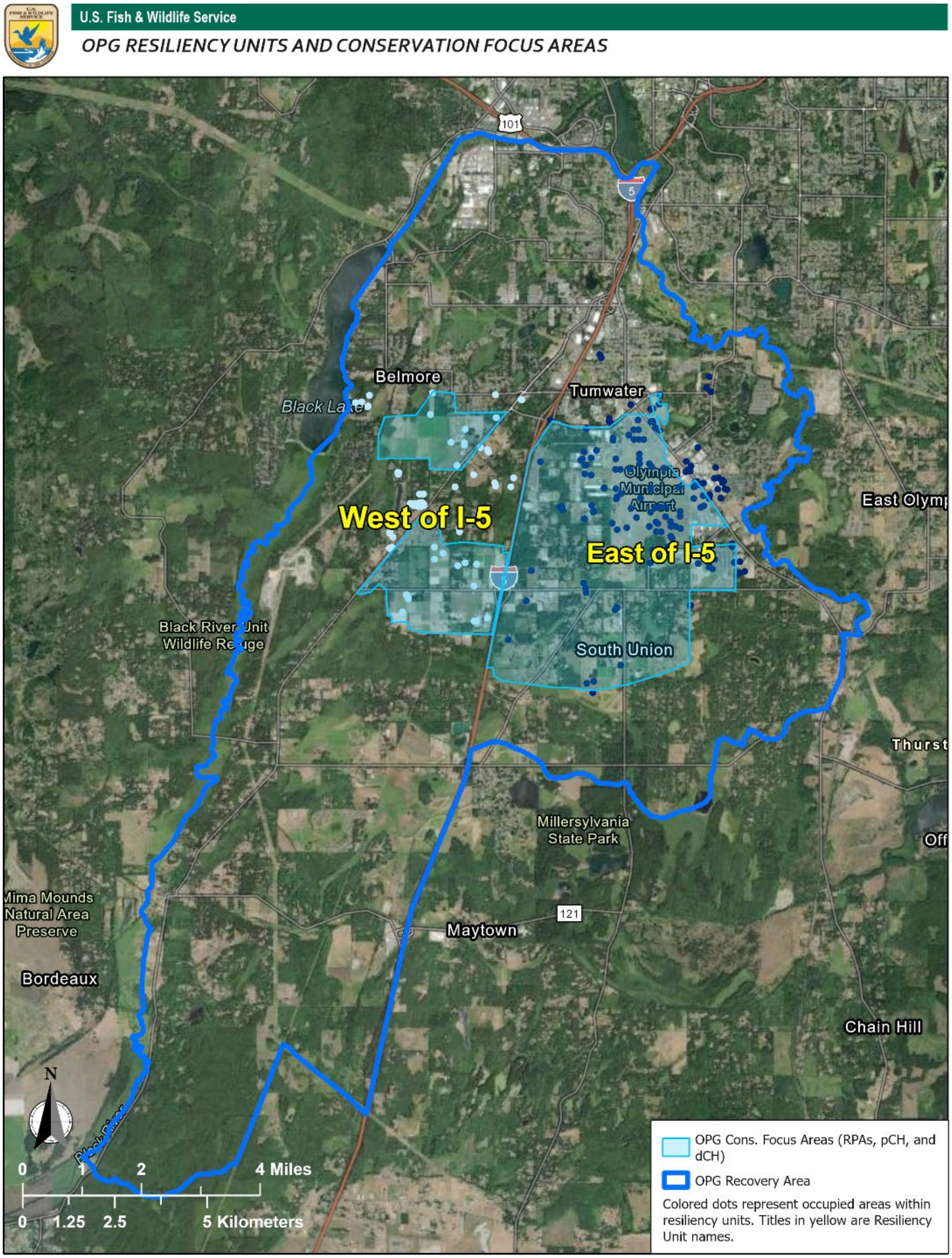
Map 2. OPG Recovery Area, Reserve Priority Areas, and Resiliency Units



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