Species Report
for
Leona's Little Blue Butterfly
(*Philotiella leona*)

Photo credit: Sarina Jepsen; The Xerces Society

U.S. Fish and Wildlife Service
May 20, 2015

Species Report for Leona's Little Blue Butterfly (*Philotiella leona*)

Purpose

The purpose of this species report is to provide the best available scientific and commercial information about Leona's little blue (*Philotiella leona*) and its habitat. The information within this report will be part of our biological basis for any potential listing, recovery, or consultation recommendations under the Endangered Species Act of 1973 as amended (Act), (16 U.S.C. 1531 *et seq.*).

Executive Summary

On May 12, 2010, the U.S. Fish and Wildlife (Service) received a petition from the Xerces Society for Invertebrate Conservation, Dr. David McCorkle of Western Oregon University, and Oregon Wild to list the Leona's little blue butterfly under the Act. On August 17, 2011, the Service published in the **Federal Register** a positive 90-day finding stating that the petition presented substantial scientific or commercial information indicating that listing the Leona's little blue butterfly may be warranted (76 FR 50971). As a result, we are initiating a status review of the species to determine if Leona's little blue butterfly is warranted for listing under the Act. The Xerces Society for Invertebrate Conservation and Oregon Wild filed a notice of intent to sue on March 7, 2013, for failure to issue a 12-month finding on whether listing the Leona's little blue butterfly is warranted under the Act. On July 31, 2014, the court ordered the Service to issue a 12-month finding for the Leona's little blue butterfly by June 30, 2015.

The Leona's little blue butterfly is a member of the Polyommatini tribe of butterflies (a taxonomic group under family) within the Lycaenidae family, and is the largest species in the *Philotiella* genus (Hammond and McCorkle 1999, pp. 1, 82; Pyle 2002, p. 222). The species is found in volcanic ash and pumice fields and meadows consisting of non-forested bitterbrush/needlegrass-sedge vegetation community (Volland 1988, p. 29; Hammond and McCorkle 1999, p. 77; Pyle 2002, p. 236; Ross 2008, p. 1; Johnson 2010, p. 2).

Information provided in the petition stated that Leona's little blue butterfly was known from a single population (estimated at 1,000 to 2,000 individuals) and that its range was limited to a 6 square mile (sq mi) (15.5 square kilometer (sq km)) area of the Antelope Desert in Klamath County, Oregon. Based on a better understanding of habitat requirements, more focused survey efforts, and more rigorous sampling methods for the species between 2009 and 2013, the current known range of the species has doubled in size from 6 sq mi (15.5 sq km) to 12.8 sq mi (33.1 sq km) (see Figure 1). Similarly, the population size estimates have increased to approximately 20,000 individuals as a result of the additional survey efforts.

Leona's little blue butterfly is dependent upon the annual spurry buckwheat (*Eriogonum spergulinum* (A. Gray) var. *reddingianum* (M.E. Jones, J.T. Howell)) (Munz & Keck 1973, pp. 340–341) for the development of its larvae. A variety of nectar plants, including spurry buckwheat, are used by adult Leona's little blue butterflies. The assemblage of plant species found within the range of the species appears to be unique and shows strong correlation with the presence of alluvial fans deposits formed after the eruption of Mt. Mazama 6,600 to 7,700 years

ago. The majority of land within the range of the species (93.7 percent) occurs on private lands (Mazama Forest, previously owned by Fidelity National Financial and now owned by Whitefish Cascade Forest Resources, LLC). A small percentage (1.5 percent) of land on which the Leona's little blue butterfly occurs is in the Fremont-Winema National Forest, U.S. Forest Service (USFS). The USFS has designated the butterfly as a sensitive species, which similarly directs that USFS actions avoid or minimize effects to the butterfly and its habitat.

The known stressors that potentially act on Leona's little blue butterfly or its habitat include timber management, lodgepole pine encroachment, fire, fire suppression, invasive plants, and competition from other invertebrates (see **Stressors Potentially Affecting Leona's Little Blue Butterfly** below for complete list of stressors). Of these known stressors, lodgepole pine encroachment and invasive plants may contribute to considerable loss of habitat and individuals. Timber management has the potential to alter or destroy habitat; however, the reduction of forested areas provides almost immediate benefits to Leona's little blue butterfly that overcome negative impacts from timber management and the stressor of lodgepole pine encroachment.

Abbreviations Used

°C	degrees Celsius
°F	degrees Fahrenheit
ac	acres
Act	Federal Endangered Species Act of 1973, as amended
APHIS	Animal and Plant Health Inspection Service
BPA	Bonneville Power Administration
C	Celsius
cm	centimeter
F	Fahrenheit
FR	Federal Register
ft	feet
GHG	greenhouse gas
ha	hectare
in	inch
IPCC	Intergovernmental Panel on Climate Change
km	kilometer
m	meter
mm	millimeter
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge
ODOT	Oregon Department of Transportation
Service	U.S. Fish and Wildlife Service
sq km	square kilometer
sq mi	square mile
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
Whitefish	Whitefish Cascade Forest Resources, LLC

Introduction

Harold and Leona Rice discovered the Leona's little blue butterfly (*Philotiella leona*) in 1995. Hammond and McCorkle (1999, p. 77) formally described Leona's little blue butterfly as a new species in 1999. The Leona's little blue butterfly occupies volcanic ash and pumice fields that form non-forested meadows in the vicinity of Sand and Scott Creeks in Klamath County, Oregon (Hammond and McCorkle 1999, pp. 77, 80; Pyle 2002, p. 236; James *et al.* 2014, p. 264). The species is known from a single location measuring approximately 12.8 sq mi (33.1 sq km) in size and is believed to be a local endemic species. Land ownership within the range of Leona's little blue butterfly consists of Fremont-Winema National Forest (1.5 percent), multiple small privately owned parcels (4.8 percent) , and Whitefish Cascade Forest Resources, LLC (Whitefish; previously owned by Fidelity National Financial, Inc.; 93.7 percent). Figure 1 provides an overview of the location of the Leona's little blue butterfly range, land ownership, and species detections. The points are representative of a single survey effort in which one or more Leona's little blue butterfly were detected.

On May 12, 2010, the Service received a petition from the Xerces Society for Invertebrate Conservation, Dr. David McCorkle of Western Oregon University, and Oregon Wild to list the Leona's little blue butterfly under the Endangered Species Act, as amended (Matheson *et al*. 2010, entire). The Service determined that an emergency listing of the Leona's little blue butterfly was not warranted on September 10, 2010 (Service 2010a, pp. 1–2). On August 17, 2011, the Service published in the **Federal Register** a positive 90-day finding stating that the petition presented substantial scientific or commercial information indicating that listing the Leona's little blue butterfly may be warranted (76 FR 50971). As a result, we are initiating a status review of the species to determine if Leona's little blue butterfly is warranted for listing under the Act.

The Xerces Society for Invertebrate Conservation and Oregon Wild filed a notice of intent to sue on March 7, 2013, for failure to issue a 12-month finding on whether listing the Leona's little blue butterfly is warranted under the Act. On July 31, 2014, the court ordered the Service to issue a 12-month finding for the Leona's little blue butterfly by June 30, 2015.

Species Description

The Leona's little blue butterfly (Figure 2) is a member of the butterfly family Lycaenidae (gossamer winged-butterflies) and the tribe Polyommatini (Pyle 2002, p. 222). The wingspan of Leona's little blue butterfly measures less than 0.75 to 1 inches (in) (1.9 to 2.5 centimeters (cm)) (Pyle 2002, p. 236). Male dorsal wing color is dark, dusky blue with black submargins while female dorsal wing color is brown (Hammond and McCorkle 1999, p. 77). Ventral wing color for both sexes is white with black spots on fore- and hind-wings (Hammond and McCorkle 1999, p. 77) (see Figure 2). Leona's little blue butterfly may be confused with other co-occurring species of little blue butterflies such as the glaucon blue (*Euphilotes glaucon*) and the lupine blue (*Plebejus lupini*) (Ross 2010, pp. 10–12), especially when in flight or observed at a distance (Ross 2008, p. 1) (see Figure 3).

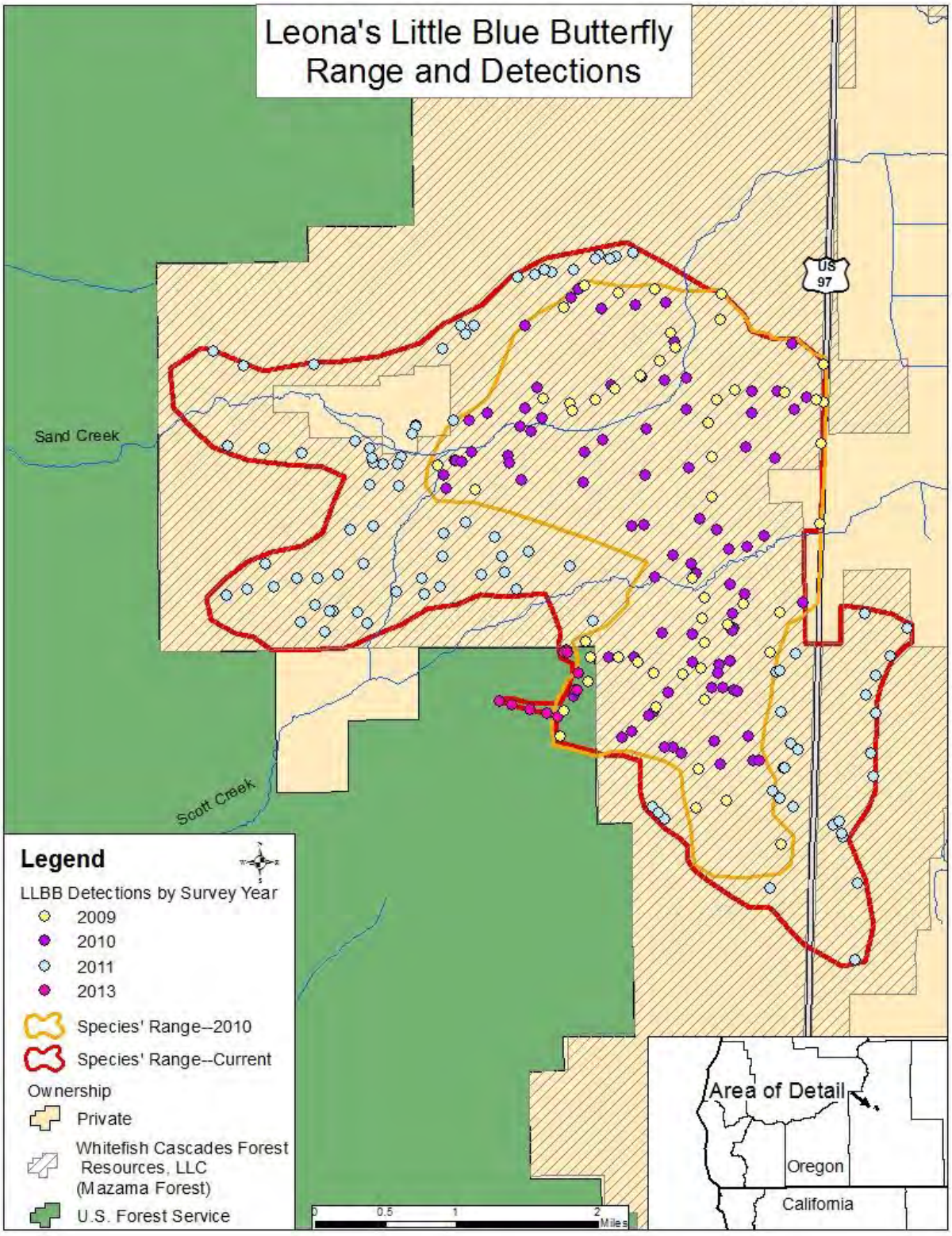

Figure 1: Map of Leona's little blue butterfly range and observation locations.

Figure 2: Leona's little blue butterfly roosting on dead twig. Photo credit: Will Hatcher

Figure 3: Similar Species: Glaucon blue (*Euphilotes glaucon*) (left) and Lupine blue (*Plebejus lupini*) (right) Photo credit: Kim Davis and Mike Stangeland

Life History, Species Needs, and Habitat Features

Life History

The life-cycle of the Leona's little blue butterfly takes approximately one year to complete, beginning with an egg and ending with an adult butterfly. Very little information is present on the exact timing of the life cycle from the wild population; however, James (2012, pp. 94–95) describes the Leona's little blue butterfly life cycle as observed in a captive setting.

Oviposition, or egg laying, by Leona's little blue butterfly under natural conditions may occur as early as June 30 (James 2011, p. 11; James *et al.* 2014, p. 269); captive Leona's little blue butterfly laid eggs in early July (James 2012, p. 94). Most eggs are laid as singles, though two eggs may be laid at the same time (James 2012, p. 95). Laying single eggs reduces mortality in the event that the host plant is devoured before larvae reach the pupa stage (Ehrlich 1992, p. 8). Eggs are deposited only on the flower bud of larval host plant, spurry buckwheat (*Eriogonum spergulinum* A. Gray) (Hammond and McCorkle, 1999 p. 80; James 2012, p. 93, 95; James *et al.* 2014, p. 269). The egg is a pale white-yellow color and measures approximately 0.02 inches (in) (0.48 millimeters (mm)) in width (James 2012, p. 94). Four to five days after egg laying, a larva (caterpillar) emerges from the egg (James 2012, p. 94). Movement between host plants by Leona's little blue butterfly larvae has not been documented, so it is uncertain if Leona's little blue butterfly require more than one host plant to complete the transformation from egg to pupa. Data are not available on the number of eggs a female Leona's little blue butterfly may lay during the oviposition stage, though James (2012, p. 94) counted a mean of 39.3 mature eggs per female during the dissection of six females that died during his study.

