Appendix B: Covered Species Descriptions

Table of Contents

Taylor's Checkerspot Butterfly (*Euphydryas editha taylori*, W.H. Edwards, 1888)

Conservation Status

Taylor's Checkerspot Butterfly (*Euphydyas editha taylori*) was listed as an endangered species on October 3, 2013, throughout the subspecies range in Washington, Oregon, and British Columbia (78 FR 61452 [October 3, 2013]). Taylor's Checkerspot Butterfly has been listed as endangered by the State of Washington since 2006. In British Columbia, Canada, it is classified as an endangered species under the Species at Risk Act (COSEWIC 2011). For additional summaries of the status of Taylor's Checkerspot Butterfly, see the Federal listing rule (78 FR 61452), the Washington State Department of Fish and Wildlife's (WDFW) Status Report for Mazama Gopher, Streaked Horned Lark and Taylor's Checkerspot Butterfly (Stinson 2005), or WDFW's Periodic Status Review for Taylor's Checkerspot (Potter 2016).

Population Trends and Distribution

Taylor's Checkerspot Butterfly was historically found at approximately 80 locations across the Puget Trough ecoregion in British Columbia, Washington, and Oregon (Potter 2016). The actual number of previously known locations is difficult to determine. Stinson (2005) had reported 70 locations, 20 on Vancouver Island, 13 in Oregon, and 37 in Washington. More recently, Potter (2016) reported 45 historically documented sites in Washington; one each in San Juan and Island Counties, 11 in Clallam County, and 32 on south Puget Sound prairies, oak woodlands, and other open habitats (Lewis, Mason, Pierce, and Thurston Counties). Figures created by Stinson (2005) and Potter (2016) suggest that many of those historical locations were in Thurston County. In either case, these sources probably underestimate the true historical distribution of the subspecies.

The number of sites where Taylor's Checkerspot Butterfly remained extant (still in existence) drastically declined into the 2010's when reintroduction programs and conservation programs began to halt and, in some cases, reverse the decline. Stinson (2005, pp. 78, 106) described 10 extant sites in Washington and 13 extant sites across the range of the species in 2005, the Service (78 FR 61455) described 14 extant sites across the range in 2013, and Potter (2016) described 11 extant sites across the range in 2016). There is no 'precise' number of populations extant in 2020 because it depends on what is considered a population (or site) and whether incomplete reintroductions and translocations count towards the total. The largest populations of Taylor's Checkerspot Butterfly in the Washington are in Pierce County at Joint Base Lewis McChord (JBLM)- including the very large population at Range 74-76 which has been the source for captive breeding and reintroductions in the south Puget Sound. In Thurston County in 2020, Taylor's Checkerspot Butterflies are extant at Scatter Creek Wildlife Area and Tenalquot Preserve. Scatter Creek Wildlife Area supports a large population that is the result of a successful reintroduction effort (Linders et al. 2020). Tenalquot Preserve is the focus of the latest reintroduction attempt by WDFW and their partners. That release began in winter 2020. "One adult checkerspot was observed at Glacial Heritage in 2019, although no formal surveys were conducted. Releases were discontinued at [Glacial Heritage] in 2018 and will not resume without a better understanding of the factors affecting success, which may include the condition of food plants, availability of microsites, pesticide residues or other unidentified factors" (Linders et al. 2020).

Life History and Ecology

Taylor's Checkerspot Butterfly is a brightly colored, medium-sized butterfly with a striking checkered pattern of orange to brick red, black, and cream. On south Puget Sound prairies, no other butterfly resembles it. Females are larger than males, though both have the same checker-patterned wings.

Taylor's Checkerspot Butterfly is univoltine, completing 1 life cycle annually. They are sedentary insects, inhabiting their sites year-round as an egg, larva, pupa, and adult. In the south Puget Sound, adults (butterflies) typically begin to emerge from their chrysalids (pupae) in April to June depending on site and weather conditions, though this and all other life stage dates for this butterfly can vary significantly due to weather conditions (Linders 2006, Potter 2016). Although individual butterflies may live only a few days, the entire adult flight period in the south Puget Sound often lasts through late May (Linders 2006, Olson and Linders 2010, Linders 2012, Linders et al. 2015). Butterflies in this region have been observed as early as late March and as late as early-June (Hinchliff 1996, Linders 2012).

Males use two strategies for mate-finding: perching and patrolling (Bennett et al. 2011). In perching, males select specific sites to perch and then dart out at passing butterflies to determine if it is a female of its species. In patrolling, males search for females by almost constant flying, often along a regular route or territory. Females lay eggs in clusters, low on their host plants, which in the south Puget Sound are the non-native English plantain (*Plantago lanceolata*) and native harsh paintbrush (*Castilleja hispida*) (Char and Boersma 1995, Hays et al. 2000, Severns and Grosboll 2011, Grosboll 2011).

Male and female butterflies feed by using their long proboscis to explore flowers and sip floral nectar. Annual variation in plant phenology and condition affects availability of nectar resources thereby causing variation in plant species use among years. An early pollination study on south Puget Sound prairies (Jackson 1982) found Taylor's Checkerspot Butterflies nectaring solely on camas (*Camassia quamash*). Hays et al. (2000) observed (but did not quantitatively study) Taylor's Checkerspot Butterfly nectar habits on a south Puget Sound prairie and found them primarily using common camas and nine-leaved lomatium (*Lomatium triternatum*). Other nectar sources regularly used by Taylor's Checkerspot Butterfly in the south Puget Sound region include deltoid balsamroot (*Balsamorhiza deltoidea*), spring gold (*Lomatium utriculatum*), wholeleaf saxifrage (*Saxifraga integrifolia*), and seablush (*Plectritis congesta*) (Linders 2012, Linders et al. 2015, Potter 2016).

Taylor's Checkerspot Butterflies generally do not disperse very far from their colony of origin. They are not migratory. Dispersal movements in checkerspots have rarely been found to exceed 2–3 km (Wahlberg et al. 2004, p. 223). In general, mark-recapture studies with other checkerspot butterflies in Finland documented that they generally flew less than 1,640 ft (500 m), studies of dispersal indicates that 95 percent of colonizations have been within 2.3 km of the nearest source, and the longest recorded colonizations were within 4 to 5 km of source populations (Singer and Hanski 2004). Research conducted in California on other Edith's checkerspot butterflies indicate the species is relatively sedentary, with over 96 percent of individuals marked recaptured in the area of previous capture; and dispersal of individuals between closely situated populations (less than 1 km) is rare even though the occupied patches were well within potential dispersal distance for the species (Hellmann et al. 2004). A mark-recapture study conducted in Oregon showed that dispersal distance was short (less than 984 ft (300 m) (Kaye et al. 2011) and that Taylor's Checkerspot Butterflies tended to move to the nearest open patch, or from poor resource patches to rich resource patches, although rates of recapture were low (Kaye et al. 2011). The USFWS generally use one quarter mile (400 meters) as an estimate for Taylor's

Checkerspot Butterfly dispersal. This is not to say that dispersal beyond one quarter mile is extremely unlikely, but simply to assume that the vast majority of dispersing individuals stay within one quarter mile of their prairie of origin.

Several scientists have observed Taylor's Checkerspot Butterfly egg masses and larvae extensively in the south Puget Sound, but their phenology in the wild has not been studied completely (Severns and Grosboll 2011). Careful and detailed phenological data for Taylor's Checkerspot Butterfly larvae has been collected by the Oregon Zoo as part of a captive-rearing program (Barclay et al. 2010). James and Nunnallee (2011) provide detailed descriptions and photographs of the species life stages. Eggs hatch in 8-9 days (James and Nunnallee 2011); eggs within a cluster typically hatch in synchrony (Barclay et al. 2010). The resulting caterpillars (larvae) create webbing and feed communally through the spring on the host plant species on which eggs were deposited, continuing to grow and shed their skins to expand, in what are referred to as instar stages. Larvae enter a dormant phase (diapause) in late-June or early-August when host plants are senescing and no longer provide palatable vegetation. Larvae often diapause in a sheltered location under rocks, logs, or litter (Guppy and Shepard 2001), and in some cases in tunnels of ground-nesting bees and ants or in soil cracks (Fimbel 2009, Potter 2016). Diapausing larvae develop a thick exoskeleton that helps prevent dehydration (Scott 1986). The diapause phase lasts for many months, until early the following spring (January to March in the south Puget Sound depending on site conditions). Upon breaking diapause, Taylor's Checkerspot Butterfly larvae reinitiate feeding on a broader array of plant species. Plant species that held egg masses remain a major component of their diet, but additional post-diapause food sources (sea blush (*Plectritis congesta*), blue-eyed Mary (*Collinsia parviflora*), and dwarf owl-clover (*Triphysaria pusilla*) as available, also are used. Larvae pupate in late-March to early May (Potter 2016).

Habitat Characteristics

The Taylor's Checkerspot Butterfly inhabits short-stature grasslands in low-elevation prairies and meadows, coastal meadows and stabilized dunes, and montane meadows and balds. Balds are shallow-soiled, grass, herbaceous vegetation, or lichen and moss dominated sites, typically less than 5 ha (12.5 ac), that occur within forested lands (Chappell 2006, Potter 2016). A few studies of Taylor's Checkerspot Butterfly habitat have been conducted outside of the south Puget Sound region, including in Oregon (Severns and Warren 2008), British Columbia (Page et al. 2009), and the north Olympic Peninsula (Severns and Grosboll 2011, Grosboll 2011). Egg-laying (oviposition) habitat is often studied with this and other butterflies because it is a limiting factor, determines the site of pre-diapause larvae, and influences the location of diapause, post-diapause, and pupation. Severns and Warren (2008) found that Taylor's Checkerspot Butterflies selected habitat for egg-laying that occurred within high cover of short-stature native bunchgrasses and adult nectar resources, indicating that females select egg-laying sites based on habitat condition. Page et al. (2009) found the most common activity of post-diapause larvae was basking and perching, demonstrating the importance of thermal habitats in this life stage. The British Columbia study population had multiple host plant species available and females' selection of egg-laying sites in this environment was influenced by host plant phenology and condition (Page et al. 2009). A characteristic of egg-laying habitat consistently identified in the British Columbia and 3 Olympic Peninsula populations was the abundance of host plants (number or percent cover) (Page et al. 2009, Severns and Grosboll 2011, Grosboll 2011).

Within the south Puget Sound region, the butterfly has been found on prairies and balds. Habitat selection by egg-laying females has been studied in 1 population (JBLM Artillery Impact Area – Range 76) by Linders et al. (2009), Severns and Grosboll (2011), and Grosboll (2011). All researchers found that females selected habitat with high host plant density for oviposition. Grosboll (2011) determined that the butterfly selected for host plant patches with >10,000 cm^3 volume. Severns and Grosboll (2011) found that the butterfly laid eggs more frequently along 2-track road edges than the open prairie, and explained this may be due to the strong association between the host plant at this site (English plantain) and the roadbeds.

Although there has been no quantitative study of Taylor's Checkerspot Butterfly nectar plant use or preference, several plants have been identified as key nectar sources in south Puget Sound populations (common camas, deltoid balsamroot, sea blush, wholeleaf saxifrage, nine-leaved lomatium, and spring gold) (Jackson 1982, Hays et al. 2000, Linders 2012). Because annual variation in plant phenology and condition determines the availability of nectar resources and causes variation in availability (and therefore use) among years, variety of nectar sources is an important habitat component.

Threats/Reasons for Decline

The primary reasons for listing included extensive habitat loss through conversion and degradation of habitat, particularly from agricultural and urban development, successional changes to grassland habitat, military training, and the spread of invasive plants; inadequate existing regulatory mechanisms that allow significant threats such as habitat loss; and, other factors, including low genetic diversity, small or isolated populations, low reproductive success, and declining population sizes (78 FR 61452). For additional information on threats to Taylor's Checkerspot Butterfly, see the Federal listing rule or the WDFW Status Review (Potter 2016).

Mazama Pocket Gopher (*Thomomys mazama* Merriam, 1897)

Conservation status

The subspecies of the Mazama Pocket Gopher (*Thomomys mazama*) in Washington have been Candidates for listing under the federal Endangered Species Act since 2001 (USFWS 2001); three subspecies in Thurston County, and one in Pierce County were listed as Threatened in 2014 (USFWS 2014). The Mazama Pocket Gopher was listed as a state Threatened species by the Washington Fish and Wildlife Commission in 2006. The species had been listed as a Candidate for state listing as threatened, endangered, or sensitive in Washington since 1996. Prior to that time, the Roy (*T. m. glacialis*), Tenino (*T. m. tumuli*), Tacoma (*T. m. tacomensis*), Shelton, (*T. m. couchi*), and Cathlamet (*T. m. louiei*) subspecies had been state Candidates since 1991. As a state Threatened species, unlawful taking of Mazama Pocket Gophers is a misdemeanor under RCW 77.15.130. The western (Mazama) pocket gopher is a Species of Local Importance in the Critical Areas Ordinances of Thurston and Pierce counties.

Distribution and Population Trends

Mazama Pocket Gophers were historically more widespread and abundant on the glacial outwash prairies of the south Puget Sound region. They also occur on subalpine meadows of the Olympic Mountains (Stinson 2005, Stinson 2013). Several populations are sufficiently distinct to be described as separate subspecies, particularly those that were geographically isolated. Other subspecies of Mazama Pocket Gophers are found in parts of western Oregon and in northern California. The species is currently represented in Washington by six extant subspecies: one in Clallam; one in Mason; three in Thurston, and one in Pierce counties. They were also historically found around Tacoma and in Wahkiakum County. The subspecies found in Thurston County are described here.

Gophers are seldom found in densely developed areas, or sites with very rocky soil (Steinberg 1996, Steinberg and Heller 1997, Stinson 2005, Stinson 2013). There are perhaps 3-4 large (i.e., 1,000s) Mazama Pocket Gopher populations in Thurston/Pierce counties. The largest populations appear to be found on the Olympia and Shelton Airports, Scatter Creek Wildlife Area, and Joint Base Lewis McChord. Many surviving gopher subpopulations are small (<50) and appear to be isolated from other subpopulations, although there are few data on dispersal to help delineate genetically connected populations (Stinson 2005, Stinson 2013). Small subpopulations are unlikely to persist for long without at least occasional demographic and genetic recharge by dispersing individuals from other nearby populations. Re-colonization becomes less likely as habitat is fragmented and populations isolated. Large populations, or clusters of subpopulations close enough and with land conditions that permits exchange of dispersers, may be important for the persistence of each subspecies and for the species (Stinson 2013).