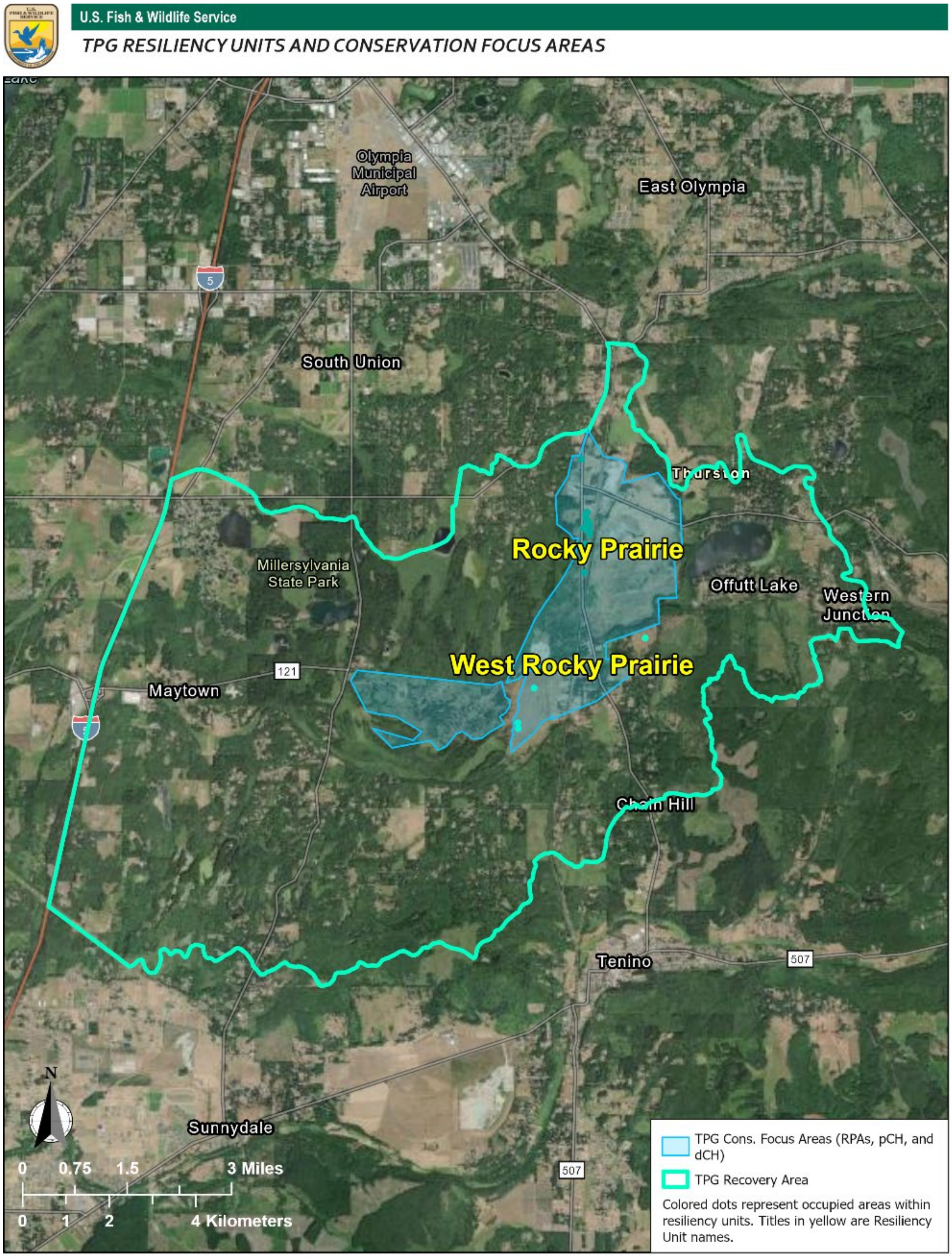
Map 3. TPG Recovery Area, Reserve Priority Areas, and Resiliency Units



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