Larval development progresses through a series of four instars; an instar is the period between molts (Figure 4) (Pyle 2002, p. 387). This development occurs over a period of 5 days or less (James 2012, pp. 94–95) and is coincident with budding and flowering of the spurry buckwheat (James *et al.* 2014, p. 270). During the instar phases, larva change from a pale yellow to red to white with red stripes, increase in length from approximately 0.04–0.4 in (1.0–10.0 mm), and setae (hairs) shorten and become more dense (James 2012, p. 94). Larvae enter the pre-pupa stage when they measure approximately 0.28–0.4 in (7.0–10.0 mm) (James 2012, p. 94); this stage lasts five to six days (James 2012, p. 95). During the pre-pupa stage, larva change color to a uniform yellow, shrink in size to 0.2–0.3 in (5.0–7.0 mm), and become sessile (James 2012, p. 94). Pupae are formed on the ground in most cases and are a uniform orange-brown color (James 2012, p. 95). Pupation lasts 10 to 11 months, though some pupa may remain dormant for two years in captivity (James 2012, p. 95).

Adult Leona's little blue butterfly begin emerging from pupa in mid-June, with males emerging a few days before females (James 2012, p. 95). Soil temperatures recorded at the time of emergence were 122 ºFahrenheit (ºF) (50 ºCelsius (ºC)) and relative humidity measured at less than 90 percent (James *et al.* 2014, p. 268). The mating period spans late June to early July and occurs very soon after females emerge (James 2012, p. 95). Adults fly for a period of six to seven weeks starting in mid-June and lasting through late July or early August (Ross 2008, p. 1; Ross 2009, p. 1; James 2011, p. 11; James 2012, p. 95; James *et al.* 2014, p. 268). A mark, release, and recapture study conducted by James *et al*. (2014, p. 272) suggests that the lifespan of adult Leona's little blue butterfly may be two weeks.

Biological Needs

The biology of Leona's little blue butterfly is very closely tied to its larval host plant, spurry buckwheat (Figure 5). Spurry buckwheat is a desert restricted annual with peak flowering occurring in July (Goodman 1948, p. 498; Reveal 1978, p. 170; James 2012, p. 93). Buckwheat species, such as spurry buckwheat, are known to be pioneer plants (Meyer 2008, pp. 499–503). Pioneer plants are plants that colonize disturbed sites and other open, less vegetated areas. Adult Leona's little blue butterfly begin flying in mid- to late-June (Ross 2008, p. 5; James *et al.* 2014,

p. 268), which coincides with the period when spurry buckwheat is producing flower buds and sources of nectar are beginning to flower (Ross 2008, p. 5; James *et al.*2014, p. 270). The majority of Leona's little blue butterfly eggs are laid at the base of spurry buckwheat flower buds in early July (James 2011, p. 19; James 2012, p. 94); eggs are less frequently deposited on stems (James 2012, p. 94). Larvae hatch a few days later and appear to feed only on the bud and flower of spurry buckwheat (James 2011, p. 19; James 2012, p. 94); these are the most nutritious parts of plants (Carey 1994, p. 264; James and Nunnallee 2011, p. 19) and likely maximize larval growth. At the end of the Leona's little blue butterfly flight period, spurry buckwheat begins to die back (James *et al.* 2014, p. 268). The reliance on spurry buckwheat as a sole food source for larvae highlights the importance of this plant to Leona's little blue butterfly (James 2011, p. 19) and the need for larval development to reach the pupa stage before the plants senesce (Holdren and Ehrlich 1981, p. 128; Ehrlich and Murphy 1987, p. 124).

Other food sources for adult Leona's little blue butterfly are flowering plants that produce nectar. The Leona's little blue butterfly is known to obtain nectar from a variety of flowering plants including the host plant, though sulphur-flower buckwheat (*Eriogonum umbellatum* Torr.) and least tarweed (*Hemizonella minima* A. Gray) were observed as two other prominent sources for nectar (Ross 2009, p. 17; Johnson 2010, p. 5; Johnson 2011, p. 9; James 2012, p. 95; James *et al*. 2014, pp. 269–271). Other flowering plants visited by Leona's little blue butterfly for nectar include Mt. Hood pussypaws (*Cistanthe umbellata* Torr. & Hershkovitz), Cascade popcorn flower (*Plagiobothrys hispidus* A. Gray), hoary aster (*Machaeranthera canescens* var. *shastensis* A. Gray), woolly groundsel (*Packera cana* W.A. Weber & A. Love), spreading groundsmoke (*Gayophytum diffusum* Torr. & A. Gray), silverleaf phacelia (*Phacelia hastata* Douglas ex Lehm.), pale agoseris (Agoseris glauca (Pursh) Raf.), rosy pussytoes (*Antennaria rosea* Greene), and *Epilobium* spp. (Hammond and McCorkle 1999, p. 82; Ross 2008, p. 5; Ross 2009, p.17; Johnson 2010, p. 5; James 2011, p. 11; Johnson 2011, p. 9; James 2012, p. 95; James *et al.*2014, p. 271).

Peak daily flight periods for Leona's little blue butterfly are coincident with weather conditions, with most activity occurring between 11 a.m. and 4 p.m. (James *et al.*2014, p. 269) when temperatures were above 70 ºF (21 ºC) (James 2012, p. 95). Leona's little blue butterfly flight activity diminishes during cloudy and windy conditions (James 2012, p. 95), and when temperatures rise above 90 ºF (32 ºC) (Ross 2010, p. 13). Flight patterns of Leona's little blue butterfly meander and occur at heights of less than 1 foot (ft) (31 centimeters (cm)) above ground (James 2012, p. 95). When not flying, Leona's little blue butterfly roost on dead twigs, dried grass, dried seed heads, rocks, and on the ground in direct sunlight; roosting is rare on green vegetation (James 2011, p. 21; James 2012, p. 95; James *et al.*2014, p. 269). Leona's little blue butterfly orient themselves such that ventral wing surfaces face the sun during morning roosting periods (James 2012, p. 95).

Leona's little blue butterfly courtship behavior includes male-male interactions and male-female interactions. James *et al.* (2014, p. 269) observed males engaging in swirling flights around each other before going separate ways. Males and females were observed making upward spiral flights to heights of 23 ft (7 meters (m)) before coming back down. Fast fast-paced chases at ground level between males and females were also observed. Mating was observed in the

afternoon and while the butterflies were on bare twigs or low-growing plants, including spurry buckwheat (James 2012, p. 95; James *et al.* 2014, p. 269).

Weather conditions influence flight periods and may affect oviposition rate (James 2011, p. 19) by limiting opportunities for mating and the actual act of laying eggs. Temperatures were warmer in 2013, in which James *et al.* (2014, p. 269) observed a shorter flight period and more rapid senescence of spurry buckwheat than he observed in 2011 and 2012. Cooler temperatures may extend plant budding and allow for an increased period for optimal oviposition (James 2011, p. 20). Weather conditions also influence larval growth. Sunny weather increases the rate of development while rainy and cloudy weather slows development (McLaughlin *et al.* 2002, p. 539).

Dispersal patterns of Leona's little blue butterfly have not been described. An estimate of 0.6 mi (1.0 km) was provided by Ross (2010, p. 4); however, the author does not provide a basis for this estimate. Leona's little blue butterfly occur in natural, small openings and openings associated with logging skid trails and roads, suggesting that these features may provide corridors for movement (James *et al.* 2014, p. 272). Dispersal outside of the Sand Creek area may be limited by the forested stands that surround the known occupied area, as well as by a lack of subsurface moisture and many of the nectar plants used by the butterfly. Heavily forested areas do not provide the openings that are important for establishment of spurry buckwheat or other nectar sources. Abundant oviposition and nectar resources within the occupied area may limit the need for female Leona's little blue butterfly to search large areas for these resources, which may curtail dispersal (Bennett *et al.* 2013, p. 956). Female movements may also be constrained by the weight of unlaid eggs (Bennett *et al.* 2013, p. 956).

Limited information exists on potential competitors and predators of the Leona's little blue butterfly. Competitors are those species that also use the same resources used by Leona's little blue butterfly. A study conducted in 2011 identified 37 species of butterflies and 159 species of moths as potential competitors for nectar (Ross and Johnson 2012, p. 8). The same study identified hornets (Family Vespidae), dragonflies (Order Odonata), damselflies (Order Odonata), robberflies (Family Asilidae), stiltbugs (Family Berytidae), and spiders (Order Araneae) as potential predators of Leona's little blue butterfly (Ross and Johnson 2012, pp. 16–17). The authors of the study concluded that predators are relatively rare and that competitors were much more abundant (Ross and Johnson 2012, p. 24). Competition for resources may be a more an important concern to Leona's little blue butterfly persistence and well-being than predation (Ross and Johnson 2012, p. 26). Similarly, James *et al.* (2014, pp. 270–271) did not observe Leona's little blue butterfly mortality from predation during their three-year study and suggest that this form of mortality is likely very low. The egg laying behavior of Leona's little blue butterfly suggests that there may be a low relative risk of predation on eggs (Henry and Schultz 2013, p. 190). Leona's little blue butterfly lay eggs on or very near flower buds and do not attempt to hide them (e.g., laying on underside of leaves). Similarly, the pink and white coloration of Leona's little blue butterfly larvae provide camouflage, which is likely an adaptation to avoid predation (see Figures 4 and 5).

Figure 4: Leona's little blue butterfly larvae coloration. Also, note the size of the larvae in comparison to spurry buckwheat flowers in the images labeled "second" and "third." Photo credit: James 2012 (p. 96)

Figure 5: Close-up of spurry buckwheat to show color resemblance to Leona's little blue butterfly larvae. Photo credit: Debbie Johnson.

Habitat characteristics

Habitat for the Leona's little blue butterfly is influenced by the geology of the Sand and Scott Creeks area, characteristics of vegetation distribution and composition, and disturbance from timber management, fires, and fire suppression activities. The habitat characteristics (i.e. plant composition, distribution, cover, etc.) associated with Leona's little blue butterfly occupied habitat appear to be unique (Ross 2009, p. 20) and may be limiting the distribution of the species (Johnson 2011, p. 5). A portion of small parcels under private land ownership contain a wet meadow associated with Sand Creek; this wet meadow is not considered suitable habitat for Leona's little blue butterfly (Johnson 2014d, pers. comm.).

Geology of Sand Creek and Scott Creek

The range of Leona's little blue butterfly is located in the rain shadow of the Cascades (Ross 2009, p. 19). The habitat characteristics of the area occupied by Leona's little blue butterfly are unique (Ross 2009, p.19). Leona's little blue butterfly occupancy appears to be coincident with the northern edge of the Sand Creek and Scott Creek alluvial fans (fan-shaped deposits of volcanic material) (Johnson 2010, p. 4) deposited after the eruption of Mt. Mazama 6,600 to 7,700 years ago (Tilden 1963, pp. 110–111; Hammond 1981, p. 180; Harris 1988, p.105; U.S. Geological Survey (USGS) 2002, p. 1; Cummings 2007, p. 30). Extensive damage to biological life forms in the Sand Creek Basin likely occurred as a result of the eruption and its wide-reaching pumice and ash fall (Tilden 1963, p. 111; Hammond 1981, p. 180).

Vegetation and Soil

The specific reasons for the parallel between the alluvial fan and Leona's little blue butterfly occupancy are unknown, although vegetation and soil composition may partially explain this observation. Vegetation recovery has been slow, more so in locations closer to Crater Lake (the caldera that formed during the eruption) where thicker layers of pumice were deposited (Tilden 1963, pp. 111–112). After the eruption of Mt. Mazama (current day Crater Lake), sedimentation consisting of a 5–10 ft (1.5–3.0 m) thick layer of glassy silt, pumice, phenocrystic (crystals derived from volcanic rocks) sand, and volcanic rocks was deposited in alluvial fans in the area of Sand and Scott Creeks (see Figure 6) (Cummings 2007, p. 105; Cummings and Conaway 2009, p. 273). Field observations make note of the "black, sparkling sand" observed within the range of Leona's little blue butterfly (Cummings 2007, p. 91; Ross and Johnson 2012, p. 2; Johnson and Ross 2013, p. 9). The shiny black particles are likely pyroxene phenocrysts (crystals) in the sand (Cummings and Conaway 2009, p. 280; Ross and Johnson 2012, p. 2), concentrated locally with the removal of fine ash by Sand Creek and Scott Creek (Johnson 2011, p. 2). The black sands were not observed during surveys for Leona's little blue butterfly in volcanic areas that are otherwise similar to Sand and Scott Creeks (Johnson and Ross 2013, p. 2; Johnson 2014a, pers. comm.).

The assemblage of plant species found in the vicinity of Sand and Scott Creeks is not likely to occur outside the ash and pumice fields deposited during the eruption of Mt. Mazama (Johnson 2011, p. 2). One reason for this may be the presence of subsurface moisture present from an alluvial fan (Johnson 2011, p. 2). Sand Creek and Scott Creek alluvial fans are thicker than other alluvial fans immediately to the north of the occupied habitat area (Johnson 2011, p. 7). Sand Creek and Scott Creek have removed most of the fine ash layer from the eruption of Mt. Mazama, improving porosity and permeability of the area (Johnson 2011, p. 2).