Most of the Mazama Pocket Gophers in the southern Puget Sound region currently occur in ~10 general areas in Pierce, Thurston, and Mason counties. These concentrations of known gopher occurrences and prairie soil types are separated by distance or rivers, and vary widely depending on soils present and the land-use history. What is known about abundance and distribution for the subspecies in Thurston County is summarized below (Stinson 2005, Stinson 2013).

- **Olympia Pocket Gopher.** What is probably the largest population of Mazama Pocket Gophers is found in the loamy sand soils at the Olympia Airport and surrounding areas in Tumwater on the historical Bush Prairie. Gophers are scattered over several hundred acres of maintained grassland at the airport, where they are relatively unmolested by humans or domestic animals. Gophers are also found in vacant lots, yards, and pastures in nearby locations on both sides of Interstate 5. In 2005, McAllister and Schmidt (2005) derived a crude population estimate of 6,040 for the airport, but no trapping was done to determine how closely this approximated the number of actual gophers.

Chambers Prairie, extending from about Ward Lake to Lake St. Clair, is the largest area of Nisqually soil type (3,700 ac (1497 ha)), and probably historically supported an extensive gopher population. Most of the area has residential development of various densities. Chambers Prairie has gophers scattered in vacant lots, roadsides, and rural and agricultural sites, but no large extensive populations like the airport are known. The northwestern half of the area is within the urban growth areas of Olympia and Lacey, and much is densely developed such that likelihood of extensive local extirpation is elevated. The southeastern half of this area also has turf, Christmas tree, and berry farms, and other smaller farms and pastures.

Little Chambers Prairie and Hawks Prairie contain substantial areas of loamy sand soils, but most of the suitable habitat is heavily developed, with dense residential neighborhoods, roads, and businesses. Small pockets of habitat with gophers exist on some less developed or undeveloped lands, but these appear to be small and isolated, and may not persist in the long-term.

- **Tenino Pocket Gopher.** Rocky Prairie, south of East Olympia and north of Tenino, totals about 2,200 ac (890 ha). Within this area, WDFW West Rocky Prairie Wildlife Area (WLA) includes 270 ac (109 ha) of mounded and terraced prairie. No gopher population appeared to be present at West Rocky WLA until a translocation project established a gopher population using gophers captured at the Olympia Airport (Olson 2011b). A 750 ac (304 ha) area adjacent to West Rocky Prairie WLA is owned by a sand and gravel company. East of West Rocky Prairie WLA, Wolf Haven International maintains 38 ac (15 ha) of native mounded prairie with a small Mazama Pocket Gopher population established by translocation (Linders 2008). North of Wolf Haven International is a large area (600 ac (243 ha)) of mounded prairie on private lands with Spanaway-Nisqually complex soil that was once a ranch. It supported a significant population of gophers in the early 1990s; current status of gophers at this site is unknown. West of this property is Rocky Prairie Natural Area Preserve (NAP) where very small numbers of gophers are detected occasionally. The translocation projects (2005-2008, 2009-2011) moved gophers from the Olympia Airport and two Tumwater sites, both within the range of Olympia Pockeg Gopher, and established populations in the range of Tenino Pocket Gopher. The population status of Tenino Pocket Gopher may have been tenuous, as Steinberg (1996) was unable to find any, and only very small numbers of gophers had been detected in the area since then. Any future translocations will maintain separation of subspecies, unless genetic analysis indicates taxonomic distinction is not warranted.

- **Yelm Pocket Gopher.** Mound Prairie, near Grand Mound, is bisected by Interstate 5 (I-5). West of I-5, north and south units of Scatter Creek Wildlife Area (WLA) support significant gopher presence. After 2004, when Scotch broom (*Cytisus scoparius*) control became widespread and intensive, gophers spread throughout the northern two thirds of the north unit, where they hadn't been observed previously. Scatter Creek WLA contains about 600 ac (243 ha) of prairie, and is mostly Spanaway-Nisqually complex soils. The north unit has about 80 ac (32 ha) of Nisqually soil and the south unit has about 8 ac (3.2 ha) of Nisqually soil. Most of the land west of I-5 near Scatter Creek WLA is subdivided into 5 ac (2 ha) parcels, with some higher density, including the Grand Mound Urban Growth Area.

Rock Prairie, an area of ~1,200 ac (486 ha) of private lands, is located southwest of Tenino. The area still supports Mazama Pocket Gophers on two large ranches (Steinberg 1996), and one ranch has a 500 ac (202 ha) Grassland Reserve Program easement with management guidelines that protect prairie vegetation and maintain conditions suitable for gophers. Some of the remaining private lands have not been surveyed for gophers.

The historical Tenalquot Prairie area includes Weir Prairie (Upper, Lower, and South Weir), and Johnson Prairie, which are in the Rainier Training Area of JBLM, and Tenalquot Prairie Preserve. Most of the area is Spanaway soil types. This area also includes private lands south of the Rainier Training Area. The Weir Prairie Research Natural Area consists of Upper Weir Prairie (547 ac (221 ha)) and Lower Weir Prairie (440 ac (178 ha)), and is protected from the most destructive forms of military training, such as off-road vehicle maneuvers and digging. A WDFW research team found a density of ~2 adult gophers/ac on Lower Weir Prairie during 2010 and 2011. Johnson Prairie is about 194 ac (79 ha) of native and semi-native grassland and is among the highest quality Puget prairies. It supports a substantial population of Mazama Pocket Gophers (Steinberg 1995, WDFW data), as well as a high diversity of plants, butterflies, Oregon Vesper Sparrows, and western toads (Remsburg 2000, Altman 2003). Past activities have primarily been foot maneuvers, parachuting, and limited vehicle use (Remsburg 2000). No tracked or wheeled vehicle use is allowed off established roads, because the site is designated a Secondary Research Natural Area. Civilian recreational impacts are an increasing concern on Johnson and Weir prairies because unauthorized off-road vehicle use has increased in recent years. These areas also are used frequently for hunting and horseback riding.

Tenalquot Prairie Preserve is a 125 ac (51 ha) preserve south of South Weir owned by The Nature Conservancy; WDFW has a Conservation Easement on the property. It is being restored to high-quality prairie by Center for Natural Lands Management. Gophers are present in low numbers in the Spanaway soils of the area.

Life History and Ecology

Description. Mazama Pocket Gophers are small fossorial rodents with stocky, short-necked bodies generally less than 5.5 in (~14 cm) long, with tails 2.5 in (~ 6.3 cm) long, and small ears and eyes. They have cheek pouches which are used to transport food, and which can be turned inside-out to empty contents (Stinson 2005, Stinson 2013). Pocket gophers use their strong claws and rootless, chisel-like incisors for tunneling and foraging, and can close their lips behind their incisors to avoid getting soil in their mouths. In the process of tunneling, pocket gophers periodically push soil behind them from angled lateral tunnels, either turning around to use their palms and blunt noses or pushing soil beneath them and using their hind legs; this creates irregular, fan or kidney-shaped mounds with soil that is characteristically finely sifted. They also plug their tunnel entrances, and the plugs are often visible when viewing their mounds (Verts and Carraway 1998, Stinson 2005, Stinson 2013). Pocket gophers spend most of their time within their system of burrows (Stinson 2005; Stinson 2013). Gophers are believed to be generally solitary and exclude other gophers from their burrows except when breeding and when females have litters (Chase et al. 1982, Stinson 2005, Stinson 2013). When pocket gophers have established a territory, they generally remain there, although they will shift their home range in response to seasonally wet soils.

Pocket gophers adjust their annual cycle of activity to the seasonal changes of weather, soil, and plant growth where they occur (Cox and Hunt 1992). Pocket gopher territory (i.e., burrow systems) sizes vary with habitat quality and reproductive status. Using radio-telemetry, Witmer et al. (1996) estimated that the late winter-early spring home range of Mazama Pocket Gophers on a fallow field averaged 1,163 ft^2 (108 m^2) for four males (range 73–143 m^2), and 1,044 ft^2 (97 m^2) for four females (range 506-1,625 ft^2 (47–151 m^2)). WDFW personnel captured an average of 9 gophers/ac in a 22 ac (8.9 ha) plot at Olympia Airport, but some gophers remained in the plot (G. Olson, unpubl. data).

Mazama Pocket Gophers attain sexual maturity by the breeding season after their birth, when ~ 9 mo old and rear a single litter of ~5 (2-7) pups per year (Witmer et al. 1996, Verts and Carraway 2000, Stinson 2005). Gopher populations can increase dramatically in the summer after the dispersal of young of the year, and may increase to 3–4 times the spring adult population. In addition to this annual influx of young-of-the-year, gopher populations also fluctuate year-to-year due to environmental conditions. Pocket gopher populations are characterized by local extinction and recolonization (Baker et al. 2003). Territoriality and extreme weather may influence pocket gopher populations more than any other factors.

Pocket gophers have been called 'keystone species' and 'ecosystem engineers' because they affect the presence and abundance of plants and other animals (Vaughan 1961, 1974; Reichman and Seabloom 2002). Their extensive excavations affect soil structure and chemistry; food caches and latrines enrich the soil, affecting plant community composition and productivity. Mazama Pocket Gophers are an important prey species for many predators, including hawks, owls, coyotes, and weasels; their burrows provide retreats for salamanders, western toads, frogs, lizards, small mammals, and invertebrates (Stinson 2005, Stinson 2013).

Habitat Characteristics

Mazama Pocket Gophers live on open meadows, prairies and grassland habitats of the glacial outwash plain where there are porous, well-drained soils (Dalquest 1948, Johnson and Cassidy 1997, Stinson 2005, Stinson 2013). Historically, Mazama Pocket Gophers are believed to have resided in high-quality prairies dominated by native vegetation; in current times, remaining gopher populations are known to live in a wide range of grasslands, particularly if they include a significant component of fleshy-rooted forbs such as clover, lupines, dandelions, false dandelions, and camas (Stinson 2005, Stinson 2013). Enhancement of remnant prairies from degraded to high-quality may prove the difference between Mazama Pocket Gophers barely surviving versus thriving. In addition to remnant prairies, occupied sites in Washington include grassy fields at airports, pastures, fields, Christmas tree farms, and occasionally clearcuts (Stinson 2005, Stinson 2013).

Although most of the populations are found in grasslands on land that historically was prairie, they will move into sites with well-drained soil where forest cover has been removed, including recent clearcuts. Gophers are known to populate sites after timber harvest and become common for a few years while grasses and forbs are available, but decline as the area regenerates to forest. This has been observed most frequently in Mason County (Stinson 2005, Stinson 2013). They are otherwise essentially absent from forest habitats in Washington, particularly those with well-developed shrub understory. Mazama Pocket Gophers occur in open woodland in Oregon, particularly in ponderosa pine communities, but they are absent from dense forest (Verts and Carraway 1998). Gophers also are rare where grassland has been taken over by dense Scotch broom (Steinberg 1996, Olson 2011b), but have been to at least temporarily persist among lower-density Scotch broom (Olson 2011b).

Perennial forbs are preferred for food over grasses, and fleshy roots and bulbs, such as camas, are important when green vegetation is not available. The availability of forbs may provide nutrients important for gopher growth and reproduction (Stinson 2005, Stinson 2013). Gophers also eat fungi and disseminate the spores of species that have an important role in facilitating plant growth.

The distribution and abundance of pocket gophers are greatly affected by soils. Soil characteristics that affect gophers include depth and texture, particularly rock and clay content that affects burrowing ability, permeability that can result in periodic flooding of burrows, and water-holding capacity and fertility that affect growth of plant foods. In general, pocket gophers prefer deep, light-textured, porous, well-drained soils, and do not occur in peat or heavy clay soils (Chase et al. 1982, Baker et al. 2003).

Distribution of Mazama Pocket Gophers appears correlated with prairie soil types, but they are not found on all remnant prairie sites. They rarely occur where soil is very rocky (Steinberg 1996, Olson 2011b). There are local populations in non-prairie loam, sandy, and gravelly soil types (e.g., Indianola loamy sand, Grove, Everett) that may have been unused by gophers historically due to forest cover. These occurrences often are adjacent to more typical prairie soils (e.g., Nisqually soils). They may be able to occupy any site that supports herbaceous vegetation, does not have significant tree cover, and is well-drained sandy, loamy, or gravelly soil. Mazama Pocket Gophers in Washington have not been found in clay, and there are few records in silt soils. In sum, deep, well-drained, sandy loam or loamy sand with sufficient fertility and water holding capacity to support desired forbs appears to provide optimal habitat (Baker et al. 2003).

Threats/Reason for Decline

Much of the Mazama Pocket Gopher habitat in the south Puget Sound has been lost to development, agriculture, and succession to forest, and what remains continues to be degraded by invasion of Scotch broom and other non-native plants (Stinson 2005, Stinson 2013). Residential development that becomes high density has been particularly destructive to prairie habitat, and probably led to extinction of one subspecies of Mazama Pocket Gopher: *T. m. tacomensis*. Habitat loss has eliminated most of the prairie vegetation, though significant areas remain in grassland. Though Mazama Pocket Gophers are generally protected in recent years by state, county, and local regulation, development may result in some unavoidable habitat loss and additional fragmentation and isolation of habitat patches. Degraded sites may often represent habitat that can support young that have dispersed, but offer inadequate food to consistently support reproduction. Pocket gophers may not persist in high density residential areas due to effects of frequent mowing, herbicides, impervious surfaces, and perhaps elevated mortality rates resulting from predation by cats and dogs and illegal trapping or poisoning of gophers (Stinson 2005, Stinson 2013). Most occupied habitat on public lands is affected by non-conservation uses including military training and recreation. Gopher populations at airports can be affected by development of airport-related facilities and businesses and management of the vegetation around airport runways and taxiways. Gopher populations at airports benefit from mowing which prevents invasion of the extensive grassland by woody vegetation.

Trends in the human population suggest that amount and quality of habitat will continue to decline without protection and careful management of conflicting uses. Thurston County is projected to have significant numbers of additional people and to need substantial numbers of added single-family housing units and multi-family units in the near future. As the habitat patches become smaller, fewer, and farther apart, the likelihood of each patch continuing to support grassland-dependent species declines as intervening habitat patches are lost. These trends generally affect gophers negatively.