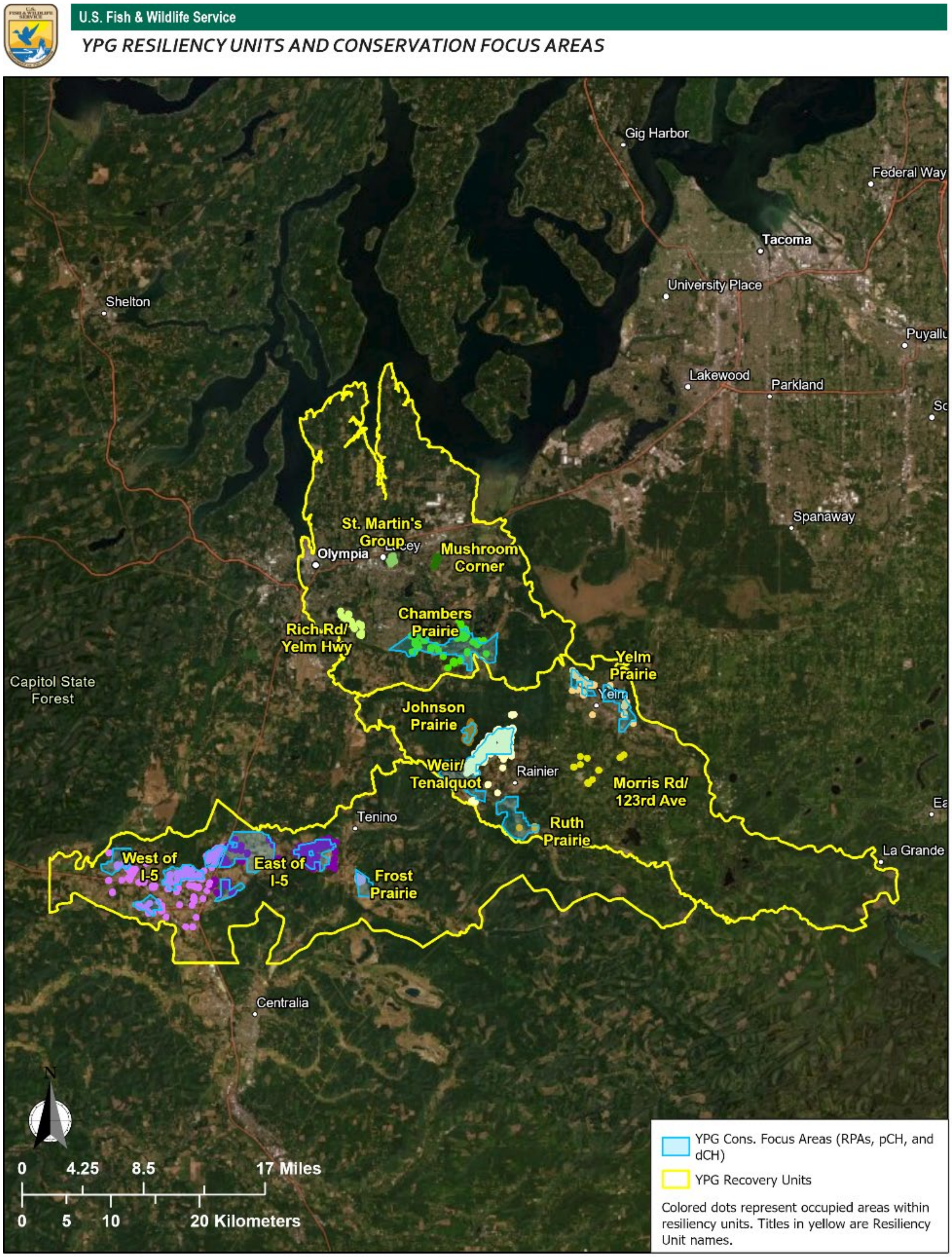
Map 4. YPG Recovery Area, Recovery Units, Reserve Priority Areas, and Resiliency Units



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