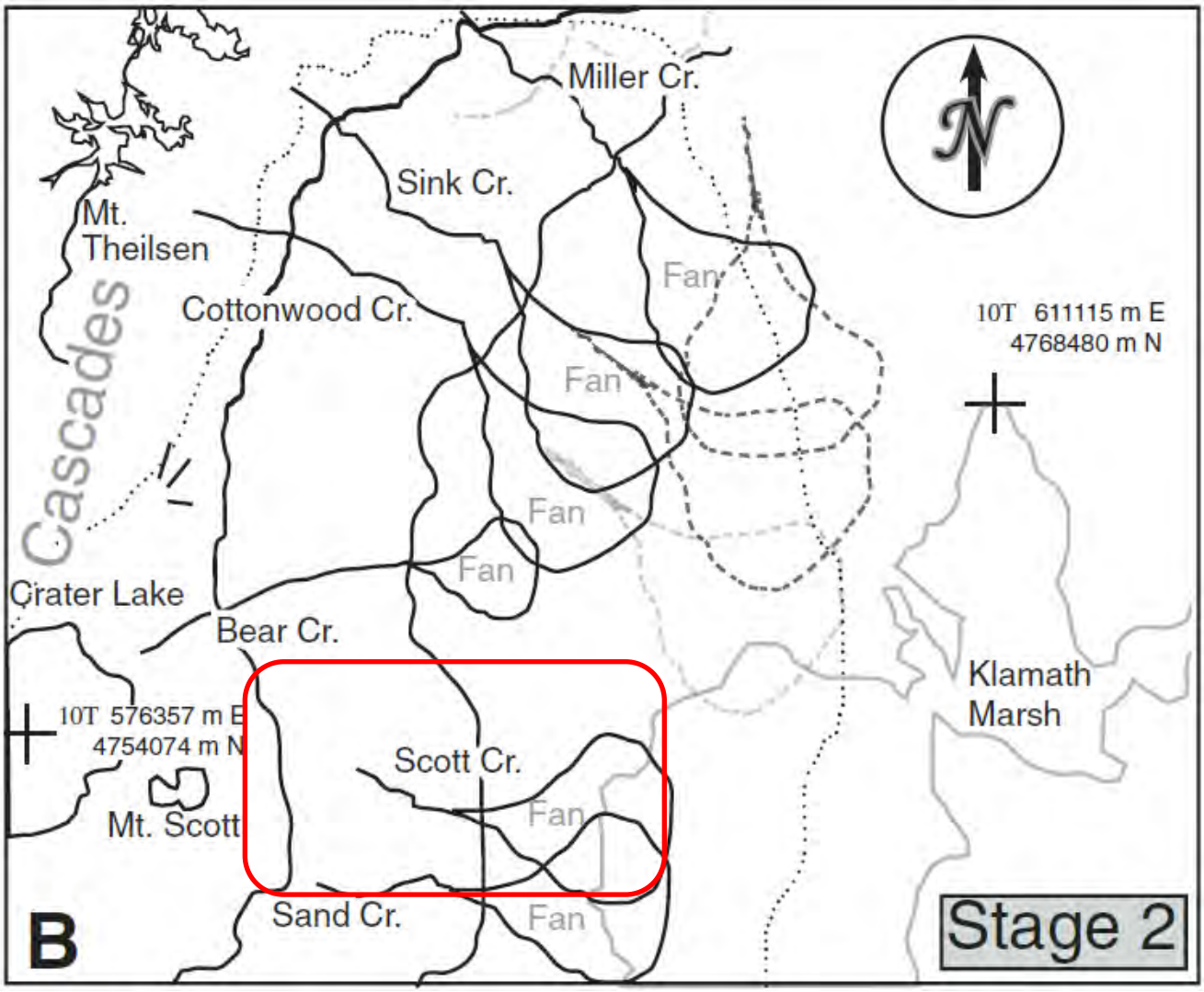

Figure 6: Location of Sand Creek and Scott Creek alluvial fan deposits in the western Williamson River Basin (Cummings and Conaway 2009, p. 273).

The transition zone between the Bitterbrush/Needlegrass-Sedge and Lodgepole Pine/Bitterbrush/Fescue plant communities described by Volland (1988, pp. 29, 39) coincides with the boundary of Leona's little blue butterfly occupancy (Johnson 2010, p. 2). Annual and perennial plants occurring within the occupied habitat include but are not limited to: spurry buckwheat, sulphur-flower buckwheat, least tarweed, Mt. Hood pussypaws, Cascade popcorn flower, hoary aster, woolly groundsel, spreading groundsmoke, silverleaf phacelia, pale agoseris, rosy pussytoes, and *Epilobium spp.* Lodgepole pine (*Pinus contorta*), ponderosa pine (*Pinus ponderosa*), and quaking aspen (*Populus tremuloides*) also occur within the range of Leona's little blue butterfly. Figure 7 is an example of Leona's little blue butterfly habitat in the foreground and lodgepole pine trees in the background.

Figure 7: Leona's little blue butterfly habitat in the foreground with lodgepole pine trees in background. The wispy, pink vegetation under the arrows is spurry buckwheat. Photo by Debbie Johnson.

Climate

The habitat is a xeric, high desert with a limited ability of the ash-pumice fields to retain moisture (Hammond 1981, pp. 180, 190). Topography of the area occupied by Leona's little blue butterfly is relatively flat (Ross 2009, p. 19) with elevations ranging from 4,530 ft (1,381 m) on the west to 4,660 ft (1,420 m) on the east (Esri, Inc. ArcMap 10.2.2 1999–2014). James (2011, pp. 16–17) recorded day and night temperatures in the Leona's little blue butterfly range from May 28 to September 1, 2011; he noted that temperatures in 2011 were lower than an average year by 3.5–5.5 ºF (2–3 ºC). Daily high temperatures ranged from 50–89 ºF (10–31.5 ºC); nighttime low temperatures ranged from 24–53 ºF (-4.5–12 ºC) (James 2011, p. 16). He also noted that six nights during the 2011 Leona's little blue butterfly flight period were at or below freezing. Most precipitation in the Sand Creek area falls in non-summer months with annual rain and snowfall totals ranging from 15–30 in (38– 76 cm) (Youngberg and Dyrness 1959, p. 111; Dyrness and Youngberg 1966, p. 123).

Within the range of Leona's little blue butterfly, annual precipitation provides recharge for ground water and flow of surface water (Cummings 2007, p. 35). The porous ash-pumice fields fail to retain moisture during the short summer growing season, with the exception of some areas where ground water does come to the surface (Hammond 1981, p. 180; Hammond and Dornfeld 1983, p. 120). However, subsurface moisture in the Sand and Scott Creeks area may be greater than the surrounding area because Sand and Scott Creeks flow year-round (Cummings 2007, pp. 49, 72, 105). Further evidence of higher subsurface moisture is indicated by the presence of a

wetland species, Baltic rush (*Juncus balticus*) (Ross and Johnson 2012, p. 2) and the presence of damp soil a few inches beneath the surface during the Leona's little blue butterfly flight period (Ross 2010, p. 5). A diversion ditch from Sand Creek north toward Scott Creek is seasonally operated (Cummings 2007, p. 90) and likely contributes to moisture to the alluvial fan (Ross and Johnson 2012, p. 4).). A portion of small parcels under private land ownership in the northwest portion of the Leona's little blue butterfly range (see Figure 1) contains a wet meadow and is not considered suitable habitat for the butterfly (Johnson 2014d, pers. comm.).

Disturbance Regime

Factors contributing to the disturbance regime of the Sand and Scott Creeks area include timber management and small, infrequent fires (Johnson 2010, pp. 6, 8–9). Both of these factors determine the distribution and abundance of habitat available for Leona's little blue butterfly.

Timber Management

Prior to 2006, a large portion of the Sand and Scott Creek areas consisted of a lodgepole pine forest interspersed with openings vegetated by shrubs and herbaceous plants (Johnson 2010, pp. 8–9). Timber harvest operations within the area (consisting of tree removal, skid trail construction, road construction, machine piling of logging slash, and burning of slash piles) between 2006 and 2008 on what is now Whitefish property, reduced the amount and distribution of lodgepole pine and created a much more open landscape (Johnson 2010, pp. 8–9). Spurry buckwheat colonized the area and is thriving in the created openings (Johnson 2010, pp. 8–9; James *et al.* 2014, p. 270). Within this ownership, a power line corridor also runs north–south through the range of Leona's little blue butterfly and provides approximately 105 acres (ac) (43 hectares (ha)) maintained as openings that are partially occupied by Leona's little blue butterfly (Ross 2008, pp. 5, 8). Power line corridors have been documented as important butterfly habitat and they are correlated with higher butterfly abundance when compared to semi-natural grasslands (pastures) (Wojcik and Buchmann 2012, pp. 21–24; Berg *et al*. 2013, p. 644).

The portions of the Leona's little blue butterfly habitat that are owned by the Fremont-Winema National Forest are more densely forested than those owned by Whitefish (James *et al.* 2014, p. 270) due to differences in management strategies. Spurry buckwheat and Leona's little blue butterfly do occur on Fremont-Winema National Forest lands, but are not as abundant because suitable habitat areas are restricted to openings between trees (Ross 2009, p. 20; James *et al.* 2014, p. 270).

Fire History

Fire history within the Leona's little blue butterfly range includes historical and contemporary records. A survey by Leiberg (1900, p. 337) documents observations of lodgepole pine reforestation in the area occupied by the butterfly (Township 31 south and Range 7 east) "after fires burned and destroyed the timber" 30–40 years prior to his survey. His records also document similar observations in adjacent townships. The Klamath Indian Reservation began forest management in the area in 1912; under this management, there are no records of stand-replacing fires between 1912 and 1940 for the Upper Williamson River watershed (USFS 1998, p. 43) (the watershed within the range of Leona's little blue butterfly). A large fire (approximately 200,000 ac (80.9 ha)) burned within the "central portion" of the Klamath Indian Reservation in 1918 (Weaver 1961, p. 569). It is likely that this fire occurred within the current

range of the butterfly (Johnson 2014e, pers. comm.). The fire "did not cause excessive damage" (Weaver 1961, p. 569).

Record keeping since 1940 has identified an average of 50 fire starts per year with lightning strikes responsible for 80 percent of the starts within the range of Leona's little blue butterfly (USFS 1998, p. 43). Since 1940, stand-replacing fires outside the range of Leona's little blue butterfly range burned over 18,000 ac (7,284 ha) in a series of smaller and larger fires (4 ac (1.6 ha) Wocus fire, 1,000 ac (405 ha) Prophecy fire, and 14,000 ac (5,666 ha) Cave Mountain fire) (USFS 1998, pp. 43–44). Between 1968 and 2014, Oregon Department of Forestry records (*http://www.odf.state.or.us*) indicate 19 fires were started by lightning within the Township and Range where Leona's little blue butterfly occur. The mean fire size is 0.2 ac (0.08 ha), ranging from 0.06–0.4 ac (0.02–0.16 ha). Records since Leiberg's survey (1900, p. 337) do not indicate the occurrence of large, stand-replacing fires in the current range of Leona's little blue butterfly (USFS 1998, p. 43; *http://www.odf.state.or.us*).

The small relative size of recorded fire events is likely due to the close proximity of an Oregon Department of Forestry fire station (Sand Creek Fire Station) and the varied fuel conditions present near Sand Creek and Scott Creek. The Sand Creek Fire Station is located within the range of the butterfly, allowing for quick response time to fire events. Similarly, the types of vegetation that grow on pumice based soils generally have low productivity (Volland 1988, p. 38; Dunn 2011a, p. 9) and are not the types that will carry fire very far (e.g., very low concentrations of leaf litter and duff layers, very few ladder fuels). Additionally, the discontinuity of the vegetation also slows down the potential for rapid progression of fire through the area (Dunn 2011a, p. 4; Dunn 2011b, p. 12). This does not mean that large fires are not possible; under extreme weather conditions (e.g., very high temperatures and winds) fire can spread across landscapes like that occupied by the butterfly (Dunn 2011a, p. 3). Fire models indicate that if a large-scale fire were to occur in Leona's little blue butterfly habitat, the open glades would either not burn or would be mostly intact after a fire event (Dunn 2011b, p. 12). See Fire stressor discussion for more information.

Historical Distribution and Population Trends

Historical Distribution

The discovery of Leona's little blue butterfly in 1995 is a relatively recent event (Hammond and McCorkle 1999, p. 77). As stated earlier, the species is currently known to occur in only one location. Historical information on the distribution of the species prior to 1995 is unknown. Based on habitat characteristics, the historical distribution of Leona's little blue butterfly may have been more restricted before the butterfly's discovery. Leiberg (1990, p. 337) reported that Township 31 south and Range 7 east, where the butterfly occurs, consisted of 13 percent non-forest and 87 percent forest. The Mazama Forest, a 90,000 ac (36,422 ha) area that overlaps the Leona's little blue butterfly range, consisted of approximately 11 percent openings in 2008 (Hatcher 2014, p. 1–2).

Timber harvest operations from 2006 to 2008 on the Whitefish property contribute to the current distribution and abundance of openings. These operations removed overstory lodgepole pine on 75 percent of the area now contained within the range of Leona's little blue butterfly (Hatcher

2014, p. 2). Prior to harvest, the area consisted of openings interspersed with lodgepole pine forest (Johnson 2010, p.8). Soil disturbance occurred during logging operations from blading roads, skidding logs to landings, and creating landing slash piles (Johnson 2010, p.8). The increase in open areas from this timber harvest and its associated ground disturbance increased habitat availability for Leona's little blue butterfly. Open areas are assumed to have quickly become suitable habitat for the butterfly as spurry buckwheat is a colonizing species that is capable of rapid establishment.

Population Trends

There are only two estimates of Leona's little blue butterfly population size; therefore, it is difficult to draw conclusions on population trends. The original Leona's little blue butterfly population size was estimated to be between 1,000 and 2,000 individuals (Ross 2008, p. 4) occupying a 6 sq mi (15.5 sq km) area (Matheson *et al.* 2010, p. 5). A recent mark-release-recapture study estimates that the population may contain approximately 20,000 individuals (James *et al.* 2014, p. 272) occupying a 12.8 sq mi (33.1 sq km) area. This population estimate is based on the number of butterflies per sample site multiplied by the amount of similar sites present in the occupied area (James *et al.* 2014, p. 272). The increase in population estimates is attributed to more rigorous sampling procedures, increases in available habitat, and more thorough surveys for Leona's little blue butterfly. It is also important to understand that butterflies can be an irruptive species, meaning that populations may fluctuate widely between years (Ehrlich *et al.* 1975, p. 222; Ehrlich and Murphy 1987, p. 127; Harrison *et al.* 1988, p. 375; Murphy and Weiss 1988, pp. 371–372; Murphy *et al.* 1990, p. 49). One example of fluctuations in other butterfly populations is explained by weather conditions that limited flight time and similarly limited oviposition rates (James 2011, p. 19). James *et al.* (2014, p. 269) observed a shortened period of Leona's little blue butterfly flight during warmer ambient temperatures in 2013, as compared to temperatures in 2011 and 2012; information on how this may or may not have affected oviposition rates is not described.