The persistence of Mazama Pocket Gophers on roadsides, vacant lots, lightly grazed pastures, and within commercial timberland suggests that they are relatively resilient, and may be able to persist in rural and low density developed areas. However, recent extinction of the Tacoma pocket gopher indicates that life for gophers in high density residential and commercial areas is hazardous and recruitment and re-colonization is inadequate to maintain local populations. The last possible records of the Tacoma pocket gopher were animals that were killed by domestic cats (*Felis catus*) and identified as gophers by homeowners (Ramsey and Slipp 1974). It is not known if the mortalities from these sources have a significant effect on gopher populations, particularly in less densely settled areas. Domestic dogs (*Canis lupus familiaris*) also are known to kill pocket gophers, but are probably less often free-roaming in unfenced areas. Pocket gophers can damage young trees and, like moles, their diggings can be an untidy nuisance to landowners desiring attractive lawns. They can also be a problem in vegetable gardens and at Christmas tree, berry, and vegetable farms in the area. Mazama Pocket Gophers are currently protected from killing without a permit; the frequency that they might be trapped or poisoned is unknown. When larger populations are suppressed by these methods, they readily recover if habitat remains suitable, but for small and isolated populations, mortality from persecution added to other hazards may lead to extirpation.

Livestock grazing. Gophers may survive in pastures in rural residential areas, but studies in California indicate that gopher density tends to decrease in heavily grazed pastures (Eviner and Chapin 2003). *T. mazama* has persisted on well-managed ranches in Thurston County.

Gravel mining. South Puget Sound prairies are located on glacial outwash gravels. Some of these glacial gravel deposits are very deep and valuable for use in construction and road-building, and prairie sites of significant size may be destroyed by gravel mining. One of the historic sites where Tacoma pocket gophers were collected became a large gravel pit, and 2 gravel pits have been opened on occupied gopher habitat in Pierce County south of Roy, and on historical Rock and Rocky prairies in Thurston County. These sites may be restorable to suitable condition for gophers when gravel removal operations have ceased if adequate layers of friable well-drained subsoil and topsoil are restored.

Airport Management and Development. Pocket gophers occur in grasslands surrounding airport runways and adjoining lands at Olympia and Shelton. Airport safety considerations require that the vegetation be mowed to maintain visibility, eliminate cover for large animals that might pose a hazard for aircraft, and provide a safety margin should aircraft overshoot or land short of the runway. This management benefits gophers by keeping out woody vegetation and maintaining the grassland. Development of aviation facilities and the surrounding port lands at the Olympia Airports pose a potential threat of habitat loss for what may be the largest populations of Mazama Pocket Gophers. The Olympia Airport designated 8.6 ac (3.5 ha) as a Mazama Pocket Gopher habitat conservation area in an interlocal agreement with WDFW as part of the Airport Five Year Development Plan, and any additional development would be subject to Tumwater Critical Area Ordinances. The Port of Olympia is currently updating their master plan. The Plan projects significant future land developed for general aviation (~114 ac (46 ha)), aviation related/compatible industry (~245 ac (99 ha)), and additional area for parallel taxiways (Barnard Dunkelberg & Co. 2011).

Military Training. The presence of Fort Lewis (part of Joint Base Lewis-McChord) has prevented the loss of habitat to agricultural and residential development for some of the largest remaining Mazama Pocket Gopher populations. The gophers exist primarily on prairies where vehicular traffic is currently restricted to established roads, but there are no specific restrictions on training to protect gophers (J. Foster, pers. comm.). The number of Army personnel stationed at JBLM has increased and additional increase is planned (Ft. Lewis Directorate of Public Works 2010). Steinberg (1995) speculated that military training by mechanized units may have negatively affected some gopher populations by compacting the soil. The increase in training needs is likely to increase impacts on grasslands and pocket gophers, but the most damaging training has been concentrated on the same areas, so some less-used prairies have been maintained in good condition. Since gophers do not require native vegetation, the effect of degraded vegetation on gopher populations is uncertain. Changes that decreased the cover of perennial forbs would likely have a negative effect on gophers. Areas damaged by military training are repaired by the Land Rehabilitation and Maintenance program.

Fires that burn the vegetation, whether as part of restoration activities or as a side-effect of training during the summer, help reduce invasion by Douglas-fir (*Pseudotsuga menziesii*) and Scotch broom and have maintained some of the highest quality prairie sites on JBLM. However, smaller portions of the AIA seem to burn too frequently, have a low percentage of native species, and a cover of mostly exotic annual grasses (Tveten and Fonda 1999).

Succession and invasive plants. The fire regime established and perpetuated by Native Americans maintained the south Puget Sound prairies for the past 4,000 years, or more. Fire suppression allows succession by native and exotic flora, and without vegetation management the native prairies would probably disappear. Fire suppression allows fire-sensitive species to invade and allows an unusual build-up of fuels that can lead to very hot fires, harming the normally fire-tolerant native species (Tveten 1997). The largest remaining prairie (91st Division) is maintained by prescribed and accidental fires, but large portions of these areas are also subject to disturbance during military training.

Fire suppression allows Douglas-fir to invade and overwhelm prairie. Disturbances such as grazing and vehicle traffic may accelerate colonization by Douglas-fir because Douglas-fir seed germination is enhanced by disturbance that increases mineral soil contact, while native plants may decline with the loss of the moss carpet. Prairie areas where Douglas-fir control has been conducted in recent years include Johnson Prairie and Weir Prairie RNA on JBLM, Mima Mounds and Rocky Prairie NAP, Thurston County's Glacial Heritage Preserve, and Scatter Creek WLA.

Scotch broom is the most visible invasive species that can cover prairies relatively rapidly. Olson (2011a) reported that Scotch broom negatively affected the probability of gopher site occupancy and plot use; the model suggested that plot use appears to decline as Scotch broom cover approached 10%. Parker (2002) reported that the glacial outwash prairie ecosystem is readily invaded by Scotch broom and that simply reducing soil disturbance and fires would not stop broom invasion (Parker 2002). Rook et al. (2011) noted that Scotch broom has long lasting effects on the soil that reduces germination and success of some native species. Scotch broom is killed through burning, hand pulling, or herbicide, but control requires an ongoing program because the plants produce abundant seeds that remain viable in the soil for several decades. Regular mowing can prevent additional Scotch broom seed production. Fire often stimulates germination of broom seeds in the soil, so a second burn, or herbicide is needed to kill the abundant seedlings. Portions of the Artillery Impact Area on JBLM are broom free, indicating that frequent burning prevents broom establishment, but this can also affect native species. All control methods can be detrimental to native species if not well planned.

There are numerous invasive exotic plants that degrade native prairies in the south Puget Sound region, in addition to Scotch broom. Techniques for restoration of the prairies and oak woodlands of the Willamette Valley-Puget Trough-Georgia Basin ecoregion are reviewed in Dennehy et al. (2011), Dunwiddie and Bakker (2011), Hamman et al. (2011), and Rook et al. (2011).

Implications of habitat loss for populations. Pocket gophers are vulnerable to local extinctions because of the small size of local breeding populations (Steinberg 1999). Low effective size of local populations and relatively large genetic differences between populations may be typical of gopher populations (Daly and Patton 1990). Pocket gophers have probably persisted by continually re-colonizing habitat after local extinctions; the loss of habitat patches and increases in hazards such as busy roads may have inhibited the re-colonization that historically occurred. Where additional habitat exists within a few hundred meters, some dispersal and resulting gene flow probably occurs between local populations, and vacant habitat is rapidly colonized. However, as habitat patches become smaller, fewer, and further apart, the likelihood of each patch continuing to support pocket gophers declines.

Oregon Vesper Sparrow (*Pooecetes gramineus affinis* Miller, 1888)

Conservation Status

The Oregon Vesper Sparrow (*Pooecetes gramineus affinis*) is a subspecies of conservation concern across its range in western Washington and Oregon. The American Bird Conservancy considers Oregon Vesper Sparrow to be a priority for conservation and have been documenting its status over the last two decades (Altman 2000, 2011, 2015, 2017). In British Columbia, where it is called the 'Coastal Vesper Sparrow,' it was listed as endangered in April 2006 (COSEWIC 2006) and has likely been extirpated as a breeding species (S. Beauchesne, pers. comm. *in* Altman et al. 2020, p. 2). The USFWS was petitioned by The American Bird Conservancy to list Oregon Vesper Sparrow under the Endangered species Act in November 2017 (American Bird Conservancy 2017). The USFWS made a finding that that petition was substantial in June 2018 (USFWS 2018) and the subspecies is current awaiting a 12-month review that will determine if listing is warranted. WDFW completed a status assessment for Oregon Vesper Sparrow in May 2020 that recommended endangered status for Oregon Vesper Sparrow in Washington (Altman et al. 2020). WDFW is scheduled to present the findings and recommendation to the Washington Wildlife Commission in October 2020.

Population Trends and Distribution

The breeding range of Oregon Vesper Sparrow previously extended from southwestern British Columbia through western Washington, western Oregon, and into the northwestern tip of California (Campbell et al. 2001; Jones and Cornely 2002; Altman 2003), but the breeding range has since contracted in the north and south (Altman et al. 2020, pp. 6-7). "Oregon Vesper Sparrows are migratory and overwinter in California, west of the Sierra Nevada Mountains and south of San Francisco Bay, and historically into northwestern Baja California, Mexico (Erickson 2008). Regular wintering areas extend from Sutter County southward, primarily through the low foothills surrounding the Sacramento and San Joaquin valleys, to the foothills and valleys of southwestern California (Erickson 2008)" (Altman et al. 2020, p. 2).

In Washington, Oregon Vesper Sparrow occur in lowland areas west of the Cascade Mountains (Jewett et al. 1953, Smith et al. 1997; Mlodinow 2005). Although nesting records are few, historical breeding range is believed to have extended from northern Skagit County, the San Juan Islands, and Clallam County (Dungeness and Sol Duc) south through southern Puget Sound (including Thurston County) and probably included Clark County (Camas and Vancouver) (Altman et al. 2020, p. 2). The current breeding population in Washington is now limited almost entirely to remnant prairies in Thurston and Pierce Counties. Outside of Thurston and Pierce counties small numbers still breed in near Shelton in Mason County (Smith et al. 1997; Mlodinow 2005; G. Slater pers. comm. *in* Altman et al. 2020, p. 9). Oregon Vesper Sparrow recently occupied San Juan Island in San Juan County but have not been detected in several years (S. Vernon pers. comm. *in* Altman et al. 2020, pp. 9, 11, 28).

Breeding season presence in Thurston County during the past 20 years has been recorded at Scatter Creek, Mima Mounds, West Rocky Prairie, Weir Prairie, Johnson Prairie, Tenalquot Prairie, the Olympia airport, Glacial Heritage Preserve, north of Bucoda, Goodard Road SW, and unspecified sites in Grand Mound, Rainier, Lacey, Tumwater, and Nisqually (WDFW WSDM internal database; not publicly accessible). The vicinity of Yelm was once considered a prime area for the subspecies (Jewett et al.

1953), but is no longer occupied. Current breeding season records in Thurston and Pierce County are focused around the prairie habitats of JBLM. Oregon Vesper Sparrow territories also straddle the boundaries between JBLM, CNLM, and private properties on Tenalquot and Weir prairies (G. Slater in litt. 2020). Multiple years of observations at these boundaries suggest that there are at least a few private properties that contain breeding Oregon Vesper Sparrow in Thurston County (Altman 2017, p. 24; G. Slater in litt. 2020). Recent observations of Oregon Vesper Sparrow at Scatter Creek where Oregon Vesper Sparrow were previously considered extirpated (EBird 2020) suggest that Oregon Vesper Sparrow breeding season presence in Thurston County is not fully understood and is not likely to be entirely static in the near future.

Vesper sparrow populations have been declining throughout North America since at least the 1960s (Jones and Cornely 2002). Recent trends in Oregon Vesper Sparrow abundance and distribution continue to reflect that trend, with declines evident across the breeding range (Beauchesne 2006; Altman 2011; Altman 2017; Altman et al. 2020, pp. 28-30). In Washington, the subspecies was originally described as "fairly common" to "rather abundant" in localized areas of western Washington (Altman 2011), but apparently was never common over a widespread area. Larrison and Sonnenberg (1968) reported it as being of limited abundance and range by the mid-1960s. It was "rare and local….in remnant prairie areas" by the 1990s (Smith et al. 1997), with the exception of 91st Division Prairie on JBLM, where about 100 singing males were on established territories in 1998 (Rogers 2000). Altman (2011) previously estimated that there were 250-300 birds in the Puget Lowlands and 50-100 birds on islands along the lower Columbia River. As of 2015, numbers of Oregon Vesper Sparrows in Thurston County were quite small (i.e., zero to a few birds each) at Mima Mounds, Scatter Creek, and West Rocky Prairie (Altman 2015). Oregon Vesper Sparrow are now probably locally extirpated at several places where they were known to breed in the last 15 years, including Mima Mounds, West Rocky Prairie, and the Olympia Airport. "The estimated population of Oregon Vesper Sparrows in Washington is approximately 300 birds, with most (~75%) of them on a single site, JBLM's 91st Division Prairie" (Altman et al. 2020, p. 19).

Life History and Ecology

Vesper sparrows have narrow streaks on their breasts, whitish bellies, notched brown tails, pinkish legs, and dusky brown bills with pinkish lower mandibles (Risining 1996; Altman 2017). Oregon Vesper Sparrow is a medium- to large-sized bird, with a chestnut or rufous shoulder patch, white edges on its outer tail feathers, and white-ringed eyes (Altman 2017). In general, Oregon Vesper Sparrow are somewhat larger and longer-tailed than other sparrows (Jones and Cornely 2002; Altman 2017). Oregon Vesper Sparrow is accepted as a taxonomically distinct unit based on morphological measurements (Ridgeway 1901; American Ornithological Union 1957; Paynter 1970; Pyle 1997; *in* Altman et al. 2020, p. 1). There has not yet been a genetic assessment conducted of the Vesper Sparrow subspecies.

Oregon Vesper Sparrow are present in western Washington mainly from early April through late September (Mlodinow 2005; Altman et al. 2020, p. 4). Males arrive a week or two earlier than females (Best and Rodenhouse 1984; Altman et al. 2020, p. 4) and begin singing and establishing territories. After nesting concludes, Vesper sparrows typically gather in small groups until fall migration (Bailey and Niedrach 1965). Fall migration through western Washington is primarily from mid-August to late September, with fewer records extending into October (WDFW WSDM internal database; not publicly accessible). Migration usually occurs at night, with most individuals joining small flocks of up to 10 birds (Rising 1996; Jones and Cornely 2002). The species sometimes migrates with Horned Larks (*Eremophila alpestris*) and Savannah Sparrows (*Passerculus sandwichensis*) (Berger 1968; Hyde 1979).