Survey History

Surveys have expanded the known range of Leona's little blue butterfly to approximately 12.8 sq mi (33.1 sq km), but have not documented additional populations (Ross 2008, pp. 5–9; Ross 2009, pp. 4, 8–17; Johnson 2010, p. 2; Johnson 2011, p. 5; Chew 2013, p. 2; Johnson and Ross 2013, pp. 2–12). Surveys conducted in 2011 used a predictive habitat model to search 18,654 ac (7,549 ha) in Oregon adjacent to and more distant from the known population (Johnson 2011, p. 5). After 2011, requests by the Service and Applegate Forestry, LLC for permission to access Whitefish property (owned by Fidelity National Financial at the time) for further surveys were denied (Chew 2013, p. 1; Johnson and Ross 2013, p. 4); however, data provided in James *et al.* (2014, p. 264) includes areas located on what is now Whitefish property and the Fremont-Winema National Forest. In 2013, surveys of Fremont-Winema National Forest lands led to additional refinements of the Leona's little blue butterfly boundary (Johnson and Ross 2013, p. 2).

Searches for additional Leona's little blue butterfly populations and its habitat outside of the occupied area located similar but different characteristics from habitat observed at Sand and Scott Creeks (Ross 2009, p. 20). The differences observed related to the absence or reduced abundance of host and nectar plants and a lack of black sparkling sands. Johnson and Ross

(2013, pp. 2–12) summarize surveys for Leona's little blue butterfly that took place in Oregon and California in 2013. They note that vegetation present in Sink Creek and Miller Creek alluvial fans and at the base of Mt. Shasta, California are very similar to that of Sand Creek; however, Leona's little blue butterfly were not observed at these locations. These surveys further refined the known population boundary, documented potential patterns of influence of Sand Creek and Scott Creek, and identified a correlation between the underlying alluvial fan with the presence of Leona's little blue butterfly (Johnson 2011, p. 5). Despite the presence of spurry buckwheat on recently harvested land immediately to the north of the occupied habitat, Leona's little blue butterfly were not detected north of the mapped alluvial fan (Johnson 2011, p. 5). Johnson (2011, p. 5) did observe "small numbers" of Leona's little blue butterfly beyond the west edge of the mapped alluvial fan coincident with Sand Creek and Scott Creek drainages. Others have noted that the presence of the host plant alone may not be a good indicator of species presence due to factors including climatic differences, soil variations, or herbivore pressures (Aardema *et al*. 2011, p. 296).

Johnson and Ross (2013, p. 2) indicate that new populations of Leona's little blue butterfly are not likely to be discovered based on negative survey results from Oregon and California in habitat with a high potential for occupancy. However, they do believe that continued refinement of the current range is possible with more survey effort on private and public lands (Johnson and Ross 2013, pp. 2, 7).

Species' Biological Information

Only one population of Leona's little blue butterfly is known to occur. Biological and physical factors that are important to the life history needs of the Leona's little blue butterfly were modeled in an attempt to predict habitat that may contain Leona's little blue butterfly (Johnson 2011, p. 5). The model included plant assemblages, alluvial fan deposits, and perennial streams in pumice plateau forests, as well as meadows (Johnson 2011, p. 2). The plant assemblages included annual and perennial species found within the Sand and Scott Creek areas, in addition to the presence of lodgepole pine and ponderosa pine growing on pumice soils. The alluvial fan deposits provided a potential boundary for search areas based on previous surveys that noted the correlation between alluvial fans and Leona's little blue butterfly present in Sand and Scott Creeks. Perennial streams may be an indicator of high relative subsurface moisture, which is important to the establishment and persistence of the vegetation community present in Sand and Scott Creeks. All of these model elements proved to be vital to Leona's little blue butterfly presence after searches failed to locate the species when one or more of the elements were absent.

Occurrence Table

Table 1: Leona's little blue butterfly occurrence data and land ownership within the species' range.

Population Name	Land Ownership	Approximate Area (acres (hectares))	Number of Individuals Observed	Current Status of Population
Sand Creek[1]	Whitefish	7,653.6 (3,097.3)	Population estimated at 20,000 (James *et al.* 2014, p. 272). Data not available by landowner.	Extant
	Fremont-Winema National Forest	119.5 (48.4)		
	Other Private Lands	396.0 ac (160.3) from a total of 48 parcels.		

[1] The species was first described in the vicinity of Sand Creek, which has been used to identify the population. Further surveys expanded the range and the species is now known from the vicinity of both Sand and Scott Creeks.

Occurrence discussion

Information is not available at this time to determine population trends for the Leona's little blue butterfly. Past survey efforts have contributed to the overall knowledge of the potential extent of the Sand Creek population. Because Fidelity National Financial owned the majority of the occupied area (93.7 percent) until early 2015, and did not allow access to the property after 2011, data collection to estimate population trends has not been possible.

Spurry buckwheat is locally abundant within the Sand Creek population; similarly, the area contains a diverse assemblage of flowering plants documented as nectar sources for Leona's little blue butterfly. Habitat within the Sand Creek population improved on Whitefish ownership since the species was discovered in 1995. The improvements are a result of increases in open areas from timber management by the previous owners of the Whitefish property. On the Fremont-Winema National Forest, Leona's little blue butterfly is restricted to openings that contain spurry buckwheat and nectar plants within forested stands. Habitat contained on the Fremont-Winema National Forest has not been altered since the butterfly was described in 1995; the most recent timber harvest occurred approximately 90 years ago (Brown 2014, pers. comm.).

Species' Range

The range of the Leona's little blue butterfly appears to be restricted to a single location near Sand Creek in the Antelope Desert. When the Service was petitioned to list Leona's little blue butterfly in 2010, the area of known occupancy measured 6 sq mi (15.5 sq km). Surveys conducted since 2010 expanded the known area of occupancy to a 12.8 sq mi (33.1 sq km) area. Figure 1 shows the range of the species in 2010 and 2013. The changes in the range of the species are attributed to a better understanding of the life history needs of the species, which has informed where and when to survey. The expansion of the range, therefore, is a factor of improved search efforts for Leona's little blue butterfly and does not necessarily represent population growth. Information is not available on population changes as a result of timber management by the previous owners of the Whitefish property.

Stressors Potentially Affecting Leona's Little Blue Butterfly

This section evaluates potential past, ongoing, and future stressors that may be acting on Leona's little blue butterfly and its habitat. Stressors are the activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, or impairment of Leona's little blue butterfly and its habitat. In our review, we have identified the scope, severity, and timing of each stressor and how it may impact Leona's little blue butterfly. The scope is the proportion of the Leona's little blue butterfly range that can reasonably be expected to be affected by a particular stressor. The severity is the level of impact to the Leona's little blue butterfly population and/or its habitat that can reasonably be expected to occur from the stressor. Timing of stressor is based on the time period that can be reasonably assumed to have affected the Leona's little blue butterfly population and/or its habitat.

Time periods include past, ongoing, near-term future, and long-term future. The time periods are defined as follows:

- *Past* is used to describe the time period from the present back to the discovery of the species in 1995.

- *Ongoing* is used to describe stressors that are occurring now (time of development of this report).

- *Near-term future* is used to describe stressors that could act on the butterfly or its habitat in the next two years (from the timeframe for development of this report). The two-year time period was determined based on reproductive success measured over two Leona's little blue butterfly life cycles. Reproductive success, and therefore the continuation of the species, is partially described by the number of female offspring that reach reproductive age (Cushman *et al.* 1994, p. 195). The lifespan of the Leona's little blue butterfly is one year and ends shortly after egg laying. Eggs hatch and larva develop in the same year in which they are laid before entering diapause to overwinter. Each female that survives diapause and is able to contribute to the next generation represents successful reproduction by the parent.

- *Long-term future* is used to describe stressors that could act on the butterfly or its habitat beyond the two-year timeframe of "near-term future" defined above to a point sometime in the future when the effects of the stressor can no longer be reasonably predicted or information is otherwise lacking. The timeframe this represents may vary for each stressor and is discussed under each stressor separately, unless otherwise noted.

The level of impact of each stressor is provided in the summary for the stressor. Low-level impacts are those considered baseline for a species under natural conditions that are causing a minor amount of loss of individuals and/or habitat currently or in the future. Moderate-level impacts are those that are causing a more than minor but not widespread loss of individuals and/or habitat currently or in the future. High-level impacts are those that are causing widespread loss of individuals and/or habitat currently or in the future.

We evaluate the following potential stressors affecting Leona's little blue butterfly. The stressors are not listed in order of magnitude or level of threat.

1. Timber Management
2. Lodgepole Pine Encroachment
3. Fire
4. Fire Retardant
5. Fire Suppression
6. Right-of-Way Maintenance
7. Cinder Mining
8. Livestock Grazing
9. Herbivory from Native Animals
10. Herbicides
11. Invasive Plants
12. Insect Collection
13. Competition with Other Invertebrates
14. Predation
15. Disease
16. Pesticides
17. Isolated Population Effects
18. Effects of Climate Change
19. Potential Change in Land Ownership

1. Timber Management

Description of Stressor

Timber management is a broad term that encompasses many activities associated with the removal of trees. Activities may include creation of new temporary or permanent roads, use of existing roads, creation of new landings for log or equipment staging, use of existing landings, heavy equipment traveling on and off roads, felling of trees, lambing trees, skidding of trees to landings, piling of logging slash by machine or hand, and burning slash piles. Ground disturbance from all of these activities can impact Leona's little blue butterfly habitat through trampling of host and nectar plants making them a less viable resource for Leona's little blue butterfly. Similarly, timber management activities that utilize heavy machinery can affect all life stages of individual Leona's little blue butterfly through crushing of eggs, larvae, pupae, and adults. Activities that result in clearing of suitable habitat (e.g., creation of new roads and landings) have a greater potential impact as host and nectar plants are no longer available for use by Leona's little blue butterfly until plants have a chance to regenerate during the following growing season.

Timber management can also be beneficial to Leona's little blue butterfly and its habitat. The removal of trees and ground disturbance provides conditions suitable to colonization by spurry buckwheat. As spurry buckwheat and nectar plants become abundant in the open areas, the habitat becomes suitable for Leona's little blue butterfly. Additionally, the removal of trees and logging slash reduces the overall potential risk of wildfire and limits the potential intensity, severity, and rate of spread of wildfire (see Fire discussion below).

Scope of Stressor
All ownerships within the range of Leona's little blue butterfly have some degree of forested area and therefore could be subject to timber management activities. Timber management on Whitefish owned-lands has the ability to impact a larger proportion of the Leona's little blue butterfly population and its habitat than similar activities that may occur on Fremont-Winema National Forest lands or on private lands owned by other small landowners.

The majority of timber management activities will occur in forested areas as opposed to non-forested areas. Approximately 75 percent of the forest overstory on the Whitefish property was harvested between 2006 and 2008. While this recent harvest does not guarantee that timber operations will not occur here again, the scope of this stressor on Whitefish property is more likely limited to the remaining 25 percent of forest. There is no estimated proportion of forest to non-forest for lands owned by the Fremont-Winema National Forest or small private parcels; it is assumed for the purposes of this analysis that all areas may be subject to timber management.

Timber management activities, such as the use or creation of roads and landings, may occur in non-forested areas. Because this varies depending upon current travel routes and the location of the forested areas, it is not possible to make reasonable assumptions on the location of the non-forested areas impacted. However, it can be assumed that any new roads, staging, or landings will occur in some of the open non-forested areas, which may contain Leona's little blue butterfly or its habitat.

Severity of Stressor
Because timber extraction is the focus of timber management activities, forested areas will be the most heavily impacted. Leona's little blue butterfly prefer open habitats that are either not forested or have sparse tree cover such as natural openings, road edges, unimproved roads, and previously harvested or cleared areas. Leona's little blue butterfly therefore would be subject to impacts of timber activities when they occur in their preferred habitat (e.g., use of existing unimproved roads and landings, creation of new landings in open areas, tractor piling of slash in open areas that were not previously forested). Habitat and individuals in these areas could be subject to both habitat degradation and direct mortality. Anecdotal information from Ross (2009, p. 18) indicates that an area previously known to be occupied by Leona's little blue butterfly was not occupied after an apparent increase in traffic on unimproved roads, possibly a result of timber harvest activities.

Leona's little blue butterfly benefit from timber management activities that increase the size of existing openings and create new openings. More sunlight from the reduction in tree cover and disturbance to the ground is favorable for the colonization of spurry buckwheat and nectar plants. Higher densities of spurry buckwheat are correlated with higher densities of Leona's little blue butterfly (Johnson 2011, p. 9; James *et al.* 2014, p. 270). Similarly, timber management reduces the potential for stand-replacing fire through the removal of trees and logging slash.

The overall severity from timber management as a stressor is low. Severity is low because impacts are more likely to affect forested areas that are not suitable habitat and are not occupied by Leona's little blue butterfly. Impacts to existing open areas containing butterflies would be

localized and affect few individuals. Beneficial effects from timber management promote the development of new habitat and maintenance of existing habitat.

Timing of Stressor

Past

Past impacts to the Leona's little blue butterfly population from timber management are not known. It is reasonable to assume that areas that were heavily forested were not suitable for Leona's little blue butterfly and subsequent timber harvest did not result in the loss of Leona's little blue butterfly or its habitat. The most recent timber management on lands now owned by Whitefish occurred from 2006 to 2008. This management resulted in large reductions of forest canopy and the creation of new openings from road and landing construction, which has allowed spurry buckwheat and nectar plants to colonize. Leona's little blue butterfly have recently occupied these newly harvested areas (James *et al.* 2014, p. 270; Johnson 2010, p. 8).

Past timber management in Leona's little blue butterfly occupied habitat on the Fremont-Winema National Forest occurred approximately 90 years ago (Brown 2014, pers. comm.). The harvest resulted in the removal of large ponderosa pine. Firewood cutting also removed a few scattered, dead lodgepole pine (Brown 2014, pers. comm.). Information on timber management for the other small private landowners is not available.

Current

Whitefish recently acquired lands previously owned by Fidelity National Financial. Information on current timber management activities is not available; however, it is reasonable to assume that these activities are on hold while the new owner becomes familiar with the property.

The Fremont-Winema National Forest is currently engaged in timber management activities in Leona's little blue butterfly occupied habitat. The Fremont-Winema National Forest has initiated timber harvest on 38 of the 119.5 ac (15.4 of the 48.4 ha) it owns within the Leona's little blue butterfly range (USFS 2014, p. 2). The objective of the treatment is to create more open areas that could facilitate butterfly movement to the north and provide additional habitat for Leona's little blue butterfly once spurry buckwheat and nectar plants have had a chance to colonize. Timber management activities include the felling of lodgepole pine trees, skidding the trees to landings, and logging slash will be piled and burned (USFS 2014, p. 2). Protection measures will be implemented to minimize potential project impacts to the butterfly. Primarily, timber management actions will occur during winter months when Leona's little blue butterfly host and nectar plants have already died back or are dormant and are not likely to be damaged by vehicles traveling over snow or frozen ground. The operation of machinery over snow or on frozen ground may afford some protection to the few Leona's little blue butterfly pupae that may occur in areas subject to vehicle traffic. Additional protection measures include restrictions on placement of burn piles and equipment staging areas and provisions to prevent the introduction of noxious weeds (USFS 2014, pp. 3–4). Information is not available on current timber management activities on the other small private parcels.

Future

We do not have information on future timber management activities on Whitefish property; however, it is very likely that the land will continue to be managed for timber production for the next few decades. Near- and long-term future timber management Whitefish property is expected to continue to create a mosaic of recently disturbed areas, forested areas in mixed age and canopy cover class, and densely forested areas.

The Service does not have information on long-term future plans for management of timber on USFS property within the range of Leona's little blue butterfly.

Information is not available on future timber management activities on the other small private parcels. The distribution, small individual size, and overall total acreage of these parcels limits the potential for any significant positive or negative effects from timber management activities.

Summary of Timber Management stressor

Ground disturbing activities resulting from timber management can impact Leona's little blue butterfly and its habitat. This stressor is present across all ownerships, however is limited to forested areas and areas that allow access to forested areas. More of the occupied Leona's little blue butterfly habitat is subject to this stressor on the Whitefish property compared to areas under other ownership given the proportion of Leona's little blue butterfly habitat on that ownership (93.7 percent). Tree removal and ground disturbance are beneficial to Leona's little blue butterfly's host plant spurry buckwheat. Spurry buckwheat is a colonizer plant species and is capable of rapidly inhabiting open areas resulting from timber management that may not have been previously available to Leona's little blue butterfly. Timber management also reduces the risk of stand-replacing fire. This stressor has occurred in the past and will occur in the near- and long-term future.

Timber management acts as a low-level stressor on Leona's little blue butterfly and its habitat. The limited scope and low severity of the stressor suggest that this is not a considerable source of loss of individuals or habitat. Rather, the longer-term benefits from timber management promote habitat for the butterfly.

2. Lodgepole Pine (*Pinus contorta*) Encroachment

Description of Stressor

Leona's little blue butterflies occupy open habitat areas that are treeless or sparsely treed. In some cases, natural openings are being encroached by lodgepole pine. Encroachment is different from the natural regeneration of previously forested areas. Encroachment occurs when lodgepole pine, for example, gradually expands into open areas where it was previously absent. Encroachment is identified most readily when small seedlings/saplings are observed in areas that were never forested. Natural regeneration occurs when areas that were harvested become forested again through the gradual sprouting of seeds and growth of seedlings over time. Encroachment and natural regeneration may result in the gradual conversion of these open habitat areas to forested habitats.

The rate of lodgepole pine encroachment within the range of Leona's little blue butterfly is unknown. Horn (2009, pp. 203–204) observed a three-fold increase (from n=27 to n=76) in the

number of lodgepole pine over a period of 40 years within a 100 ac (40.5 ha) plot in the Pumice Desert of Crater Lake National Park. The Pumice Desert was formed during the eruption of Mt. Mazama and is a large opening surrounded by lodgepole pine forest (Horn 2009, p. 200). Horn (2009, p. 204) observed that most of the encroachment occurred closest to the existing forested edge. Approximately one-half (n=38) of the lodgepole pine were less than 3 ft (1 m) tall; thirty-one percent (n=24) of trees were less than 1.6 ft (0.5 m) tall. These sizes represent saplings and seedlings that are indicative of encroachment.

The rate of natural regeneration of lodgepole pine within the range of Leona's little blue butterfly is unknown. Natural regeneration in this area requires a minor degree of protection from mature trees (Volland 1988, pp. 38, 40). Factors that influence the rate of regeneration include weather, soil conditions, and availability of a seed source (Cochran 1973, pp. 4–5; Geist and Cochran 1990, pp. 3, 9). Good conditions for seed germination occur in areas that receive full sunlight and lack competing vegetation or soils that are otherwise disturbed (Lotan and Critchfield 1990, p. 306). Germination rates ranged from 0.6 to 45.5 percent in a study conducted between 1970 and 1972, located approximately 60 miles north of the Leona's little blue butterfly range (Cochran 1973, p. 3). Seedlings are vulnerable to drought and frost heaving due to the shallow root systems of lodgepole pine (Cochran 1973, p. 5; Lotan and Critchfield 1990, pp. 307, 309). Over-winter survival rates of seedlings ranged from 6.7 to 17.5 percent in one study plot (Cochran 1973, p. 5). Lotan and Critchfield (1990, p. 305) report similar rates for "good crops" of lodgepole pine occurring at 1 to 3 year intervals.

Lodgepole pine encroachment and natural regeneration pose a stressor to Leona's little blue butterfly through the loss of habitat that supports its host and nectar plants. As encroachment and natural regeneration into open areas progress, host and nectar plants lose the ability to persist in open areas. As the canopy closes, sunlight needed by these plants diminishes and reduces their abundance on the landscape. A reduction in host and nectar plant quantity is likely to reduce the number of plants on which Leona's little blue butterfly will find to lay eggs and to find nectar.

Scope of Stressor

Lodgepole pine encroachment and natural regeneration impacts open habitat areas within the range of Leona's little blue butterfly. Open habitat areas occur to varying degrees across all ownerships. As the largest landowner, Whitefish likely has the highest proportion of openings that could be affected by lodgepole pine encroachment and natural regeneration.

Severity of Stressor

Lodgepole pine is a pioneer and a climax species in cold environments and on young, infertile soils like those found in the deep pumice fields of the Sand Creek Basin (Youngberg and Dyrness 1959, p. 118; Tilden 1963, p. 112; Stuth and Winward 1976, p. 453; Lotan and Critchfield 1990, p. 303; McCrimmon 1990, p. 1). Lodgepole pine is present in varying densities on lands within the area occupied by Leona's little blue butterfly. Areas with lower stocking levels and non-forested areas provide current habitat for Leona's little blue butterfly. Lodgepole pine encroachment is believed to have reduced the extent of openings in areas occupied by Leona's little blue butterfly (Johnson 2010, p. 6). Hatcher (2014a, p. 3) notes that "only a small number of trees" have become established in meadows. Despite the documented presence of

lodgepole pine and its encroachment or natural regeneration into occupied Leona's little blue butterfly habitat, there are large openings (approximately 760 acres (308 ha)) that appear to have never supported lodgepole pine (Ross and Johnson 2012, p. 2; Johnson 2014e, pers. comm.). These areas lack visible stumps or other remnants of woody material indicating these areas were ever forested. This may be due to the deep soils that are present within the Sand Creek Basin. Tilden (1963, p. 111) suggests that the recovery of vegetation since the eruption of Mt. Mazama appears to be inversely related to the depth of the pumice.

The overall severity from lodgepole pine encroachment and natural regeneration as a stressor is moderate. Severity is moderate because lodgepole pine has the ability to reduce many of the open habitats used by Leona's little blue butterfly. Large open areas are present that do not show signs of lodgepole pine encroachment; this may be related to the depth of the pumice and may act as a natural inhibitor to encroachment by lodgepole pine.

Timing of Stressor

Past

Based on aerial imagery, openings present in 1995 were still present in 2012. It is not possible to tell from the scale of the aerial imagery if lodgepole pine encroachment was occurring; small seedlings and saplings would not be visible on the images. It is unknown how much of the past timber harvest took place in areas that were the result of lodgepole pine encroachment versus natural regeneration. Specific information on the rate of past lodgepole pine encroachment is not available for any of the landownerships within the range of Leona's little blue butterfly; however, Hatcher (2014a, p. 3) notes minimal encroachment has occurred in meadows. Similarly, information on the rate of past natural regeneration of lodgepole pine is not available within the range of the butterfly; however, information from the literature suggests the rate of germination and seedling survival varies between years.

Current

Encroachment and natural regeneration by lodgepole pine is occurring on Whitefish and Fremont-Winema National Forest lands within the range of Leona's little blue butterfly. Information is not available on current lodgepole pine encroachment and natural regeneration on the other private small private landownership within Leona's little blue butterfly range.

The Fremont-Winema National Forest recently initiated a project to remove encroaching lodgepole from 38 of the 119.5 ac (15.4 of 48.4 ha) of occupied butterfly habitat (USFS 2014, p. 2). The objective of the treatment is to expand existing open areas and create additional open areas that could provide habitat for Leona's little blue butterfly once spurry buckwheat and nectar plants have had a chance to colonize. See Timber Management Stressor discussion above for more information.

Future

Lodgepole pine encroachment and natural regeneration is likely to continue into both the near- and long-term future across the range of Leona's little blue butterfly. However, future timber management practices on Whitefish lands are likely to continue harvesting lodgepole pine and therefore remove some of the lodgepole pine that is encroaching and regenerating in open habitats. The Service does not have information to suggest that there would be any significant

change to the rates of lodgepole pine encroachment and natural regeneration in the near- or long-term future based on the information provided for past and current rates of encroachment and regeneration combined with the expected continuation of timber management activities over the next few decades.

Summary of Lodgepole Pine Encroachment Stressor
Lodgepole pine encroachment and natural regeneration is an ongoing stressor affecting the area occupied by Leona's little blue butterfly. The rate of encroachment and regeneration within the range of the butterfly is not known. Lodgepole pine encroachment resulted in a threefold increase in lodgepole pine in the Pumice Desert over a period of 40 years; encroachment was greater near the forest edge. Encroachment is absent in areas that appear to lack suitable conditions for lodgepole pine establishment. Past actions by previous owners of the Whitefish property and current actions by the Fremont-Winema National Forest are limiting the encroachment and natural regeneration of lodgepole pine in some areas occupied by Leona's little blue butterfly. Land management practices that result in the removal of lodgepole pine by these two entities are expected to maintain and enhance some open patches through expansion of their perimeters.

Lodgepole pine encroachment and regeneration acts as a moderate-level stressor on Leona's little blue butterfly and its habitat. The scope and moderate severity of the stressor suggest that this could be a considerable source of loss of habitat and subsequently individuals.

3. Fire
Description of Stressor
There are two types of fires that may impact Leona's little blue butterfly: wildfire and prescribed fire. Wildfires are not planned fire events, but are started by natural events (i.e. lightning) or non-natural sources (e.g., arson, machinery, power lines, etc.). Prescribed fires are burn operations that follow a prescription dictating proper fuel and weather conditions that allow for control of fire severity, intensity, and rate of spread per stated management objectives. Prescribed fire can occur in many forms ranging from burning material piled after timber harvest to broadcast burning in which large areas are burned over a series of days.

Both types of fire can result in the loss of Leona's little blue butterfly host and nectar plants, but can also create new openings if a fire burns through dense brush or at high severity through dense forest stands. Potential rates of fire spread and intensity can vary across the occupied habitat based on fuel loading, weather conditions, and response time of suppression efforts. Soils within the Leona's little blue butterfly range are pumice based and have low productivity for sustaining fire (Dunn 2011a, p. 9). Because of the low productivity, the types of vegetation that grow in the Sand Creek and Scott Creek area (Volland 1988, p. 38) are not the kinds that will carry fire very far (low leaf litter, very little if any duff layer, no or very few ladder fuels) (Simpson 2007, p. 9-5; Dunn 2011a, p. 9). Similarly, the discontinuity of the vegetation also slows down the potential for rapid progression of fire through the area (Dunn 2011a, p. 4; Dunn 2011b, p. 12). This does not mean that large fires are not possible; under extreme weather conditions (e.g., very high temperatures and winds) fire can spread across the landscape (Dunn 2011a, p. 3). Fire models indicate that if a large-scale fire were to occur in Leona's little blue

butterfly habitat, the open glades would either not burn or would be mostly intact after a fire event (Dunn 2011b, p. 12).

If exposed to fire, Leona's little blue butterfly in the egg, larvae, and adult life stage may be killed by fire. Death of biological tissue occurs when exposed to temperatures 140 ºF (60 ºC) for 1 minute (Dunn 2011b, p. 2). Pupae are exposed to temperatures up to 154 ºF (68 ºC) (James 2014, p. 268) and, therefore, may be able to withstand slightly higher temperatures. As mentioned earlier, pupae are formed at or below ground level where spurry buckwheat grows; spurry buckwheat is associated with open areas that lack trees and dense shrub layers (Dunn 2011a, p. 8). During fire events, surface temperatures in open glade habitats such as those favored by spurry buckwheat are not likely to reach lethal heating temperatures of 140 ºF (60 ºC) (Dunn 2011b, p. 10). Instead, fire in open glade habitats is likely to result in the rapid flaming of vegetation. Open glade habitats within the area do not have accumulated surface fuels (woody material, abundant dead vegetation) that would create smoldering heat and increase soil temperature (Dunn 2011b, p. 10).