Birds begin singing after arriving at their breeding sites (Altman 2003). Singing occurs most frequently early in the morning, subsides during the day, and then increases again from sunset to dusk (Jones and Cornely 2002). Singing is typically performed from elevated perches, such as fences, trees along the edges of fields, shrubs, grass, and the stalks of forbs, but may be conducted from the ground when perches are lacking (Berger 1968; Wiens 1969; Castrale 1983; Jones and Cornely 2002; Altman 2003).

The diet of Oregon Vesper Sparrow is comprised of grass and forb seeds year-round, but is heavily supplemented with insects (especially grasshoppers, beetles, and caterpillars) and other arthropods during the breeding season (Berger 1968, Rotenberry 1980, Jones and Cornely 2002). Most foraging occurs on the ground, but birds will hop and hover to glean food from vegetation.

"In recent years, the Oregon Vesper Sparrow is generally found in large grasslands (e.g. >50 ac) in Washington, but not in small patches of similar habitat (S. Pearson, pers. comm.). In the Willamette Valley, they have been recorded breeding in relatively small areas of 20 acres (8 hectares), but are also absent from many more areas of suitable habitat of that same-size (B. Altman, pers. obs.). Breeding territory size throughout its range averaged 3.6 ac (1.45 ha; n=88; Altman 2016), and likely varies with habitat quality (Jones and Cornely 2002, Altman 2016). On JBLM, average territory size was 2.5 ac (1 ha; n=4) in 2013, and 3.3 ac (1.3 ha; n=7) in 2015 (Altman 2015, 2016). Minimum patch size of grassland has been noted as an important factor in site selection for Vesper Sparrows (Kershner and Bollinger 1996, Vickery et al. 1994)" (Altman et al. 2020, p. 4).

Vesper sparrows become sexually mature a year after hatching and are seasonally monogamous (Jones and Cornely 2002). Average lifespan of Vesper sparrows is unknown, but a maximum of 7.1 years has been recorded for a banded individual in the wild (Klimkiewicz 1997). Females construct the nest alone (Rising 1996). Nests are made from grasses in the shape of a shallow bowl and have an outer diameter of 3-4 in (8-10 cm) (Berger 1968, Godfrey 1986, Peck and James 1987). Nests are placed on flat ground or in a shallow depression, and are usually located next to a clump of vegetation, crop residue, dirt clod, or at the base of a shrub or tree (Jones and Cornely 2002; Altman 2003; Altman 2015; Altman 2017). "Fledging rates were 2.8 young/successful nest and 2.2 young/active nest in the south Puget lowlands in 1996 (n=6 nests; S. Pearson pers. comm.), and 3.4 young/successful nest and 1.6 young/active nest in the south Puget lowlands in 2017-2019 (n=34 nests; G. Slater, pers. comm.)" (Altman et al. 2020, p. 5).

Oregon Vesper Sparrow nest from about late April to mid-July (Bowles 1921, Altman 2003, Beauchesne 2006, Altman et al. 2020, p. 4). Oregon Vesper Sparrow has been observed to start a second brood (re-nest) following a successful first nesting (B. Altman unpubl. data, Altman 2017, Altman et al. 2020, pp. 1, 5). Eggs measure 20 mm (0.8 in) long by 15 mm (0.6 in) wide on average (Jones and Cornely 2002). Clutch size for Vesper sparrows (including Oregon Vesper Sparrow) is usually 3-5 eggs (range = 2-6 eggs). Incubation averages 12-13 days and is performed mostly by the female. Both parents feed the chicks, although primary responsibility of the first brood may fall to the male if the female begins a second brood (Berger 1968). Young fledge from the nest after 9-10 days on average and remain dependent on the parents for another 20-29 days (Perry and Perry 1918, Dawson and Evans 1960).

Vesper sparrows in general exhibit high site fidelity. For example, Best and Rodenhouse (1984) reported that about half of breeding adults return to their nesting site the following year. Oregon Vesper Sparrow, however, exhibit a particular significant site fidelity that challenges their ability to colonize or recolonize suitable habitat. High fidelity to breeding locations of Vesper Sparrows also limits the demographic and genetic interchange between sites (Altman et al. 2020, p. 16). Altman and others (2020, pp. 4, 15-6) emphasized the importance of site fidelity for Oregon Vesper Sparrow in Washington.

Gary Slater, quoted in Altman et al. 2020 (p. 4), noted that none of the 19 banded Oregon Vesper Sparrow have returned to a different breeding location. Anecdotal information suggests this is possible though. Compared E-bird data and surveys suggest that Oregon Vesper Sparrow were extirpated from Scatter Creek Wildlife Area but may have returned in 2020 (Altman et al. 2020, p. 29; EBird 2020).

Habitat Characteristics

Vesper sparrows inhabit a variety of grassland types, including shortgrass and tallgrass prairie, desert and semi-desert grasslands, shrub-steppe, croplands, hay fields, pastures, weedy fence rows and roadsides, and woodland edges (Campbell et al. 2001, Jones and Cornely 2002, Altman 2015). Preferred areas for breeding territories typically have short, sparse and patchy grassy and herbaceous cover, some bare ground, low to moderate shrub or tall forb cover, and low tree cover (Reed 1986, Campbell et al. 2001, Dechant et al. 2002, Jones and Cornely 2002). Some structural diversity of vegetation appears to be an important factor in site selection, with shorter vegetation chosen for foraging and scattered taller plants used for cover and singing perches (Davis and Duncan 1999, Beauchesne 2006).

Oregon Vesper sparrows also show some variation in breeding habitat. In western Washington, the subspecies was originally widespread in prairies and pastures (Jewett et al. 1953), but had become restricted to the edges of open prairies by the 1990s (Rogers 2000, Mlodinow 2005). Breeding habitat in the state remains poorly quantified. Clegg (1998, 1999) reported that all breeding territories (n = 23) at JBLM were in areas of high-quality prairie supporting intact Idaho fescue (*Festuca idahoensis*) located near prairie edge. Size of the prairie appears to be an important factor in current site selection, with only large prairies occupied now. As noted above, “in recent years, the Oregon Vesper Sparrow is generally found in large grasslands (e.g. >50 ac) in Washington, but not in small patches of similar habitat (S. Pearson, pers. comm.)” (Altman et al. 2020, p. 4).

In strong contrast to western Washington, nearly all detections of Oregon Vesper sparrows in Oregon’s Willamette Valley are in young Christmas tree farms (i.e., 2-5 years after planting) with extensive grass and weed cover, or in lightly grazed pastures with scattered shrubs and grass heights of less than 30-60 cm (1-2 ft) high (Altman 1999, 2003). Habitats avoided include cultivated grass fields, highly manicured Christmas tree farms, and fallow fields with grass heights exceeding 2 ft (60 cm) high. In southwestern British Columbia, the subspecies originally bred in pastures, agricultural land, and airport fields with patches of grasses and weeds (Campbell et al. 2001), then only in grasslands next to hayfields, which contain native and non-native plants (Beauchesne 2006), and now Oregon Vesper Sparrow appears to be extirpated in Canada (S. Beauchesne, pers. comm. *in* Altman et al. 2020, p. 2).

The only study characterizing the microhabitat of nest locations of Oregon Vesper sparrows reported that nests in the Willamette Valley were built in areas with relatively reduced grass cover (49%) and sizable amounts of bare ground (24%) and litter/ residue (21%), compared to other locations within territories (Altman 1999, 2000). Woody vegetation also was regularly present near many nests. Rogers (2000) reported reduced vegetation heights (average = 6-8.5 in (15-21 cm)) and densities at foraging locations compared to random sites in prairies in Pierce and Thurston counties, Washington. Altman (2017, p. 47) suggested that suitable breeding habitat for Oregon Vesper Sparrow has less than 10% tree cover, less than 15 % shrub cover, 5 to 15% bare or sparsely vegetated ground cover, more than 15% forb cover, and herbaceous cover that is structurally and compositionally diverse with mean graminoid height in mid to late May of 6 to 20 in (with more than 40% of that less than 12 in (30 cm) height, less than 40 % of that 12-24 in (30-60 cm), and less than 20% of that greater than 24 in (60 cm) tall).

Threats/Reasons for Decline

In a recent summary of Oregon Vesper Sparrow status in Washington, Altman and others (2020, p. 14) wrote: "The primary factor responsible for historic declines in Oregon Vesper Sparrows in Washington is likely habitat loss and degradation. The primary factor(s) affecting continued existence are less certain. Habitat degradation is probably still an issue, but several other potential factors include higher nest predation in fragmented habitat, human disturbance during the nesting season, genetic and demographic factors associated with small population size, and possibly neonicotinoid pesticides (Smith et al. 1997, Altman 1999, 2003, 2011, Rogers 2000, Beauchesne 2006, Eng et al. 2016, Frankham et al. 2017)."

Two major factors contributing to the declines of Vesper Sparrows in much of their North American range are habitat loss through conversion of native grasslands and shrublands to unsuitable types of agriculture, and the shift in farming practices to more intensive tillage and greater use of chemicals (Jones and Cornely 2002). Grazing impacts on Vesper Sparrows vary with grazing intensity and soil type, but locations exposed to heavy grazing typically support lower breeding densities than sites with moderate and light grazing (Kantrud and Kologiski 1982, Altman 1999). In addition to habitat modification, grazing can result in trampling of nests (Altman 1999).

Declining populations of Oregon Vesper Sparrow result primarily from habitat loss and degradation, and potentially from increased predation and human disturbance (Smith et al. 1997, Altman 1999, 2003, 2011, Rogers 2000, Beauchesne 2006). South Puget Sound prairies originally covered an estimated 60,470 ha (149,360 ac), but had declined in size by 90% by the mid-1990s, with only 3% remaining in intact prairies (Crawford and Hall 1997). During this period, the number of prairies in south Puget Sound fell from 233 to 29 sites and average size decreased from 641 to 433 ac (260 to 175 ha). This decline was driven by urban conversion, encroachment of Douglas-fir forests caused by fire control, and conversion to farmland (Chappell and Kagan 2001). Many remaining prairies are degraded by the invasion of Scotch broom and other non-native plants (Chappell and Kagan 2001).

Oregon Vesper Sparrows also may be experiencing increased predation from species associated with semi-urban and residential areas such as feral and domestic cats, raccoons (*Procyon lotor*), American crows (*Corvus brachyrhynchos*), and opossums (*Didelphis virginiana*) (Altman 1999, Rogers 2000, Pearson 2003, Stinson 2005, Beauchesne 2006). "Vander Haegen et al. (2002) and Vander Haegen (2007) reported that real and simulated songbird nests in a fragmented landscape in Washington were nine times more likely to be depredated than those in continuous landscapes" (Altman et al. 2020, p. 16).

"The main threat on the wintering grounds is likely human and agricultural development of relatively open, flat ground at low elevations (e.g., the development of the Los Angeles basin and San Fernando Valley) (Erickson 2008). This includes agricultural pressures, especially a proliferation of vineyards, and development particularly from Ventura County south. Chemically treated seed in existing cropland in wintering areas may also be an important potential threat" (Altman et al. 2020, p. 15). "Some recent studies suggest the widespread use of neonicotinoids is correlated with declines in grassland birds (Mineau and Palmer 2013, Mineau and Whiteside 2013, Hallmann et al. 2014). Turfgrass seed and oil seeds are produced on substantial acreage in the Willamette Valley which has also seen a dramatic decline in Oregon Vesper Sparrows (Myers and Kreager 2010). Seeds of canola, corn, wheat, and turf grasses are routinely treated with neonicotinoid insecticides and/or fungicides, and some neonicotinoids are sufficiently toxic to small birds such that ingestion of a few treated seeds can cause death, inhibit normal reproduction, or affect migratory ability (Goulson 2013, Mineau and Palmer 2013, Gibbons et al. 2015, Eng et al. 2017). Eng et al. (2017) reported that during captive trials, White-crowned Sparrows (Zonotrichia leaucophrys) consuming the equivalent of four imidacloprid-treated canola seeds per day over three days suffered significant weight loss and failed to orient normally for migration" (Altman et al. 2020, p. 17).

"Environmental events, such as severe droughts, fires, or disease can decimate small populations. Genetic problems can occur with small isolated populations and can interact with demographic and habitat problems, leading to a population's extinction (Frankham et al. 2017). Inbreeding and poor genetic diversity can result in weak immune systems (Allendorf and Ryman 2002), reduced reproductive fitness (Höglund et al. 2002), low hatchability of eggs (Briskie and Mackintosh 2004), and the reduced ability to adapt, all of which increases extinction risk (Brook et al. 2002, Frankham et al. 2017). Also, chance shifts in sex ratios or age distributions can affect breeding and recruitment (Foose et al. 1995). Preliminary data on low egg hatch rates in the Puget lowlands (S. Pearson, pers. comm., G. Slater, pers. comm.) and Willamette Valley (B. Altman, unpubl. data) suggest cause for concern" (Altman et al. 2020, p. 16).

Oregon Spotted Frog (*Rana pretiosa* Baird and Girard, 1853)

Conservation Status

The Oregon Spotted Frog (*Rana pretiosa*) is listed by the USFWS as Threatened (USFWS 2014b), and was listed as endangered in Washington in 1997. The species persists in seven Washington subbasins/watersheds (79 FR 51663). In Thurston County, Oregon Spotted Frogs occur in the Black River drainage. The Oregon Spotted Frog population on Beaver Creek (a tributary of the Black River) occurs adjacent to West Rocky Prairie and is the only remaining population in the south Puget Sound Lowlands associated with native prairie. Washington State status has been reported (McAllister and Leonard 1997, http://wdfw.wa.gov/publications/00382). Information herein relies heavily on information gathered for the Draft Washington State Recovery Plan for the Oregon Spotted Frog (Hallock 2013).

Population Trends and Distribution

The Oregon Spotted Frog is a Pacific Northwest endemic historically distributed from southwestern British Columbia, Canada (Matsuda et al. 2006, Hallock 2013) to northeastern California, USA (Hayes 1997a), including the Puget Trough-Willamette Valley, and East Cascades-Modoc Plateau ecoregions. Oregon Spotted Frog populations have declined throughout the range and have been extirpated from large portions of their historical distribution. Range loss based on historical site analysis is estimated to be 79%, but may approach 90% (Hayes 1997a, Haycock 2000, Hallock 2013). Available evidence indicates the species has been extirpated from the southern portion of its range in California and the lowland Willamette Valley in Oregon; the fate of populations at the northern extreme of the range in Canada is precarious (Hayes 1997a, Haycock 2000).

Locations of Oregon Spotted Frog populations in Washington went largely undocumented historically (Hallock 2013). McAllister and Leonard (1997) reviewed museum records from major herpetological collections of North America. These specimens reveal an historical distribution in the Puget Trough lowlands and southern Washington Cascades (McAllister 1995, McAllister and Leonard 1997) with nine widely separated populations verified by specimen records (McAllister and Leonard 1990, 1991, McAllister et al. 1993). McAllister and Leonard (1997) identified 2 additional historical localities, Pattison Lake and Kent, based on reports by Professor James Slater and Warren Jones. In 2011 and 2012, Oregon Spotted Frogs were found in the South Fork Nooksack River, Samish River, and Chilliwack River drainages (Gay and Bohannon 2011, Bohannon et al. 2012). Assuming that watersheds currently occupied were also occupied historically, Oregon Spotted Frogs occupied at least 14 watersheds in Washington. All Washington sites, historical and extant, are found below 634 m (2,080 ft). Six extant occurrences persist in Washington including populations in the lower South Fork Nooksack River (Whatcom Co.), lower Chilliwack River (Whatcom Co.), upper Samish River (Whatcom & Skagit Cos.), upper Black River (Thurston Co.), lower Trout Lake Creek (Klickitat and Skamania Cos.) and Conboy Lake in Outlet Creek (Klickitat Co.) (Hallock, 2013).

In 2020, Oregon Spotted Frog distribution in the Upper Chehalis sub-basin is limited to habitat in the Black River watershed including tributaries to the Black River above River Mile 10. Surveys for Oregon Spotted Frog in seemingly suitable habitat within the upper Chehalis sub-basin have not detected the species outside the Black River Watershed (Hallock 2016, p. 61; Hayes *et al*. 2017, p 3). Currently Oregon Spotted Frogs are known to occupy wetlands in the floodplain and tributaries of the upper Black River drainage between Black Lake and Mima Creek. There are 13 breeding populations. Oregon Spotted Frog habitat in this sub-basin is managed by a variety of owners, including USFWS Nisqually National Wildlife Refuge-Black River Unit, WDFW, land conservancy groups, private companies, and private individuals.

Oregon Spotted Frogs are currently known to occur at four locations within the Black River floodplain (“Pipeline” near the confluence of Dempsey Creek, Blooms Ditch near 110th Avenue Bridge, near 123rd Avenue, and the confluence with Mima Creek) and in four tributaries: Dempsey Creek, Salmon Creek (including Hopkins Ditch), Allen Creek, Bloom's Ditch, and Beaver Creek (Hallock 2013, pp. 29-32; WDFW 2019, unpublished data). In 2012, 2013, and 2018 new breeding locations were detected along the Fish Pond Creek system, which flows directly into Black Lake, not Black River. Oregon Spotted Frog breeding areas in the Black River may be isolated from each other by roads, distance, and areas of unsuitable habitat. Sites associated with Fish Pond Creek may be similarly isolated from sites in the Black River due to the human alteration of the Black Lake drainage pattern, habitat issues, non-native fish, and non-native bullfrogs. The Black River adult breeding population was comprised of at least 1,748 breeding adults in 2012 (Hallock 2013, p. 27), 3,330 breeding adults in 2013, and an estimated 1,816 breeding adults in 2019 (WDFW 2019, unpublished data). Like sub-basins farther north in Washington State, access to private lands was limited, resulting in a likely underestimate in number of breeding adults. Since listing, a number of locations in the Black River and Lake Watersheds have been identified on private lands east of I-5 and as far south as Mima Creek along Black River. Therefore, further survey efforts are needed to determine the full extent of the Oregon Spotted Frog’s distribution, abundance, and trend in the Black River.

Life History and Ecology

The Oregon Spotted Frog is a medium-sized, aquatic, ranid frog. It is named for the black spots covering the head, back, sides, and legs. These spots have ragged edges and light centers, and become larger, darker, and increasingly ragged-edged as the frogs age. An additional characteristic includes upward-oriented, yellow-green eyes, pointed snout, white lip line, and eye mask (Nussbaum et al. 1983, Stebbins 2003, Jones et al. 2005, USFWS 2011, Hallock 2013). Oregon Spotted Frogs aggregate to breed following the coldest weeks of winter. Breeding frogs gather in seasonally flooded margins and shallows of emergent wetlands in areas that receive minimal shading from the surrounding vegetation. Frogs use the same breeding areas every year and, depending on topography and site conditions, may lay eggs at the same site. Orientation to the breeding site is poorly understood, but seems to involve a combination of non-vocal and vocal cues (Licht 1969, Risenhoover et al. 2001a). Due to their lacking vocal sacs (Hayes and Krempels 1986), the male advertisement call sounds like faint, rapid, low-pitched tapping (Stebbins 2003; Hallock 2013). Calling occurs at the water surface and subsurface (Licht 1969, Bowerman 2010). The surface calls orient females to the egg deposition (oviposition) site (Licht 1969). Initiation dates of egg deposition vary by year depending on spring conditions (Licht 1969). In general, oviposition commences when subsurface waters are 45-48°F (7-9°C) and minimum water temperatures rarely fall below 41°F (5°C) (Licht 1971, Hayes et al. 2000, McAllister and White 2001). Other cues also may be involved.

Breeding occurs in February or March at lower elevations (such as Thurston County) and between early April and early June at higher elevations (Leonard et al. 1993). Once initiated, breeding is "explosive" with many pairs breeding during a short time period (Licht 1969, Nussbaum et al. 1983, Briggs 1987). Most frogs spawn mid-day (Licht 1969), but nocturnal spawning also has been detected using wildlife cameras (J. Tyson & M. Hayes, WDFW, pers. comm.). Within a breeding area, multiple bursts of egg deposition may occur over a 2-3 week period.

Oregon Spotted Frogs may have a serially monogamous mating system with each female laying a single clutch per year that is fertilized by a single male, and each male breeds with only one female (Phillipsen et al. 2009). Fertilization is external. The male clasps the female around the upper body with his forearms in an embrace called amplexus. This embrace aligns the vents of the male and female in close proximity for spawning. The first pair of frogs to lay eggs selects the oviposition site (Hallock 2013). Each female lays a single, compact, globular egg mass that expands to the size of a softball, ~5 to 8 in (12 to 20 cm) in diameter when fully expanced (Nussbaum et al. 1983, Hallock 2013). Additional females subsequently deposit their egg masses on top of or immediately adjacent to the initial egg mass. Eggs are deposited in shallow water typically up to 12 in deep (≤ 15 cm but up to 30 cm) (Licht 1969, Hayes et al. 2000, Lewis et al. 2001, McAllister and White 2001, Risenhoover et al. 2001a). Oregon Spotted Frogs occasionally lay egg masses on floating mats of prostrate reed canarygrass (*Phalaris arundinacea*) in waters that are deeper than typically used (> 12 in (30 cm) (McAllister and White 2001; M. Bailey, USFWS, pers. obs. and L. Hallock, WDFW, pers. obs.). When a communal egg mass cluster is established, males call from near it and on top of it (Licht 1969). Licht (1969) showed the significance of the egg mass clustering behavior by moving the initial egg mass. All subsequent females laid their eggs on the communal cluster at or near the new location and no females laid at the original location. At a low elevation site in British Columbia (Canada), females bred every year, averaging 643 eggs (range 249-935) in each mass (Licht 1974).

Egg laying habits and certain aspects of the globular egg mass shape are adaptations for rapid development. The large egg mass retains more heat than smaller egg masses (Hassinger 1970, Duellman and Trueb 1986, Hallock 2013) and communal egg deposition produces higher daytime temperatures for the developing embryos (Licht 1971, Duellman and Trueb 1986, McAllister and White 2001, Hallock 2013). The clustering of egg masses also may provide the majority of embryos protection from temporary stranding events, freeze damage, and egg predators. The placement of egg masses in the comparably warmer shallow waters and the selection of sites that receive minimal shading from the surrounding vegetation also speed development rates. Non-shaded habitat quickly warms on sunny days limiting potential freeze damage from cold nights. Embryos do not survive freezing (Licht 1971, Hallock 2013). Non-shaded habitat also enhances development of algae that live symbiotically in the eggs and may be critical for oxygen delivery to and removal of nitrogenous waste from the innermost embryos in communal clusters (Pinder and Friet 1994, Hallock 2013).

Embryo development to hatching can occur in as little as 10-14 days with 18-30 days being the typical development time (Lewis et al. 2001, McAllister and White 2001, Risenhoover et al. 2001a, Bowerman and Pearl 2010, Hallock 2013). The free-swimming larvae disperse from communal egg mass clusters a week or so after hatching. The tadpoles are primarily herbivorous feeding on algae, decaying vegetation, and detritus (Licht 1974); this life stage is dedicated to eating and growth. The tadpole stage lasts about 4 months (Licht 1974). In late summer, the tadpoles metamorphose into fully-formed, small frogs about 1.3 in (33 mm) snout-vent length (Nussbaum et al. 1983, Hallock 2013).

Metamorphosed frogs prey primarily on invertebrates (Licht 1986b). Growth is rapid until adult sizes are achieved 1 to 2 years following metamorphosis (Licht 1975). At a low-elevation site in Thurston County, adult males continued to grow an average of 0.09 in (2.2 mm) per year and adult females grew 0.24 in (6.2 mm) per year (Watson et al. 2000). Longevity > 9 years was documented for a PIT-tagged Oregon Spotted Frog (K. McAllister, WA Department of Transportation, pers. comm.); longevity for most Oregon Spotted Frogs likely is shorter (Licht 1975, McAllister and Leonard 1997, Hallock 2013). Oregon Spotted Frogs do not have a prolonged period of hibernation (<1 month; Hayes et al. 2001, Hallock and Pearson 2001, Risenhoover et al. 2001b, Watson et al. 2003, Shovlain 2005) and they can be active under ice (Leonard et al. 1997, Hallock and Pearson 2001). Oregon Spotted Frogs rarely move long distances and have not been recorded moving > 2,360 m (7,750 ft; Forbes and Peterson 1999, McAllister and Walker 2003).

Oregon Spotted Frogs suffer mortality mainly from predators and chance environmental events (Hallock 2013). Freezing temperatures and stranding of egg masses are the main threats to developing Oregon Spotted Frog embryos. An entire cohort can be lost in years when water retreats after breeding is underway (Licht 1974, Hallock 2013). Freeze damage is a cause of embryonic mortality in years where temperatures drop below freezing after breeding is underway. The highest rates of embryo mortality are observed in years when the egg masses became temporarily stranded due to a period without precipitation that coincides with freezing night temperatures (Hallock 2013). Significant mortality also can result when tadpoles become isolated in breeding pools away from more permanent waters (Licht 1974, Watson et al. 2003).

In terms of predators, tadpoles are most vulnerable to predation when small (Licht 1974, Hallock 2013). In southwestern British Columbia, Licht (1974) found predators on Oregon Spotted Frog tadpoles to be mostly invertebrates. Fish also are likely predators on tadpoles (Hayes and Jennings 1986, McAllister and Leonard 1997, Hayes 1997a, Pearl 1999). The frogs are preyed on by a variety of vertebrate predators including native (Licht 1974) and non-native amphibians (e.g., American Bullfrogs, *Lithobates catesbeianus* formerly *Rana catesbeiana*; McAllister and Leonard 1997, Pearl et al. 2004), Common Garter Snake (*Thamnophis sirtalis*; Licht 1974, Hayes 1997a, McAllister and Leonard 1997, Forbes and Peterson 1999, Pearl and Hayes 2002, Watson et al. 2003, Hallock 2013), birds such as Sandhill Cranes (*Grus canadensis*; Hayes et al. 2006) and Great Blue Herons (*Ardea herodias*; Licht 1974), and mammals such as Mink (*Neovison vison*; Bowerman and Flowerree 2000; Watson et al. 2000, Hallock and Pearson 2001, Hallock 2013) and river Otters (*Lontra canadensis*; Hayes et al. 2005). Adult annual survival of a study population at Dempsey Creek (Thurston County) was 38% (Watson et al. 2000).

Habitat Characteristics

Washington's remaining populations of Oregon Spotted Frogs occupy still-water wetlands connected by riverine systems. The perennial creeks and associated network of intermittent tributaries provide aquatic connectivity between breeding sites, active season habitat, and overwintering habitat (Hallock 2013). Additionally, perennially flowing waters may provide the only suitable habitat during extreme summer drought or during winter when oxygen levels drop in still-waters under ice and snow. Associated wetlands have a mix of dominance types including aquatic bed, emergent, scrub-shrub, and forested wetlands. The seasonally inundated wetland margins are frequently hay fields and pasture. The less disturbed sites have wet meadows and prairie uplands (Hallock 2013). Some occupied sites are formed by American Beaver (*Castor canadensis*) activity. All the remaining Oregon Spotted Frog sites have moderate to severe habitat alteration including a history of cattle grazing and/or hay production as well as encroaching or established rural residential development. Hydrology has been altered to some extent at all sites (Hallock 2013).

Watson et al. (2003) stressed that the most important features for microhabitat use were water depth, flow characteristics (still water was used over flowing water), and a high degree of water surface exposure (i.e., 50-75% water) or conversely, a low to moderate degree of emergent vegetation (i.e., 25-50%). The predominant use of shallow water habitat by Oregon Spotted Frogs was illustrated by Watson et al. (1998, 2003), who found Oregon Spotted Frogs selected water depths of 4-11.7 in (10-30 cm) with less emergent vegetation and more submergent vegetation than adjacent habitats (Hallock 2013).

Oregon Spotted Frogs select breeding sites in seasonally flooded wetland margins adjacent and connected to perennial wetlands (Licht 1971, Hayes et al. 2000, Pearl and Bury 2000, Watson et al. 2000, Hallock and Pearson 2001, Lewis et al. 2001, McAllister and White 2001, Risenhoover et al. 2001a, Watson et al. 2003, Pearl and Hayes 2004, Hallock 2013). Full solar exposure also seems to be a significant factor in breeding habitat selection (McAllister and White 2001, Pearl and Hayes 2004, Hallock 2013). Oviposition sites are in shallow waters with low vegetation structure that does not shade the eggs. Typically these locations are near shore but can also be in areas with extensive shallows. Low vegetation structure is typical of early successional vegetation stages but also can result from cattle grazing, haying, and mowing. Heavy snowpack also can flatten emergent vegetation providing suitable oviposition conditions (Hallock 2013).