Fire within lodgepole pine forests is likely to spread quickly due to the relative abundance of standing and downed material contributing to fuel loads (Dunn 2011b, p. 12). Fire may completely consume stands of trees or it may creep around in the understory; fire behavior is dependent upon weather conditions and fuel loading. Extreme weather conditions including high temperature, high wind speed, and low relative humidity can result in rapid rates of fire spread at higher intensity and severity than would be expected under more normal weather conditions. Areas with light fuel loads are not expected to burn at the same intensity or severity as those with higher fuel loads.

Fire can result in improved habitat condition through reduced competition to host and nectar plants from removal or reduction in tree and brush cover. The reduced competition from trees and shrubs results in increased light, water, nutrients, and space for host and nectar plants and more open conditions for dispersal and connectivity of habitat patches for Leona's little blue butterfly. Logging slash piles burned by previous owners of the Whitefish within newly opened habitat now contain spurry buckwheat and are associated with a high relative abundance of Leona's little blue butterfly (Johnson 2010, p. 9; Ross 2010, p.5; James *et al.* 2014, p. 270).

Scope of Stressor
All ownerships have the potential to be impacted by fire. Fire on Whitefish lands has the ability to impact a larger proportion of occupied Leona's little blue butterfly habitat than fire that may occur on Fremont-Winema National Forest or on other small landowner's properties. Forested areas contain higher concentrations of fuels compared to the open glade habitats preferred by Leona's little blue butterfly and spurry buckwheat. Forested areas are expected to be impacted by fire to a greater degree than open areas due to the difference in fuels, which results in differences in fire behavior.

Severity of Stressor
Fire is most impactful in areas of higher fuels, and less so in open areas. The overall stressor of wildfire has been reduced by timber management activities conducted by the previous owners of the Whitefish property. These timber management activities have reduced the volume of

material that could burn and created gaps in the forest that break up the continuity of fuels. Leona's little blue butterfly are expected to persist in the Sand Creek area after fire because open glade habitats are not expected to carry fire in the same way forested stands will carry fire. In the event that fire does occur in open glades, Leona's little blue butterfly host and nectar plants could be destroyed by fire, which could reduce the number of Leona's little blue butterfly in an area and impede reproduction, egg laying, larval feeding, and nectaring by Leona's little blue butterflies persisting in the area. Fires occurring during the growing season (June through August) could result in an initial reduction in spurry buckwheat immediately following fire, but 2 to 3 years later spurry buckwheat is likely to increase in fire-affected areas (Dunn 2011a, p. 9). If fires occur after spurry buckwheat has senesced, there is not much vegetation to burn due to the sparsely vegetated nature of this plant (Blackwell 2006, p. 236). We would not expect a significant reduction in germination, growth, and flowering for the next season under "normal" growing conditions and as a result there would be no significant impact to Leona's little blue butterfly.

Due to the mix of forest and open areas observed within the Leona's little blue butterfly range, fires are not expected to burn at the same intensity across all areas. Fire events could burn in a mosaic pattern, with higher severity fire in densely vegetated areas and low severity or no fires in sparsely vegetated areas. The open glade habitats occupied by Leona's little blue butterfly will allow the species to persist after a fire event (Dunn 2011b p. 12).

Other factors aside from vegetation and weather that likely contribute to the relatively small size of fires recorded in the Sand Creek area include high road density and proximity of fire management personnel. The area within and adjacent to the Leona's little blue butterfly range has a high road density due to timber management on Whitefish lands. The Oregon Department of Forestry operates the Sand Creek Fire Station during fire season with crews to suppress wildfires. The Sand Creek Fire Station is located within the Leona's little blue butterfly habitat polygon. The local presence of fire suppression crews and the high density of roads allow for quick response times, provide fuel breaks, and increase accessibility to fires that may start within Leona's little blue butterfly habitat.

Fire is also beneficial to Leona's little blue butterfly habitat. Fire can result in brush clearing that reduces competition for Leona's little blue butterfly host and nectar plants (Dunn 2011a, p. 9). James *et al.* (2014, p. 270) provided an anecdotal observation that spurry buckwheat thrives in the footprints of burned slash piles. Huntzinger (2003, p. 9) found that butterflies were more frequent in areas that were prescribe burned, possibly due to increased sunlight.

The overall severity from fire as a stressor is low. Severity is low because impacts are more likely to affect areas that are not suitable habitat and are not occupied by Leona's little blue butterfly. Further fire history indicates that fires are small and infrequent. Beneficial effects from wildfire and prescribed fire promote the development of new habitat and maintenance of existing habitat.

Timing of Stressor

Past

The history of wildfire events occurring in and adjacent to the range of the Leona's little blue butterfly are described in detail in the *Disturbance Regime* section above. Impacts from wildfires occurring since 1995 have been low due to the small size and number of fires. Within the Township and Range that overlaps the range of Leona's little blue butterfly, Oregon Department of Forestry records indicate 14 fires burned a total of 287 ac (116 ha); the average fire size is 20.5 ac (8.3 ha) and ranges from 0.02–200 ac (0.01–81 ha). Of those fires, nine are within the range of Leona's little blue butterfly and burned a total of 19.8 ac (8.0 ha); the average fire size is 2.2 ac (0.9 ha) and ranges from 0.02–17 ac (0.01– 6.9 ha).

Past prescribed fire is not documented for property now owned by Whitefish, but appears to have been conducted post-timber harvest to remove piled logging slash. Information is not available to determine if these areas were habitat for Leona's little blue butterfly prior to piling and burning of material.

The Fremont-Winema National Forest has not conducted prescribed fire on its lands within the range of Leona's little blue butterfly (Libercajt 2014, pers. comm.). Information is not available on past prescribed fire on the other small private parcels.

Ongoing

Whitefish recently acquired lands previously owned by Fidelity National Financial that are within Leona's little blue butterfly range. Information on current prescribed fire activities is not available; however, it is reasonable to assume that these activities are on hold while the new owner becomes familiar with the property.

The Fremont-Winema National Forest is not conducting prescribed burning in Leona's little blue butterfly occupied habitat.

Information is not available on current prescribed fire on the other small private parcels.

Future

Future wildfires within the range of Leona's little blue butterfly are expected to continue to occur in the near- and long-term future. Fire frequency and size are expected to be similar to what has been recorded historically. The majority of wildfires are likely to be small given the scattered nature of the fuels, the limited ability of Leona's little blue butterfly habitat to carry fire, high road density allowing for easy access to fire starts, and proximity of Sand Creek Fire Station providing rapid response for fire suppression. Wildfire potential is greater for forested areas and minimal for open habitats.

Near-term future risk of wildfire will be reduced on 38 ac (15.4 ha) of the Fremont-Winema National Forest after timber management is completed in late fall or early winter 2014. On Whitefish lands and the other small parcels of private land, near-term fire risk is greatest in areas that are heavily timbered. Wildfires are expected to occur within the long-term future (next few decades) at similar rates and intensities as observed in the past across all ownerships. See Climate Change section for additional projections relating to future wildfire through 2085.

Prescribed fire is proposed in the near-term as part of the Fremont-Winema National Forest's project to improve habitat for Leona's little blue butterfly. Information is not available on the Fremont-Winema National Forest's long-term future plans for prescribed burning activities. Information is not available on near- or long-term future prescribed fire on private lands. Based on past use of prescribed fire, it is reasonable to assume that future prescribed fire may occur following logging operations on Whitefish lands.

Summary of Fire Stressor

Fire could result in loss of individual butterflies and host and nectar plants across the entire area occupied by Leona's little blue butterfly. The forested stands within the Leona's little blue butterfly habitat area are at greater risk of high intensity and severity fires than the more open areas occupied by Leona's little blue butterfly. Past fires have been small in size and the presence of fire suppression crews at Sand Creek Guard Station suggest that the while there is risk of fire in Leona's little blue butterfly habitat, the impacts of fire are not expected to encompass large areas or be widespread. The condition of the standing and ground fuels are mixed, and when combined with the inability of some areas to carry fire, further support the concept that if a large fire were to occur it would burn in mosaic pattern and open areas could continue to support Leona's little blue butterfly and its habitat. Beneficial effects from wildfire and prescribed fire promote the development of new habitat and maintenance of existing habitat.

Fire acts as a low-level stressor on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur range-wide, this stressor is not a considerable source of loss of individuals or habitat. Additionally, the benefits from fire promote habitat for the butterfly.

4. Fire Retardant

Description of Stressor

Fire retardant is a substance or chemical agent which reduces the flammability of combustibles and is typically applied by aircraft. Fire retardant used by the USFS is approximately 85 percent water mixed with inorganic fertilizers (ammonia polyphosphate makes up 60–90 percent of remaining 15 percent), thickeners, suspending agents, dyes, and corrosion inhibitors (USFS 2011, pp. 15–16). Fire retardent coats and adheres to vegetation, which slows the progression of fires. Fire retardant can be applied during direct attack or indirect attack. Fire retardant is not used on every fire event; its use is dependent upon the values at risk and potential for rapid fire growth (USFS 2011, p. 8). Fire suppression strategies assess the risk to human life; fire retardant may be used during initial attack and/or over a longer term as dictated by the situation (USFS 2011, p. 8). The USFS estimates the area of impact by aerially applied fire retardant at 50–75 ft (15–23 m) long by 800 ft (244 m) long (0.9–1.4 ac (0.4–0.6 ha)) (USFS 2011, p. 32).

Any fire retardant exposure is likely to be lethal to Leona's little blue butterfly life forms that are above ground due to its inherent stickiness, which would severely restrict movement and could also result in suffocation (USFS 2011, p. 179). No data are available regarding the toxicity of fire retardant to larvae of invertebrates (USFS 2011, p. 179). Leona's little blue butterfly in the pupa stage may or may not be exposed to fire retardant dependent upon whether they are at or below ground level. Fire retardant would also potentially result in the killing of host and nectar

plants if photosynthesis were inhibited; similarly, flowers coated in retardant would not be available for nectaring. Fire retardant may also act as a fertilizer, increasing plant growth of both native and non-native species.

The USFS uses mapped buffers to avoid the aerial application of fire retardant in waterways and habitats occupied by some, but not all, threatened, endangered, or proposed species listed under the Act (USFS 2011, p. 3). These mapped avoidance area buffers only occur on National Forest lands. There are no mapped avoidance buffer areas within the range of the Leona's little blue butterfly.

Scope of Stressor
The areas within and surrounding the Leona's little blue butterfly range are forested to varying degrees. Fire retardant application is possible on all lands within the range of Leona's little blue butterfly, but may be more likely in areas closer to buildings or residences. Structures are present within and adjacent to Leona's little blue butterfly range, but are not numerous and are typically associated with smaller parcels of private land outside the range of the species.

Severity of Stressor
The above ground life cycle of Leona's little blue butterfly occurs from late June to July/August, which is within the normal fire season for Sand and Scott Creeks and adjacent areas. Any Leona's little blue butterfly that is exposed to fire retardant has a high likelihood of mortality. Host and nectar plants could have diminished vigor or die from fire retardant application. Fire retardant is not used on every fire nor does it cover large contiguous areas, but it could be used within the area occupied by Leona's little blue butterfly. Fire retardant may be applied to both forested areas and to open areas. The history of fires in and around the area occupied by Leona's little blue butterfly (see fire stressor discussion above) has been small in size and number. The potential for Leona's little blue butterfly and its habitat to be impacted by fire retardant is low based on the history of fires. The fertilization effect of fire retardant may improve the vigor of host and nectar plants, but can also have the same effect on any non-native plants that may be in the area. Non-native plants may be a source of competition for native plants as discussed below (see invasive plants stressor discussion below).

The benefit of fire retardant use in and adjacent to the range of Leona's little blue butterfly is that fire spread will be reduced, potentially keeping fire out of areas occupied by the butterfly.

The overall severity of fire retardant as a stressor is low. While mortality of butterflies and negative effects to plants are expected when fire retardant is used, the impacts are expected to be localized and small in size.

Timing of Stressor
<u>Past</u>
Information regarding past use of fire retardant in the area occupied by Leona's little blue butterfly is lacking. It is reasonable to assume that use may have occurred during suppression efforts of past fire events.

<u>Current</u>

Fire retardant may be applied to fires occurring within the range of Leona's little blue butterfly.

Future

Fire retardant may be applied to fires occurring in the area occupied by Leona's little blue butterfly for the near- and long-term future (next few decades). The Service does not expect to see a change in trends of fire retardant use in near- or long-term future as fire size and intensity are not expected to change (see Fire discussion above).

Summary of Fire Retardant Stressor

Exposure to fire retardant can result in lethal impacts to Leona's little blue butterfly and the plants it depends upon to complete its lifecycle. Aerial application of fire retardant has a relatively small footprint and would not result in widespread loss of Leona's little blue butterfly or its habitat. Further the history of fires in the area are small in size and number, indicating that this stressor, while possible, has low potential for widespread impacts Leona's little blue butterfly or its habitat.

Fire retardant may act as a low-level stressor on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur range-wide, it this is not a considerable source of loss of individuals or habitat. Use of fire retardant can slow or inhibit the progression of fire spread in areas occupied by Leona's little blue butterfly.

5. Fire Suppression

Description of Stressor

Ground disturbing activities arising from suppression efforts have the ability to impact Leona's little blue butterfly habitat and individuals. These activities may include creation of fire line by hand or machinery and vehicle travel on and off roads. Creation of fire line involves digging down to mineral soil, which may remove host and nectar plants and disrupt the life cycle of Leona's little blue butterfly. Other actions associated with the creation of fire line include the felling of trees and/or limbing of trees to reduce ladder fuels. Felling and limbing of trees are likely to result in more open areas and more open forest canopy, which can provide new areas for host and nectar plants to colonize. In addition, when machinery is moved from one area to another, there is the potential for the spread of invasive plants. The stressor of Invasive Plants to Leona's little blue butterfly is discussed below.

The intent of fire suppression is to extinguish fires quickly. Fire suppression in turn interrupts historic fire return intervals by not allowing fires to burn as they have in the past and changes the habitat away from its expected, natural condition (Crawford 2011, p. 3). Suppression allows for vegetation to become denser, fuels to accumulate, and for conifer encroachment to occur over time. Fire suppression, consequently, can lead to larger fires and loss of open areas. The stressors of Fire and Lodgepole Pine Encroachment to Leona's little blue butterfly and its habitat are discussed above.

Scope of Stressor

The areas within and surrounding the Leona's little blue butterfly range are forested to varying degrees. Fire suppression is possible on all lands within the Leona's little blue butterfly occupied habitat area.

Severity of Stressor
Fire suppression activities would not impact all habitat at any one time. The amount of area impacted during any one event would depend upon the fuels present and tactics employed to control fire spread. Ground disturbance is beneficial for the colonization of spurry buckwheat. Similarly, areas that opened up due to the felling or limbing of trees could result in more areas suitable for Leona's little blue butterfly host and nectar plants.

The overall severity from fire suppression as a stressor is low. Severity is low because fire history indicates that fires are small and infrequent, therefore the impacts are not expected to impact large areas of occupied habitat. Beneficial effects from ground disturbance and tree felling will promote colonization of spurry buckwheat, which will create or enhance habitat for Leona's little blue butterfly.

Timing of Stressor
Past
Past fire suppression impacts from ground disturbance and tree felling are not known, but are expected to have been small given the small size and number of fires since 1995. Beneficial impacts from ground disturbance and tree felling may have improved or created small areas of potential habitat. Fire suppression likely contributed to higher risk of wildfire in forested stands and conifer encroachment into open areas.

Current
Fire suppression activities may occur in the area occupied by Leona's little blue butterfly.

Future
It is reasonable to assume that fire suppression activities will continue to occur in the near- and long-term future (next few decades) in the area occupied by Leona's little blue butterfly. Suppression can result in densely stocked forests, accumulation of fuels, and conifer encroachment in open areas (see Timber Management, Lodgepole Pine Encroachment, and Fire discussions above). The Service does not expect to see a change in trends of fire suppression activities in the near- or long-term future, as fire size and intensity are not expected to change (see Fire discussion above).

Summary of Fire Suppression Stressor
Fire suppression activities can have positive and negative impacts to Leona's little blue butterfly and its habitat. Habitat and individuals can be destroyed by suppression that removes habitat. Ground disturbance and tree felling can improve habitat for Leona's little blue butterfly. Suppression can result in densely stocked forests, accumulation of fuels, and conifer encroachment in open areas, which can result in impacts to Leona's little blue butterfly from fire and encroachment that are described above.

Fire suppression may act as a low-level stressor on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur range-wide, it is not a considerable source of loss of individuals or habitat. Beneficial effects from ground

disturbance and tree felling will promote colonization of spurry buckwheat, which will create or enhance habitat for Leona's little blue butterfly.

6. Right-of-Way Maintenance

Description of Stressor

Several rights-of-way occur within the range of the Leona's little blue butterfly. The rights-of-way are maintained by Bonneville Power Administration (BPA), TransCanada (Pacific Gas Transmission Company), Oregon Department of Transportation (ODOT), Klamath County, and American Tower Corporation (Johnson 2014e, pers. comm.).

BPA/TransCanada. The BPA and TransCanada rights-of-way co-occur in one corridor. It is our understanding that BPA maintains this joint right-of-way corridor, so information from BPA is used to assess the potential activities that occur within this right-of-way. The BPA manages vegetation at its facilities (rights-of-way, electric yards, and non-electric facilities) using four general control methods (manual, mechanical, biological control agents, and herbicides) (BPA 2000, p. 3). The objective of the vegetation management program is to keep vegetation away from facilities and to control noxious weeds (BPA 2000, p. 3). Within rights-of-way, the BPA vegetation management program promotes low-growing vegetation through the removal of tall-growing vegetation (BPA 2000, p. 5). Depending upon topography, location, and vegetation type the vegetation management occurs every three to ten years (BPA 2008, p. 3). Manual clearing with chainsaws is heavily relied on to remove all vegetation types, while mechanical clearing may be used around tower legs, access roads, and dense patches of vegetation (BPA 2000, p. 5). Biological control agents would only be used to treat noxious weeds; herbicide application is most likely to be in the form of spot or localized treatments (BPA 2000, p. 5).

Maintenance of power line rights-of-way results in the reduction of woody plants and encourages early successional plants (Forrester *et al.* 2005, p. 489). Power line rights-of-way can be important butterfly habitat (Berg *et al.* 2013, p. 646) and have been correlated with higher butterfly abundance when compared to semi-natural grasslands (pastures) (Berg *et al*. 2013, p. 644).

ODOT. ODOT maintenance of rights-of-way occurs as part of the *ODOT Integrated Vegetation Management Statewide Plan* (IVM). The IVM identifies the control of vegetation through one or more of the following methods: mechanical (mowing, shoulder blading, brush moving, and bush cutting), cultural (re-seeding), biological (use of natural predators to control vegetation), and herbicide (ODOT 2013, pp 1, 6). Mechanical activities may result in the clearing of vegetation along road shoulder edges and cutting back vegetation to a minimum height of 6 in (15 cm) (ODOT 2013, pp. 6–7). Cultural control involves the use of weed-free seed to prevent the establishment of noxious weeds (ODOT 2013, p. 7). Biological control agents may be used to target specific plant species and must be coordinated with Oregon Department of Agriculture (ODOT 2013, pp. 7–8). Herbicides may be used to control unwanted vegetation, including noxious weeds (ODOT 2013, pp. 8–10).

ODOT utilizes best management practices when implementing the IVM. Best management practices for the four activities described above including a directive regarding timing of activities to minimize impacts to migratory birds during "prime nesting period" (February 15 to September 15), mowing noxious weeds prior to seed setting, adjusting mower heights, cleaning

of equipment to prevent spread of noxious weeds, herbicide application when wind speed is less than 10 mi per hour (16 km per hour), and whenever possible apply herbicides in fall or winter to minimize the appearance of dead vegetation (ODOT 2013, pp.6–9). Similarly, shoulder blading is likely to reduce the risk of fire from vehicles because these areas are vegetation free or sparsely vegetated. Please see the Herbicide Stressor, Invasive Plants Stressor, and Fire Stressor discussions for more information on potential impacts to Leona's little blue butterfly.

Klamath County. We are unable to locate information on the activities that occur within the Klamath County right-of-way. Activities within this area are likely to be a similar to the activities conducted within the ODOT right-of-way.

American Tower Corporation. We are unable to locate information regarding activities that may occur within the American Tower Corporation right-of-way.

Scope of Stressor
This stressor is limited to rights-of-way that occur within the Leona's little blue butterfly range.

The BPA/TransCanada. It is our understanding that BPA maintains this joint right-of-way corridor, so information from BPA is used to assess the potential activities that occur within this right-of-way. This right-of-way runs approximately north-south through the range of Leona's little blue butterfly on lands owned by Whitefish. The right-of-way is approximately 105 ac (43 ha) in size and makes up 1.4 percent of the range of Leona's little blue butterfly. Some portions, but not all, of the power line right-of-way are occupied by Leona's little blue butterfly (Ross 2008, p. 8).

ODOT. A portion of State Highway 97 measuring approximately 3.3 mi (5.4 km) runs through the Leona's little blue butterfly range. The right-of-way runs contains 0.4 mi (0.7 km) and 2.9 mi (4.7 km) of small privately owned parcels and Whitefish ownership, respectively.

Klamath County. There are approximately 7.6 mi (12.3 km) of county road within the Leona's little blue butterfly range. Of these roads, 0.7 mi (1.1 km) and 6.9 mi (11.2 km) are on small privately owned parcels and Whitefish ownership, respectively.

American Tower Corporation. The footprint of this communication tower measures approximately 0.2 ac (0.1 ha) and is located on Whitefish property.

Severity of Stressor
The exact schedule and specific types of maintenance that occur within the rights-of-way in Leona's little blue butterfly occupied habitat are not known. However, maintenance appears to occur regularly within the BPA/TransCanada, ODOT, and Klamath County rights-of-way and results in the overall reduction of woody plants. Maintenance of rights-of-way in an open condition has allowed spurry buckwheat and Leona's little blue butterfly nectar plants to persist, creating habitat suitable for Leona's little blue butterfly. Maintenance work likely uses passenger vehicles and heavy equipment. Vehicles and equipment traveling off roads is assumed to trample host and nectar plants used by Leona's little blue butterfly. Trampling results in loss of habitat for eggs and larvae and a loss of potential nectar sources for Leona's little blue

butterfly. Similar effects are expected from the removal or cutting of vegetation. If activities occur during the flight period, adult Leona's little blue butterfly may be killed by vehicles directly. Maintenance is expected to be a sporadic event during the growing season rather than one that is continuous, reducing the potential for conflicts between activities and Leona's little blue butterfly. Restrictions for heavy equipment use that can cause fires are in place during the fire season and may further serve to reduce the temporal overlap between maintenance activities and Leona's little blue butterfly.

The use of biological control agents is not expected to occur within the range of Leona's little blue butterfly. Biological control agents are only used to treat noxious weeds (BPA 2000, p. 3) and are regulated by the Oregon Department of Agriculture (ODOT 2013, pp. 7–8). Noxious weeds have not been documented within the range of Leona's little blue butterfly (Johnson 2011, p. 9). Cheatgrass (*Bromus tectorum*), which occurs within the butterfly's range (Johnson 2012, pers. comm.), is considered an invasive species by the Natural Resources Conservation Service (NRCS; *www.plants.usda.gov*) and is not on the Federal or Oregon State list of noxious weeds. Therefore, biological control agents are not expected to be used within the BPA/TransCanada right-of-way.

Herbicide application may result in changes to plant distribution and abundance. Information is not available to determine the frequency or area impacted by herbicide application within the rights-of-way. ODOT does recommend herbicide application during the fall or winter, which is during the pupa stage for Leona's little blue butterfly; therefore, annual plants used by the butterfly would not be affected if this timing preference is followed. Please see the Herbicide section below for more information on how herbicides may act as a stressor on Leona's little blue butterfly.

The overall severity of right-of-way maintenance as a stressor is low. While mortality of butterflies and negative effects to plants may occur, there are beneficial results of long-term removal of woody plants including lodgepole pine. The impacts are limited to the rights-of-way, which represents a relatively small portion of the range of Leona's little blue butterfly.

Timing of Stressor

The maintenance of rights-of-way is ongoing. Stressors from right-of-way maintenance are expected to continue for the near- and long-term future. The duration of long-term future for this stressor is related to the length of time into the future for which the entities involved maintain their respective rights-of-way; there is no information to suggest future changes to the rights-of-way.

Summary of Right-of-Way Maintenance

The maintenance of rights-of-way is beneficial to Leona's little blue butterfly because it maintains open habitats that are preferred by host and nectar plants. Negative effects may occur through trampling, removal, or cutting of vegetation that are used by Leona's little blue butterfly. The area of potential impact is limited to the rights-of-way for BPA/TransCanada, ODOT, Klamath County, and American Tower Corporation.

Right-of-way maintenance may act as a low-level stressor on Leona's little blue butterfly and its habitat. The scope and low severity of the stressor suggest that this is not a considerable source of loss of individuals or habitat. Maintenance of rights-of-way retains open habitat areas.

7. Cinder Mining

Description of Stressor

Cinder mining activities including exploration, drilling, and expansion of existing sites could remove habitat for Leona's little blue butterfly and may result in mortality of individuals. Mortality of individuals may result from trampling by vehicles/equipment.

Scope of Stressor

Cinder mines are not currently present within areas occupied by Leona's little blue butterfly.

Severity of Stressor

Cinder mining activities could result in trampling or removal of host and nectar plants. To the extent that spurry buckwheat is trampled or removed, Leona's little blue butterfly eggs and larvae may be killed. Information other than that provided by the petitioner is not available to assess the potential area of impact. The Fremont-Winema National Forest cancelled the expansion of two cinder mines (USFS 2010, p. 2); the two mines are located 7 miles from the known, occupied habitat. Information is not available regarding the status, proximity, or future considerations of other potential cinder mines in or near Leona's little blue butterfly habitat.

The severity of this stressor is non-existent to low because there are no cinder mines within range of Leona's little blue butterfly. The low rating reflects the potential for future cinder mines to impact habitat and individuals on small, localized scales.

Timing of Stressor

Because there are no current cinder mines within the range of Leona's little blue butterfly, only future impacts are possible. Information regarding any future cinder mine activity is lacking for private lands. The Fremont-Winema National Forest does not have plans in the near- or long-term future to conduct cinder-mining activities on the portion of their land within occupied Leona's little blue butterfly habitat.

Summary of Cinder Mining Stressor

Cinder mines are not currently present within areas occupied by Leona's little blue butterfly. If cinder mining were to occur, it could impact habitat and individuals. The potential for future cinder mines to impact habitat and individuals would be on small, localized scales. Information other than that provided by the petitioner is not available to assess the potential area of impact. Future cinder mining is not planned by the Fremont-Winema National Forest and no information about plans for future cinder mines is available for private lands.

Cinder mining does not appear to be a stressor that is acting on Leona's little blue butterfly and its habitat. The scope and non-existent to low severity of the stressor suggest that this is not a considerable source of loss of individuals or habitat.