Post-breeding habitat use is the least studied of Oregon Spotted Frog habitat associations in Washington. During the summer drought (July to September), frogs in Thurston County were restricted to remnant pools that persisted during this time (Watson et al. 2003, Hallock 2013). At a site in Oregon, habitat use was primarily near-stream with frogs showing high micro-site fidelity (Shovlain 2005, Hallock 2013). During the coldest months, Oregon Spotted Frogs require well-oxygenated waters (Hallock and Pearson 2001, Hayes et al. 2001, Tattersall and Ultsch 2008, Hallock 2013) and sheltering locations protected from predators and freezing conditions (Risenhoover et al. 2001b, Watson et al. 2003, Hallock 2013). This is especially important during the coldest periods when activity of this ectotherm is expected to be the lowest.

Slipp (1940) reported Oregon Spotted Frogs to be associated with prairie lakes and streams in the area between Tacoma and the Nisqually River (Tacoma Plateau/Nisqually Plains). Oregon Spotted Frogs require breeding habitat with low vegetation structure and full solar exposure (McAllister and White

2001, Pearl and Hayes 2004). Puget Sound prairies would have provided such habitat within an otherwise densely forested landscape.

Threats and Reasons for Decline

The decline of Oregon Spotted Frogs is attributable to several related factors. Among the most significant is the loss and alteration of wetland habitat. Oregon Spotted Frogs have life history traits, habitat requirements, and population characteristics that make them vulnerable to such loss and limit their distribution. These include 1) a completely aquatic life history; 2) communal reproduction concentrated on the landscape with the same localized breeding areas used annually; 3) high levels of population fluctuation; 4) dispersal limited to aquatic corridors; 5) relatively large permanent wetlands (> 4 ha, 10 ac) that include shallow, warm-water habitats; 6) breeding habitats that have shallow water (≤ 30 cm, 12 in), short vegetation, and full sun exposure with relatively stable hydrology and aquatic connectivity to permanent waters; and 7) overwintering habitats that provide adequately oxygenated water and shelter from freezing conditions and predators (Hallock 2013). Additional threats include geographic isolation of Oregon Spotted Frog populations, loss of natural processes that set back vegetation succession (e.g., beaver activity), invasion of exotic grasses into shallow wetland habitats, colonization of wetlands by non-native predators, and increase of water-borne pollutants and emerging diseases. This list of threats is neither exhaustive nor independent, as a number of factors are interconnected. Climate change is a further concern because it involves potential changes that are likely to increase effects of the above factors on Oregon Spotted Frog habitat (Hallock 2013).

Based on conservative estimates, Washington lost over 33% of its wetlands between pre-Euro-American settlement condition and the 1980s (Canning and Stevens 1990, Hallock 2013). This percentage accounts for complete loss from draining or filling, but does not account for alteration or degradation. Freshwater marshes and forested wetland experienced the greatest losses. Snohomish County estimated wetland losses of 180 acres (72 ha) per year during the 1990s. Assuming a similar rate, losses for the 8 urbanized counties with similar growth projections plus King and Pierce counties would be 1,800 acres (728 ha) per year (Canning and Stevens 1990, Hallock 2013). These counties are primarily in the Puget Sound Ecoregion where the majority of the historic distribution of Oregon Spotted Frogs in Washington State had been documented (McAllister and Leonard 1997, Hallock 2013). More specifically, case studies in Washington showed losses of freshwater wetland acreages reflected on U.S. Geological Survey quadrants to be 55% for Tenino and Yelm (south Thurston County), 82% for Tacoma South (Pierce County), and 70% for Lake Washington (King County) (Boule et al. 1983, Hallock 2013). Data on wetland changes in Washington since 1995 are lacking.

Invasive wetland species that alter wetland structure and function impact Oregon Spotted Frog habitat. reed canarygrass is present at all Washington sites and is the invasive plant of greatest concern due to the potential loss of Oregon Spotted Frog habitat from shading and impenetrable thatch (Hallock 2013). The grasses' high rate of transpiration and ability to outcompete native plant species also are of concern for Spotted Frog habitat. In the south Puget Sound, reed canarygrass is especially problematic because there is no snowpack to compress it and the vertical structure shades breeding habitat (Hallock 2013).

South Puget Sound prairies. The south Puget Sound prairies were reduced to about 10% of their former abundance primarily due to agriculture and development (Crawford and Hall 1997). This likely affected the associated wetlands, especially seasonally flooded areas that would have been easily drained and converted to uplands. Historically, depressions and low areas of Thurston County, when drained, were better suited to hay and pasture than most of the well-drained upland soils and conversion to pasture was extensive. By 1947, pasture occupied more farmland than all other crops combined in Thurston County (Poulson et al. 1947). Therefore, loss of prairie habitat which formerly surrounded wetlands has likely played a role in the decline of Oregon Spotted Frog populations in Washington State (Slipp 1940, Hallock 2013).

The identified threats to the Oregon Spotted Frogs in the Black River sub-basin include, but are not limited to habitat loss and/or modification due to land conversions, hydrologic changes (*e.g*., drainage ditches and loss of beaver), development (both urban and agricultural), shrub and tree encroachment and riparian restoration plantings, invasive reed canarygrass, reduced water quality, introduced predators (bullfrogs and warm and cold water fish), and isolated breeding locations. Breeding habitat maintenance, utilizing a variety of methods, is ongoing at multiple locations, but are not consistent or extensive. Currently, the need for habitat management has not kept pace abating or reducing threats in this sub-basin. Cattle grazing is maintaining vegetation height that is necessary for suitable breeding habitat but may result in less than optimal water quality conditions if not properly managed.

References

Altman, B. 1999. Status and conservation of state sensitive grassland bird species in the Willamette Valley. Unpublished report to: Oregon Dept. of Fish and Wildlife, Corvallis, OR. 60 pp.

Altman, B. 2000. Conservation strategy for landbirds in lowland valleys of western Oregon and Washington. American Bird Conservancy and Oregon-Washington Partners in Flight.

Altman, B. 2003. Prairie Management Plan for the Fort Lewis Military Installation. Report Prepared for U.S. Army, Fort Lewis Military Installation, Environmental and Natural Resources Division, Wildlife Branch, and The Nature Conservancy, Washington State Office.

Altman, B. 2003. Vesper Sparrow Pooecetes gramineus. Pages 542-545 in D. B. Marshall, M. G. Hunter, and A. L. Contreras, editors. Birds of Oregon: a general reference. Oregon State University Press, Corvallis, Oregon.

Altman, B. 2011. Historical and current distribution and populations of bird species in prairie-oak habitats in the Pacific Northwest. Northwest Science 85:194-222.

Altman, B. 2015. Oregon Vesper Sparrow Range-Wide Inventory and Habitat Assessment Final Report. A report for State Wildlife Grant G1024-06, Center for Lands Management, Sub-award Grant Number WA-S-2013-001-0 by Bob Altman, American Bird Conservancy.

Altman, B. 2017. Conservation Assessment for Oregon Vesper Sparrow (*Pooecetes gramineus affinis*). For USDA Forest Service, Region 6 and USDI Bureau of Land Management, Oregon and Washington Interagency Special Status and Sensitive Species Program. March 2017. Prepared by Bob Altman, American Bird Conservancy. 64 pp.

Altman, B., D.W. Stinson, and G.E. Hayes. 2020. Draft Status Report for the Oregon Vesper Sparrow in Washington. Washington Department of Fish and Wildlife, Olympia, Washington. 31+ iii pp

American Bird Conservancy 2017. Petition to list Oregon vesper sparrow (*Pooecetes gramineus affinis*) as endangered or threatened under the U.S. Endangered Species Act. October 2017. USFWS Document ID# FWS-R1-ES-2018-0019-0002. 32 pp.

Bailey, A. M. and R. J. Niedrach. 1965. Birds of Colorado. Vol. 2. Denver Museum of Natural History, Denver, Colorado.

Baker, R. J., R. D. Bradley, and L. R. McAliley, Jr. 2003. Pocket Gophers. Pp. 276-287 in G. A. Feldhamer, B. C. Thompson, and J. A. Chapman. Wild Mammals of North America: Biology, Management, and Conservation (2nd ed.). John Hopkins University Press, Baltimore, MD. 1,232 pp.

Barclay, E., M. Arnold, K. Lewis, M. Anderson, and D. Shepherdson. 2010. Oregon ZooTaylor's Checkerspot (*Euphydryas editha taylori*) Rearing and Breeding 2009-2010. Final Report. Portland, Oregon.

Barnard Dunkelberg & Co. 2011. Master Plan Update: Working Paper 2. Olympia Regional Airport. Prepared for the Port of Olympia. 98 pp.

Beauchesne, S. M. 2006. COSEWIC assessment and status report on the Vesper Sparrow affinis subspecies Pooecetes gramineus affinis in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario.

Bennett, V. J., W. Smith, and M. Betts. 2011. Evidence of mate-guarding behavior in the Taylor's checkerspot butterfly. J. Insect Behavior 23(3) DOI 10.1007/s10905-011-9289-1.

Berger, A. J. 1968. Vesper Sparrow. Pages 868-886 in O. L. Austin, editor. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and their allies. Part 2. U.S. National Museum Bulletin No. 237.

Best, L. B. and N. L. Rodenhouse. 1984. Territory preference of Vesper Sparrows in cropland. Wilson Bulletin 96:72-82.

Best, L. B., H. Campa, III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks, Jr., and S. R. Winterstein. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: a regional approach. Wildlife Society Bulletin 25:864-877.

Bohannon, J., D. Gay, C. Johnson, M. Widner and C. Bauman. 2012. Oregon Spotted Frog presence surveys in Skagit and Whatcom Counties, Washington. Final Report on the 2011 survey submitted to USFWS, Region 1, Washington Fish and Wildlife Office. 20 pp.

Bowerman, J. 2010. Submerged calling by Oregon Spotted Frog (*Rana pretiosa*) remote from breeding aggregations. IRCF Reptiles & Amphibians 17(2): 84-87.

Bowerman, J. and C.A. Pearl. 2010. Ability of Oregon Spotted Frogs (*Rana pretiosa*) embryos from central Oregon to tolerate low temperatures. Northwestern Naturalist 81: 198-202

Bowerman, J. and L. Flowerree. 2000. A survey of the Oregon Spotted Frog in the area between Sunriver and LaPine, Oregon. Unpublished report prepared for U.S. Fish and Wildlife, Service, Oregon Department of Fish and Wildlife and Sunriver Owners Association. 6 pp. + tables.

Bowles, J. H. 1921. Notes on the California gray squirrel (*Sciurus griseus griseus*) in Pierce County, Washington. Murrelet 2: 12-13.

Briggs, J.L. 1987. Breeding biology of the Cascades Frog, with comparisons to R. aurora and R. pretiosa. Copeia 1987(1): 241-245.

Campbell, R. W., N. K. Dawe, I. McTaggart-Cowan, J. M. Cooper, G. Kaiser, A. C. Stewart, and M. C. E. McNall. 2001. The birds of British Columbia. Volume 4, passerines: wood-warblers through Old World sparrows. UBC Press, Vancouver, British Columbia.

Canning, D.J. and M. Stevens. 1990. Wetlands of Washington: A resource characterization. Washington Department of Ecology, Olympia. 45 pp.

Castrale, J. S. 1983. Selection of song perches by sagebrush-grassland birds. Wilson Bulletin 95:647-655.

Chappell, C. B. 2006. Plant associations of balds and bluffs of western Washington. Natural Heritage Report 2006-02. Washington Department of Natural Resources. Olympia. 70 pp.

Chappell, C. B. and J. Kagan. 2001. Westside grasslands. Pages 41-43 in D. H. Johnson and T. A. O'Neil, managing directors. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Chase, J. D., W. E. Howard, and J. T. Roseberry. 1982. Pocket gophers. Pp 239-255 in J. A. Chapman and G. A. Feldhamer (eds.). Wild Mammals of North America. John Hopkins University Press, Baltimore, MD. 1,147 pp.

Clegg, M. 1998. The LCTA 1998 bird report. Fort Lewis, Washington.

Clegg, M. 1999. Avian report, LCTA program 1999. Fort Lewis, Washington.

COSEWIC, 2011. COSEWIC assessment and status report on the Taylor's checkerspot *Euphydryas editha taylori* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 60 pp.

Cox, G. W., and J. Hunt. 1992. Relation of seasonal activity patterns of valley pocket gophers to temperature, rainfall, and food availability. Journal of Mammalogy 73:123-134.

Crawford, R. and H. Hall. 1997. Changes in south Puget Sound Landscape, Pp. 11-15. In Dunn, P. and K. Ewing (editors),. Ecology and Conservation of the South Puget Sound Prairie Landscape. The Nature Conservancy, Seattle, Washington. 289 pp.

Dalquest, W. W. 1948. Mammals of Washington. University of Kansas Publications, Museum of Natural History 2:1- 444.

Dalquest, W. W., and V. B. Scheffer. 1944. Distribution and variation in pocket gophers, Thomomys talpoides, in the State of Washington. American Naturalist 78:308-333, 423-450.

Daly, J. C., and J. L. Patton. 1990. Dispersal, gene flow, and allelic diversity between local populations of Thomomys bottae pocket gophers in the coastal ranges of California. Evolution 44:1283-1294.

Davis, S. K., and D. C. Duncan. 1999. Grassland songbird occurrence in native and crested wheatgrass pastures of southern Saskatchewan. Studies in Avian Biology 19:211-218.

Dawson, W. R. and F. C. Evans. 1960. Relation of growth and development to temperature regulation in nestling Vesper Sparrows. Condor 62:329-340.

Dechant, J. A., M. F. Dinkins, D. H. Johnson, L. D. Igl, C. M. Goldade, and B. R. Euliss. 2002. Effects of management practices on grassland birds: Vesper Sparrow. Northern Prairie Wildlife Research Center, Jamestown, North Dakota.

Dennehy, C., E. R. Alverson, H. E. Anderson, D. R. Clements, R. Gilbert, and T. N. Kaye. 2011. Management strategies for invasive plants in Pacific Northwest prairies and oak woodlands. Northwest Science 85:329-351.

Duellman, W.E. and L. Trueb. 1986. Biology of Amphibians. The Johns Hopkins University Press, Baltimore. 670 pp.

Dunwiddie, P. W. and J. Bakker. 2011. The future of restoration and management of prairie-oak ecosystems in the Pacific Northwest. Northwest Science 85: 83–92.

EBird. 2020. https://ebird.org/media/catalog?taxonCode=vesspa&view=List&yr=YCURRENT&mediaType=p&regionCode=US-WA-067&q=Vesper%20Sparrow . Thurston County 2020 Vesper Sparrow observations with pictures. Data extracted June 16, 2020.

Erickson, R. A. 2008. Oregon Vesper Sparrow in California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California (W.D. Shuford and T Gardali, editors). Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

Eviner, V. T., and F. S. Chapin III. 2003. Gopher-plant-fungus interactions affect establishment of an invasive grass. Ecology 84:120-128.

Fimbel, C. 2009. Investigation of Taylor’s checkerspot diapause habitat characteristics. The Nature Conservancy, Olympia, Washington.

Forbes, T. and L. Peterson. 1999. Annual progress report: Jack Creek population of the Oregon Spotted Frog (Rana pretiosa) on Chemult Ranger District, Winema National Forest (Klamath County, Oregon). 38 pp.

Ft. Lewis Directorate of Public Works. 2010. Final Environmental Impact Statement for the Fort Lewis Army Growth and Force Structure Realignment.

Gay, D. and J. Bohannon. 2011. Oregon Spotted Frog presence surveys in Skagit and Whatcom counties, Washington. A WDFW report on the 2011 surveys submitted to USFWS, Region 1, Washington Fish and Wildlife Office. 15 pp.

GeoEngineers, Inc. 2003. Revised Comprehensive Habitat Management Plan for the Shelton Pocket Gopher (Thomomys mazama counchi) at Sanderson Field, Shelton, Washington (Revision 2). Unpublished report prepared for Port of Shelton. 21 pp. + appendices.

Godfrey, W. E. 1986. The birds of Canada. Revised edition. National Museum of Canada, Ottawa, Ontario.

Grosboll, D. N. 2011. Taylor’s checkerspot (Euphydryas editha taylori) oviposition habitat selection and larval hostplant use in Washington State. M.E.S. Thesis, The Evergreen State College, Olympia. 77 pp.

Guppy, C.S. and J. Shepard. 2001. Butterflies of British Columbia. UBC Press and Royal British Columbia Museum, Victoria, British Columbia. 414 pp.

Hallock, L. A. 2016. Connectivity, seasonal movement and summer habitat of Oregon Spotted Frogs in the Black River watershed, Thurston County, Washington. Agreement No. F13AC00271. Final Report. Washington Department of Fish and Wildlife, Wildlife Program, Olympia. 45 pp + appendices.

Hallock, L. and S. Pearson. 2001. Telemetry study of fall and winter Oregon Spotted Frog (Rana pretiosa) movement and habitat use at Trout Lake, Klickitat County, Washington. Report prepared by Washington Natural Heritage Program for Washington State Department of Transportation and Washington Natural Areas Program, Department of Natural Resources, Olympia. 19 pp. + appendix

Hallock, L. In prep. Draft Washington Recovery Plan for the Oregon Spotted Frog. Washington Department of Fish and Wildlife, Olympia.

Hallock, Lisa. 2013. Draft State of Washington Oregon Spotted Frog Recovery Plan. Washington Department of Fish and Wildlife, Olympia. 93 +v pp.

Hamman, S. T. P. W. Dunwiddie, J. L. Nuckols, and M. McKinley. 2011. Fire as a Restoration Tool in Pacific Northwest Prairies and Oak Woodlands: Challenges, Successes, and Future Directions. Northwest Science 85 (2): 317-328.

Hassinger, D. 1970. Notes on the thermal properties of frog eggs. Herpetologica 26(1): 49-51.

Haycock, R.D. 2000. COSEWIC assessment and status report on the Oregon Spotted Frog Rana pretiosa in Canada. Committee on the Status of Endangered Wildlife in Canada, Ontario, Ottawa, Canada. 22 pp.

Hayes, M., J. Tyson, J Layman, K. Douville, T Newman, and K. Young. 2017. 2017 Chehalis Intensive Study in Off-Channel Habitats: 4th (30 June 2016) Progress Report. Washington Department of Fish and Wildlife, Habitat Program Science Division, Aquatic Research Section. 116 pp.

Hayes, M.P. 1997a. Status of the Oregon Spotted Frog (*Rana pretiosa* sensu stricto) in the Deschutes Basin and selected other systems in Oregon and northeastern California with a range wide synopsis of the species' status. Final report prepared for The Nature Conservancy under contract to U.S. Fish and Wildlife Service, Portland, Oregon. 57 pp. + appendices.

Hayes, M.P., and D.M. Krempels. 1986. Vocal sac variation among frogs of the genus Rana from western North America. Copeia 1986(4):927-936

Hayes, M.P., and M.R. Jennings. 1986. Decline of ranid frog species in Western North America: Are Bullfrogs (*Rana catesbeiana*) responsible? Journal of Herpetology 20(4): 490-509.

Hayes, M.P., C.J. Rombough, C.B. Hayes and J.D. Engler. 2005. *Rana pretiosa* (Oregon Spotted Frog). Predation. Herpetological Review 36(3): 307.

Hayes, M.P., J. Engler, and C. Rombough. 2006. *Rana pretiosa* (Oregon Spotted Frog). Predation. Herpetological Review 37(2): 209-210.

Hayes, M.P., J.D. Engler, D.C. Friesz, and K.M. Hans. 2000. Oregon Spotted Frog (*Rana pretiosa*) oviposition at Conboy National Wildlife Refuge (Klickitat County, Washington): management implications of embryonic mortality. Final report submitted to U.S. Fish and Wildlife Service, North Pacific Coast Ecoregion, Lacey, Washington. 14 pp. + appendix.

Hayes, M.P., J.D. Engler, S.Van Leuven, D.C. Friesz, T. Quinn, and D.J. Pierce. 2001. Overwintering of the Oregon Spotted Frog, (*Rana pretiosa*) at Conboy Lake National Wildlife Refuge, Klickitat County, Washington, 2000-2001. Interim final report to Washington Department of Transportation by Science Team, Habitat and Wildlife Management Programs, Washington Department of Fish and Wildlife, Olympia, Washington. 32 pp. + appendices

Hays, D. W., A. Potter, C. Thompson, and P. Dunn. 2000. Critical habitat components for four rare south Puget Sound butterflies. Final report to The Nature Conservancy. Washington Dept of Fish and Wildlife. Olympia. 62 pp.

Hellmann, J.J., S.B. Weiss, J.F. McLaughlin, P.R. Ehrlich, D.D. Murphy, and A.E. Launer. 2004. Chapter 3: Structure and dynamics of *Euphydryas editha* populations. Pages 34-62 in:P.R. Ehrlich, and I. Hanski, eds. On the wings of checkerspots: a model system for population biology. Oxford University Press, New York. 371 pp.

Hinchliff, J. 1996. An Atlas of Washington Butterflies. Oregon State University Press. Corvallis, OR. 162 pp.

Hyde, A. S. 1979. Birds of Colorado's Gunnison County. Western State College Foundation, Gunnison, Colorado.

Jackson, L. E. 1982. Comparison of phenological patterns in prairie and subalpine meadow communities. Northwest Science 56: 316-328.

James, D.G. and D. Nunnallee. 2011. Life histories of Cascadia butterflies. Oregon State University Press, Corvallis, Oregon. 447 pp.

Jewett, S. G., W. P. Taylor, W. T. Shaw, and J. W. Aldrich. 1953. Birds of Washington State. University of Washington Press, Seattle, Washington.

Johnson, R. E., and K. M Cassidy. 1997. Terrestrial mammals of Washington State: Location data and predicted distributions. In K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich (eds.). Washington Gap Analysis- Final Report, Vol. 3. Washington Cooperative Wildlife Research Unit, University of Washington, Seattle, WA. 304 pp.

Jones, L.C., W.P. Leonard, and D.H. Olson (Eds.). 2005. Amphibians of the Pacific Northwest. Seattle Audubon Society, Seattle, WA. 227 pp.

Jones, S. L., and J. E. Cornely. 2002. Vesper Sparrow (*Pooecetes gramineus*). In A. Poole and F. Gill, editors. The Birds of North America, No. 624. The Birds of North America, Inc., Philadelphia, Pennsylvania.

Kantrud, H. A. and R. L. Kologiski. 1982. Effects of soils and grazing on breeding birds of uncultivated upland grasslands of the northern Great Plains. Wildlife Research Report 15, U.S. Fish and Wildlife Service, Washington, D.C.

Kaye, T.N., A.G. Stanley, and D. Ross. 2011. Dispersal behavior and habitat variation of Taylor's Checkerspot Butterfly. Institute for Applied Ecology, Progress Report, Corvallis, OR, July 30, 2011. 27 pp.

Klimkiewicz, M. K. 1997. Longevity records of North American birds. Version 97.1. Patuxent Wildlife Research Center, Bird Banding Laboratory, Laurel, Maryland.

Larrison, E. J. and K. G. Sonnenberg. 1968. Washington birds: their location and identification. Seattle Audubon Society, Seattle, Washington.

Leonard, W. P., H.A. Brown, L.L.C. Jones, K.R. McAllister, and R.M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Society, Seattle, Washington. 168 pp.

Leonard, W.P., L.A. Hallock and K.R. McAllister. 1997. *Rana pretiosa* (Spotted Frog). Behavior and Reproduction. Herpetological Review 28(2): 86.

Lewis, J.C., D.P. Anderson and S. VanLeuven. 2001. Oviposition ecology of the Oregon Spotted Frog at Trout Lake Marsh, Washington. Unpublished report, Washington Department of Fish and Wildlife, Olympia. 13 pp.

Licht [sic, given as Light], L.E. 1986b. Food and feeding behavior of sympatric Red-legged Frogs, Rana aurora, and Spotted Frogs, Rana pretiosa, in southwestern British Columbia. The Canadian Field-Naturalist 100: 23-31.

Licht, L.E. 1969. Comparative breeding behavior of the Red-legged Frog (*Rana aurora aurora*) and the Western Spotted Frog (*Rana pretiosa pretiosa*) in southwestern British Columbia. Canadian Journal of Zoology 47(6): 1287-1299.

Licht, L.E. 1971. Breeding habits and embryonic thermal requirements of the frogs, *Rana aurora aurora* and *Rana pretiosa pretiosa*, in the Pacific Northwest. Ecology 52(1): 116-124.

Licht, L.E. 1974. Survival of embryos, tadpoles, and adults of the frogs Rana aurora aurora and *Rana pretiosa pretiosa* sympatric in southwestern British Columbia. Canadian Journal of Zoology 52(5): 613-627.

Licht, L.E. 1975. Comparative life history features of the Western Spotted Frog, *Rana pretiosa*, from low- and high-elevation populations. Canadian Journal of Zoology 53(9): 1254-1257.

Linders, M. 2008. 2005-2007 Summary report on translocation of Mazama Pocket Gopher (*Thomomys mazama*) in South Puget Sound, Washington. Washington Department of Fish and Wildlife Wildlife Program - Region 6, Montesano.

Linders, M. J. 2006. Captive rearing and translocation methods development for Taylor's checkerspot (*Euphydryas editha taylori*), south Puget Sound, Washington. Washington Department of Fish and Wildlife. Olympia.

Linders, M. J. 2012. Captive rearing and translocation of Taylor's checkerspot in south Puget Sound: 2011-2012. ACUB Annual Progress Report. Washington Department of Fish and Wildlife. Olympia.

Linders, M. J., G. Olson, and A. Potter.2009. Taylor's checkerspot habitat characteristics selected for oviposition on Range 76, Artillery Impact Area, Fort Lewis, Washington. Final ACUB Project Report. Washington Department of Fish and Wildlife. Olympia.

Linders, M. J., L. Hynson, K. Lewis, and L. Hamilton. 2015. Captive rearing and translocation of Taylor's checkerspot in south Puget Sound: 2014-2015. Annual Progress Report to U.S. Fish and Wildlife Service and Joint Base Lewis-McChord Army Compatible Use Buffer Program. Washington Department of Fish and Wildlife. Olympia, Washington

Linders, M., K. Lewis, and K. Curry. 2020. Taylor's checkerspot (*Euphydryas editha taylori*) Captive Rearing and Translocation: South Puget Sound, Washington, 2018-2019. Final Annual Report related to: US Fish and Wildlife Service (Cooperative Agreement #F16AC00588, F19AC00408) and Joint Base Lewis-McChord (Contract #W911S8-12-H-0001, W911S8-18-2-0008, W911S81820017, W911S81920011). March 31, 2020. 58 pp.

Matsuda, B.M., D.M. Green, and P.T. Gregory. 2006. Amphibians and Reptiles of British Columbia. Royal BC Museum Handbook, Victoria, British Columbia, Canada. 266 pp.

McAllister, K., and A. Schmidt. 2005. An inventory of Mazama Pocket Gophers (*Thomomys mazama*) on the Olympia Airport, Thurston County, Washington. Washington Department of Fish and Wildlife, Olympia, WA.

McAllister, K.R. 1995. Distribution of amphibians and reptiles in Washington State. Northwest Fauna 3: 81-112.

McAllister, K.R. and H.Q. White. 2001. Oviposition Ecology of the Oregon Spotted Frog at Beaver Creek, Washington. Unpublished report, Washington Department of Fish and Wildlife, Olympia. 12 pp + appendices.

McAllister, K.R. and M. Walker. 2003. An Inventory of Oregon Spotted Frogs (*Rana pretiosa*) in the upper Black River Drainage. Unpublished report, Washington Department of Fish and Wildlife, Olympia. 13 pp. + appendices.

McAllister, K.R. and W.P. Leonard. 1990. Past distribution and current status of the Spotted Frog in Western Washington. 1989 Progress report for the Washington Department of Wildlife Management, Olympia. 16 pp. + appendices

McAllister, K.R. and W.P. Leonard. 1991. Past distribution and current status of the Spotted Frog in Western Washington. 1990 Progress report for the Washington Department of Wildlife Management, Olympia. 14 pp. + appendices.

McAllister, K.R. and W.P. Leonard. 1997. Washington State status report for the Oregon Spotted Frog. Unpublished report, Washington Department of Fish and Wildlife, Olympia. 38 pp.

McAllister, K.R., W.P. Leonard and R.M. Storm. 1993. Spotted Frog (*Rana pretiosa*) surveys in the Puget Trough of Washington, 1989-1991. Northwestern Naturalist 74(1): 10-15.

Mlodinow, S. G. 2005. Vesper Sparrow *Pooecetes gramineus*. Pages 326-327 in T. R. Wahl, B. Tweit, and S. G. Mlodinow, editors. Birds of Washington: status and distribution. Oregon State University Press, Corvallis, Oregon.

Nussbaum, R. A., E. D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and Reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho. 332 pp.

Olson, G. 2011a. Mazama Pocket Gopher Translocation Study: Progress Report. Cooperative Agreement #13410-9-J015. Washington Department of Fish and Wildlife, Wildlife Science Division, Olympia, WA.

Olson, G. and M. Linders. 2010. Analyses of Taylor's checkerspot distance sampling data collected on Range 74/76 Fort Lewis, Washington, 2007-2008. Washington Department of Fish and Wildlife. Olympia.

Olson, G.S. 2011b. Mazama Pocket Gopher occupancy modeling. Washington Department of Fish and Wildlife, Olympia, Washington. 45pp.

Page, N., P. Lilley, J. Heron, and N. Kroeker. 2009. Distribution and habitat characteristics of Taylor's checkerspot on Denman Island and adjacent areas of Vancouver island (2008). Report prepared for British Columbia Ministry of Environment and Parks Canada. Raincoast Applied Ecology, Vancouver. 32 pp.

Parker, I. M. 2002. Safe site and seed limitation in *Cytisus scoparius* (Scotch broom): invasibility, disturbance, and the role of cryptogams in a glacial outwash prairie. Biological Invasions 3: 323–332, 2001.

Patterson, M. P. and L. B. Best. 1996. Bird abundance and nesting success in Iowa CRP fields: the importance of vegetation structure and composition. American Midland Naturalist 135:153-176.

Pearl, C.A. 1999. The Oregon Spotted Frog (*Rana pretiosa*) in the Three Sisters Wilderness Area/Willamette National Forest: 1998 Summary of Findings. Unpublished report prepared for U.S. Fish and Wildlife Service in cooperation with Willamette National Forest, February 1999. 20 pp.+ appendices.

Pearl, C.A. and M.P. Hayes. 2002. Predation by Oregon Spotted Frogs (*Rana pretiosa*) on Western Toads (Bufo boreas) in Oregon. American Midland Naturalist 147: 145-152.

Pearl, C.A. and M.P. Hayes. 2004. Habitat Assessment of the Oregon Spotted Frog (*Rana pretiosa*): A literature review. Unpublished report prepared for Washington State Department of Transportation, Environmental Affairs, Olympia. 43 pp.

Pearl, C.A. and R.B. Bury. 2000. The Oregon Spotted Frog (*Rana pretiosa*) in the Three Sisters Wilderness Area, Oregon: 1999 Findings. Unpublished report prepared for U.S. Fish and Wildlife Service in cooperation with Willamette National Forest, February 2000. 15 pp.

Pearl, C.A., M.J. Adams, R.B. Bury, and B. McCreary. 2004. Asymmetrical effects of introduced Bullfrogs (Rana catesbeiana) on native ranid frogs in Oregon. Copeia 2004(1): 11-20.

Pearson, S. F. 2003. Breeding phenology, nesting success, habitat selection, and census methods for the Streaked Horned Lark in the Puget lowlands of Washington. Natural Areas Program Report 2003-2, Washington Department of Natural Resources, Olympia, Washington.

Peck, G. and R. James. 1987. Breeding birds of Ontario: nidiology and distribution. Volume 2, passerines. Ontario Museum of Life Sciences Miscellaneous Publications, Toronto, Ontario.

Perry, E. M. and A. W. Perry. 1918. Home life of the Vesper Sparrow and the Hermit Thrush. Auk 35:310-321.

Pinder, A. and S. Friet. 1994. Oxygen transport in egg masses of the amphibians *Rana sylvatica* and *Ambystoma maculatum*: Convection, diffusion and oxygen production by algae. Journal of Experimental Biology 197(1): 17-30.

Potter, A. E. 2016. Periodic status review for Taylor's Checkerspot in Washington. Washington Department of Fish and Wildlife, Olympia, Washington. 16+iii pp.

Poulson, E.N., C. Lounsbury, and T.W. Glassey. 1947. Soil survey of Thurston County. United States Soil Conservations Service, Washington Agricultural Experimental Station. USDA Soil Survey 1947-06.

Pyle, R.M. 1989. Washington butterfly conservation status report and plan. Washington Department of Fish and Wildlife, Olympia, WA. 216pp.

Ramsey, R. W., and J. W. Slipp. 1974. Draft report of a biological assessment Wapato Hills, Tacoma, Pierce County, Washington. Prepared for Wilsey & Ham, Inc. Tacoma, WA. 25 pp.

Reed, J. M. 1986. Vegetation structure and Vesper Sparrow territory location. Wilson Bulletin 98:144-146.

Reichman, O. J., and E. W. Seabloom. 2002. The role of pocket gophers as subterranean ecosystem engineers. Trends in Ecology and Evolution 17: 44-49.

Remsburg, M. 2000. Summary report of Land Condition Trend Analysis, butterfly surveys conducted on Fort Lewis, Washington. Integrated Training Area Management, Fort Lewis Land Condition Trend Analysis Field Report, 2000. Fort Lewis, WA.

Risenhoover, K.L., T.C. McBride, K. McAllister and M. Golliet. 2001a. Oviposition behavior of the Oregon Spotted Frog (*Rana pretiosa*) along Dempsey Creek, Thurston County, Washington. Unpublished report submitted to Washington Department of Transportation, Olympia. 26 pp. + appendices.

Risenhoover, K.L., T.C. McBride, K. McAllister and M. Golliet. 2001b. Overwintering behavior of the Oregon Spotted Frog (*Rana pretiosa*) along Dempsey Creek, Thurston County, Washington. Unpublished report submitted to Washington Department of Transportation, Olympia. 26 pp. + appendices

Rising, J. D. 1996. A guide to the identification and natural history of the sparrows of the United States and Canada. Academic Press, San Diego, California.

Rogers, R.E., Jr. 2000. The status and microhabitat selection of Streaked Horned Lark, Western Bluebird, Oregon Vesper Sparrow, and Western Meadowlark in western Washington. M.S. thesis, Evergreen State College, Olympia, Washington.

Rook, E. J., D. G. Fischer, R. D. Seyferth, J. L. Kirsch, C. J. LeRoy, and S. Hamman. 2011. Responses of prairie vegetation to fire, herbicide, and invasive species legacy. Northwest Science 85:288-302.

Rotenberry, J. T. 1980. Dietary relationships among shrubsteppe passerine birds: competition or opportunism in a variable environment? Ecological Monographs 50:93-110.

Schultz, C.B., E. Henry, A. Carleton, T. Hicks, R. Thomas, A. Potter, M. Collins, M. Linders, C. Fimbel, S. Black, H. Anderson, G. Diehl, S. Hamman, R. Gilbert, J. Foster, D. Hays, D. Wilderman, R. Davenport, E. Steel, N. Page, P. Lilley, J. Heron, N. Kroeker, C. Webb, and B. Reader. 2011. Conservation of prairie-oak butterflies in Oregon, Washington, and British Columbia. Northwest Science 85: 361–388.

Scott, J. A. 1986. The Butterflies of North America: A Natural History and Field Guide. Stanford University Press. Stanford, CA. 583 pp.

Severns, P. M. and A. Warren. 2008. Selectively eliminating and conserving exotic plants to save an endangered butterfly from local extinction. Animal Conservation 11: 476-483.

Severns, P. M. and D. Grosboll. 2011. Patterns of reproduction in four Washington State populations of Taylor's checkerspot (*Euphydryas editha taylori*) during the spring of 2010. Final report submitted to The Nature Conservancy, Olympia, Washington. Philomath, Oregon.

Shovlain, A.M. 2005. Oregon Spotted Frog (*Rana pretiosa*) habitat use and herbage (or biomass) removal from grazing at Jack Creek, Klamath County, Oregon. MSc Thesis. 9 June 2005. Forest Resources, Oregon State University, Corvallis, Oregon. 20 pp. + appendices.

Singer, M.C. and I. Hanski. 2004. Dispersal behavior and evolutionary metapopulation dynamics. Chapter 9, pp. 181-198 in: On the wings of checkerspots: a model system for population biology. P. Ehrlich and I. Hanski, editors. Oxford University Press, New York, New York. 371 pp.

Slater in litt. 2020. Electronic mail correspondence from Gary Slater, Avian Ecologist, Center for Natural Lands Management, Olympia, WA, to Zachary Radmer, Fish and Wildlife Biologist, USDI Fish and Wildlife Service, Lacey, WA. Topic: April 28, 2020, email transmitted unpublished data regarding Oregon Vesper Sparrow territories on Weir and Tenalquot prairies.

Slipp, J.W. 1940. The mammals, reptiles, amphibians and freshwater fishes of the Tacoma area. Unpublished report, College of Puget Sound, Tacoma, Washington. 50 pp.

Smith, M. R., P. W. Mattocks Jr., and K. M. Cassidy. 1997. Breeding birds of Washington state: location data and predicted distribution. In K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich, editors. Washington state gap analysis - final report. Volume 4. Seattle Audubon Society Publications in Zoology No. 1, Seattle, Washington.

Stebbins, R.C. 2003. Western Reptiles and Amphibians. 3rd edition. Peterson Field Guides. Houghton Mifflin Company, Boston, Massachusetts. 533 pp.

Steinberg, E. K. 1995. A study of genetic differentiation and variation in the Mazama Pocket Gopher (*Thomomys mazama*) with emphasis on Fort Lewis populations. Final Report, Submitted to Fort Lewis and The Nature Conservancy. Department of Zoology, University of Washington, Seattle, WA. 51 pp + maps.

Steinberg, E. K. 1996. Population studies and management of the threatened Mazama Pocket Gopher: a regional perspective. Final Report, Contract #WAFO-092795, The Nature Conservancy. 50 pp.

Steinberg, E. K. 1999. Diversification of genes, populations, and species: evolutionary genetics of real and virtual pocket gophers (*Thomomys*). Ph.D. Dissertation, University of Washington, Seattle. 157 pp.

Steinberg, E., and D. Heller. 1997. Using DNA and rocks to interpret the taxonomy and patchy distribution of pocket gophers in western Washington prairies. Pp. 43-51 *in* Dunn and Ewing (1997).

Stinson, D. W. 2005. Washington state status report for the Mazama Pocket Gopher, Streaked Horned Lark, and Taylor's Checkerspot. Washington Department of Fish and Wildlife, Olympia, Washington. 146 pp.

Stinson, D. W. 2013. Draft Mazama Pocket Gopher Status Update and Washington State Recovery Plan. Washington Department of Fish and Wildlife, Olympia. 91+ vi pp.

Tattersall, G.J. and G.R. Ultsch. 2008. Physiological ecology of aquatic overwintering in ranid frogs. Biological Reviews 83(2008): 119-140.

Tveten, R. 1997. Fire effects on prairie vegetation, Fort Lewis, Washington. Pp. 123-130 in Dunn, P. and K. Ewing (eds.). 1997. Ecology and Conservation of the South Puget Sound Prairie Landscape. The Nature Conservancy of Washington, Seattle, WA. 289 pp.

Tveten, R. K., and R. W. Fonda. 1999. Fire effects on prairies and oak woodlands on Fort Lewis, Washington. Northwest Science 73:145-158.

U.S. Fish and Wildlife Service. 2001. Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Species That Are Candidates or Proposed for Listing as Endangered or Threatened, Annual Notice of Findings on Recycles Petitions, and Annual Description of Progress on Listing Actions. Federal Register 66, (October 30, 2001), No. 210:54808-54832.

U.S. Fish and Wildlife Service. 2011. U.S. Fish and Wildlife Service species assessment and listing priority assignment form for the Oregon Spotted Frog (*Rana pretiosa*). U.S. Fish and Wildlife Service. Region 1, Lacey, Washington. 60 pp.

U.S. Fish and Wildlife Service. 2013. Endangered and threatened wildlife and plants; determination of endangered status for Taylor's checkerspot butterfly and threatened status for the streaked horned lark; final rule. Federal Register 78 (192):61451-61503.

U.S. Fish and Wildlife Service. 2014a MPG listing

U.S. Fish and Wildlife Service. 2014b OR Spotted Frog listing

U.S. Forest Service and Bureau of Land Management. 2012. Species fact sheet: Euphydryas editha taylori. Available at www.fs.fed.us/r6/.../sfs-iile-euphydryas-editha-taylori-2012-03.doc (Accessed 16 August 2012)

USFWS 2018. Endangered and Threatened Wildlife and Plants: 90-Day Findings for on Petition to List the Oregon vesper sparrow as Endangered or Threatened. Document ID# FWS-R1-ES-2018-0019-0001. June 27, 2018. https://beta.regulations.gov/document/FWS-R1-ES-2018-0019-0001

Vaughan, T. A. 1961. Vertebrates inhabiting pocket gopher burrows in Colorado. Journal of Mammalogy 42:171-174.

Vaughan, T. A. 1974. Resource allocation in some sympatric subalpine rodents. Journal of Mammalogy 55:764-795.

Verts, B. J., and L. N. Carraway. 1998. Land Mammals of Oregon. University of California Press, Berkeley, CA. 668 pp.

Verts, B. J., and L. N. Carraway. 2000. *Thomomys mazama*. Mammalian Species 641:1-7.

Wahlberg, N., P.R. Ehrlich, C.L. Boggs, and I. Hanski. 2004. Bay checkerspot and Glanville fritillary compared with other species. Chapter 11, pp. 219-244 in: On the wings of checkerspots: a model system for population biology. (P.R. Ehrlich, and I. Hanski, editors.) Oxford University Press, New York. 371 pp.

Washington Department of Fish and Wildlife. 2005. Washington Comprehensive Wildlife Conservation Strategy. Olympia. 778 pp.

Watson, J.W., K.R. McAllister, and D.J. Pierce. 2003. Home ranges, movements, and habitat selection of Oregon Spotted Frogs (*Rana pretiosa*). Journal of Herpetology 37(2): 292-300.

Watson, J.W., K.R. McAllister, D.J. Pierce and A. Alvarado. 1998. Movements, habitat selection, and population characteristics of a remnant population of Oregon Spotted Frogs (*Rana pretiosa*) in Thurston County, Washington. Wash

Watson, J.W., K.R. McAllister, D.J. Pierce, and A. Alvarado. 2000. Ecology of a remnant population of Oregon Spotted Frogs (*Rana pretiosa*) in Thurston County, Washington. Unpublished final report, Washington Department of Fish and Wildlife, Olympia, USA. 78 pp. + appendices.

Wiens, J. A. 1969. An approach to the study of ecological relationships among grassland birds. Ornithological Monographs 8:1-93.

Witmer, G. W., R. D. Sayler, and M. J. Pipas. 1996. Biology and habitat use of the Mazama Pocket Gopher (*Thomomys mazama*) in the Puget Sound area, Washington. Northwest Science 70:93-98.Arnett, J. 2011. Castilleja levisecta (golden paintbrush) monitoring and reporting. Natural Heritage Program Report 2011-07. Washington Natural Heritage Program. Olympia, Washington. 19 pp. + appendices.