8. Livestock Grazing

Description of Stressor

Livestock grazing can impact both Leona's little blue butterfly habitat and individuals. Habitat effects are through potential shifts in vegetation community (i.e., selective preference of livestock for some plant species over others), consumption of host and nectar plants, and trampling of vegetation, reducing the potential for flowers to provide nectar. Eggs and larvae may be consumed if spurry buckwheat is consumed. Spurry buckwheat grows in a very open, small-stemmed shape, giving it a very wispy look (Blackwell 2006, p. 236) that is not likely to be favored as a food source for livestock. Other plants in the occupied habitat area have more robust growth forms with dense foliage that could provide better nutritive value if only based on sheer volume of material to eat. Adult Leona's little blue butterfly are expected to fly away if livestock approach and, therefore, are not expected to be consumed by livestock. Nectar plants are likely to be eaten by livestock and could result in a reduction of food for adult Leona's little blue butterfly. Grazing may also result in beneficial effects to the extent that grazing may result in reduced competition for host and nectar plants by creating or maintaining openings.

Scope of Stressor
There are no grazing allotments on the Fremont-Winema National Forest portion of the occupied habitat; therefore, Leona's little blue butterfly are not affected by livestock grazing in that area. Information is not available on whether livestock grazing is permitted on private lands in the remainder of the occupied habitat area. Livestock use of lands now owned by Whitefish was not observed during fieldwork conducted in 2010 and 2011 (Johnson 2014b, pers. comm.), but does occur "far to the northeast of the Leona's area" (Hatcher 2014b, pers. comm.).

Severity of Stressor
Because spurry buckwheat is not believed to be a preferred food source for livestock, impacts to Leona's little blue butterfly eggs and larvae are not expected to occur unless livestock incidentally consume spurry buckwheat while consuming other vegetation. Livestock could consume nectar plants across large areas. Because Leona's little blue butterfly are known to use a variety of plants for nectaring, it is assumed that Leona's little blue butterfly might be impacted by a decrease in food sources and would spend more time searching for food, which could reduce adult Leona's little blue butterfly fitness. Because livestock grazing prunes vegetation, resource competition for host and nectar plants may be reduced.

The overall severity of livestock grazing as a stressor on Leona's little blue butterfly and its habitat is moderate where it occurs. The severity is moderate because livestock, in particular, cows, have the ability to browse large areas quickly. Impacts to nectar plants would be greater than to the host plant.

Timing of Stressor
There is no information to suggest that livestock grazing has occurred or will occur on private or federal lands in the area occupied by Leona's little blue butterfly. There are no grazing allotments on the Fremont-Winema National Forest portion of the Leona's little blue butterfly habitat area and no future plans to permit grazing in this area.

Summary of Livestock Grazing Stressor
Livestock grazing can impact Leona's little blue butterfly eggs, larvae, and host and nectar plants. Aside from Fremont-Winema National Forest lands, there is no information to available

to determine if livestock grazing is impacting Leona's little blue butterfly or its habitat. If grazing is occurring, Leona's little blue butterfly fitness may be reduced by a decrease in nectar plants and a resulting need to spend more time searching for nectar plants. Livestock grazing of vegetation may reduce competition for host and nectar plants.

Livestock grazing does not appear to be a stressor that is acting on Leona's little blue butterfly or its habitat. The scope of the stressor is non-existent, but the severity is moderate. Because this activity is not occurring and is not expected to occur within the range of the Leona's little blue butterfly, this is not a considerable source of loss of individuals or habitat despite a moderate severity.

9. Herbivory from Native Animals

Description of Stressor

Native animals, such as deer and rabbits, may forage on plants that are used by Leona's little blue butterfly as a larval host plant or for nectar. Deer are known to favor bitterbrush, which occurs in Leona's little blue butterfly habitat. Bitterbrush has not been documented as a known nectar plant for Leona's little blue butterfly (Johnson 2011, p. 9). Spurry buckwheat grows in a very open, small-stemmed shape giving it a very wispy shape (Blackwell 2006, p. 236) that is not likely to be a favored food source for herbivores. Other plants in the occupied habitat have more robust growth forms with dense foliage that could provide better nutritive value if only based on sheer volume of material to eat. Leona's little blue butterfly eggs and larvae are not expected to be consumed by native animals unless spurry buckwheat is consumed incidentally with other vegetation. Adult Leona's little blue butterfly are likely to flee approaching animals and are not expected to be eaten by herbivores.

Scope of Stressor

The entire Leona's little blue butterfly habitat area has the potential to be impacted by herbivory from native animals, with possible exceptions due to fences on small parcels of private land that may be present to keep large herbivores out.

Severity of Stressor

We reasonably assume that herbivory is a natural condition in which animals and the butterfly have evolved. It is in the best interest of native herbivores to forage on plants selectively; this strategy allows for maintenance of its food source. Similarly, there is no information to suggest that local herbivore populations have increased, which could increase herbivory. Therefore, widespread depletion of vegetation by native herbivores is not likely. Nectar sources for adult Leona's little blue butterfly may be eaten by herbivores; however, this is not expected to result in significant impacts to Leona's little blue butterfly fitness as Leona's little blue butterfly use a variety of plants for nectar and because herbivores are not likely to consume nectar plants across large, contiguous areas. Low numbers of Leona's little blue butterfly eggs and larvae may be consumed incidentally if spurry buckwheat is eaten.

The overall severity of herbivory from native animals as a stressor on Leona's little blue butterfly and its habitat is low. The severity is low because herbivory is part of a natural condition and native animals are not expected to consume large quantities of vegetation across on contiguous area.

Timing of Stressor
This stressor part of a natural condition and is ongoing.

Summary of Herbivory Stressor
Herbivory is a natural condition in which animals and Leona's little blue butterfly have evolved. Herbivory from native animals is most likely to impact Leona's little blue butterfly nectar plants, with a very small potential for impacts to Leona's little blue butterfly eggs, larvae, and host plants. There is no information available to determine if herbivory is impacting Leona's little blue butterfly or its habitat. If herbivory is occurring, reduced adult Leona's little blue butterfly fitness is not expected because the butterflies are able to utilize a variety of plants for nectaring and because herbivory is likely to be selective to maintain the animals' food source.

Herbivory from native animals may be a low-level stressor that is acting on Leona's little blue butterfly and its habitat. However, the butterfly likely evolved with this stressor and there is no information to suggest that the pressure from herbivory has changed. The low severity and natural condition of the stressor suggests that even though this stressor may occur range-wide, it is not a considerable source of loss of individuals or habitat.

10. Herbicides
Description of Stressor
Herbicides are used to eradicate invasive plant species. Cost is a prohibiting factor in herbicide application (Ogg 1994, 196); therefore, it is assumed that application of herbicides would be limited to those areas needing treatment rather than applied across large areas. The petition to list the Leona's little blue butterfly specifically identified chlorosulfuron, glysophate, and triclopyr herbicides as a concern for the species (Matheson *et al*. 2010, p. 14). The Service has no evidence that these chemicals are being applied to Leona's little blue butterfly habitat.

Within the range of Leona's little blue butterfly, cheatgrass is the only known invasive species (Johnson 2011, p. 9; Johnson 2012, pers. comm.). Broad spectrum herbicides are used with varying success to treat cheatgrass (Pellant *et al.* 1999, p. 322). Herbicide application most effectively reduces cheatgrass when applied during seed germination or seedling stage (Ogg 1994, 196). Cheatgrass germinates in the fall in arid portions of the Great Basin (Young *et al.* 1987, p. 266), but may germinate in the spring if fall moisture is not sufficient (Stewart and Hull 1949, p. 58). Herbicide application, therefore, may occur in the fall or spring.

Herbicide application to control cheatgrass would occur before or after the flight period and development of larvae. Herbicide application after the flight period of Leona's little blue butterfly would not impact the ability of the species to find suitable host or nectar plants. Herbicide application in the spring may reduce germination of annual plants or reduce vigor of perennial plants. Individuals may be exposed to herbicides through ingestion of treated vegetation (Russell and Schultz 2010, p. 53), depending upon how the timing of application coincides with the larval growth period. Butterfly morphology may be affected through reduction in wing area in both males and females, and increased abdomen width in females (Russell and Schultz 2010, p. 59). These changes relate to reduced fitness of adults through

impediments to flight from smaller wings and increased abdomen size (Russell and Schultz 2010, p. 61).

Scope of Stressor

Herbicide application does not occur on the Fremont-Winema National Forest portion of the Leona's little blue butterfly range. Information is not available regarding the use of herbicides on private lands within the range of Leona's little blue butterfly. Because cheatgrass is present on Whitefish lands, it is possible that herbicides are used.

Herbicide application outside of occupied habitat is not expected to affect Leona's little blue butterfly or its habitat because drift would be inhibited by the forested areas surrounding the occupied habitat (Adamson *et al.* 2012, p. 8).

Severity of Stressor

Herbicide application results in reduced vigor or death of treated plants. Herbicide application to Leona's little blue butterfly host and nectar plants could result in fewer opportunities for Leona's little blue butterfly to lay eggs, for larvae to survive to diapause, and for adults to forage. Application of herbicides is expected to be targeted spatially and temporally; therefore, some areas would not be treated or would be treated at times that minimize impacts to Leona's little blue butterfly.

The severity of herbicide application as a stressor on Leona's little blue butterfly is low. Severity is low because if application occurs, impacts to habitat and individuals would be confined to localized areas where cheatgrass occurs.

Timing of Stressor

The stressor of herbicide application is ongoing. The Fremont-Winema National Forest has not used herbicides and does not have plans to use herbicides on the portion of Leona's little blue butterfly habitat occurring on their ownership. There is no information that herbicide application has occurred or will occur on private land areas of habitats occupied by Leona's little blue butterfly.

Summary of Herbicide Stressor

Herbicides reduce plant viability and could result in reduced survival and fitness of Leona's little blue butterfly eggs, larvae, and adults. Herbicide application does not occur on the Fremont-Winema National Forest portion of the occupied habitat; similar information is not available for private lands. If herbicides are used, application is expected to occur in concentrated areas and during times of year that would minimize impacts to Leona's little blue butterfly. Drift from herbicides applied outside the Leona's little blue butterfly habitat area is not expected to reach Leona's little blue butterfly habitat as forested stands surrounding Leona's little blue butterfly habitat act as a barrier for drift.

Herbicide application may be a low-level stressor that is acting on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur across a large proportion of the species' range, it is not a considerable source of loss of individuals or habitat.

11. Invasive plants

Description of Stressor

Within the range of Leona's little blue butterfly, cheatgrass is the only known invasive species. Cheatgrass germinates in the fall in arid portions of the Great Basin (Young *et al.* 1987, p. 266), but may germinate in the spring if fall moisture is not sufficient (Stewart and Hull 1949, p. 58). Invasive or non-native plants, such as cheatgrass can outcompete native plants for resources. Competition with nonnative plants can result in reduced native plant vigor and distribution. This, in turn, can reduce growth and abundance of host and nectar plants used by Leona's little blue butterfly. Over time, the distribution and abundance of invasive plants may alter the species composition within Leona's little blue butterfly habitat. Changes to species composition may result in starvation of larvae and adults if they are not able to find adequate sources for oviposition and nectar. For example, an invasion of nonnative plants into habitat occupied by bay checkerspot butterflies (*Euphydryas editha bayensis*) has restricted the native plant community, which also restricted the areas available to the butterflies (Cushman *et al.* 1994, p. 200).

Scope of Stressor

Invasive plants are not known to occur in the Fremont-Winema National Forest portion of the Leona's little blue butterfly range (USFS 2014, p. 4). Surveys of the vegetation community of Sand and Scott Creeks were conducted to determine plant species presence (Johnson 2011, p. 9). Cheatgrass, an invasive plant, is known to occur within the Whitefish portion of the Leona's little blue butterfly range (Johnson 2012, pers. comm.). Cheatgrass occurrences within the range of Leona's little blue butterfly have not been mapped, but it is not widespread (Johnson 2014c, pers. comm.). Johnson (2014c, pers. comm.) observed "little spots of cheatgrass in a number of places." She indicated that cheatgrass was "lush in some places, which may be due to the amount of subsurface moisture in those areas." Johnson (2014c, pers. comm.) also indicated that botanists from the Fremont-Winema National Forest were uncertain whether cheatgrass could spread very far or fast in the pumice soils that occur within Leona's little blue butterfly habitat. Information is not available on invasive plants for the small private landowners within the range of Leona's little blue butterfly.

Severity of Stressor

Cheatgrass is not widespread in the range of Leona's little blue butterfly; rather it occurs in small patches that may be correlated with the availability of subsurface moisture. Cheatgrass is a highly invasive and adaptable annual species that is capable of rapid growth (Stewart and Hull 1949, p.58; Young *et al*. 1987, p. 266). Cheatgrass germinates in the fall in arid portions of the Great Basin (Young *et al.* 1987, p. 266), but may germinate in the spring if fall moisture is not sufficient (Stewart and Hull 1949, p. 58). Cheatgrass is capable of high seed production even during drought periods (Stewart and Hull 1949, p. 59). Because cheatgrass is highly adaptable, grows quickly, and produces abundant seeds, it is a strong competitor for resources with native plants (Stewart and Hull 1949, p. 62).

When present, cheatgrass burns readily during fire events and can contribute to fire spread (Stewart and Hull 1949, p. 60; Young *et al.* 1987, p. 267). Fires occurring at intervals of one to

two years in areas where cheatgrass is well established results in widespread loss of native species (Stewart and Hull 1949, p. 60). Cheatgrass can increase fire risk, but that has not been observed within the range of Leona's little blue butterfly. Widespread loss of native plants as result of fire has not been observed in the range of Leona's little blue butterfly (see Fire section above).

The severity of invasive plants acting as a stressor on Leona's little blue butterfly and its habitat is low. The severity is low because, while cheatgrass is present, there is no information to suggest that cheatgrass has overrun suitable habitat for Leona's little blue butterfly nor has it contributed to spread of fire. Where cheatgrass is present, local competition for resources between cheatgrass and native plants is expected.

Timing of Stressor
There is no information on when cheatgrass first occurred in the vicinity of Sand and Scott Creeks, therefore it is unknown if cheatgrass is a relatively recent arrival to the area or if it was present when Leona's little blue butterfly was discovered. The stressor of invasive species acting on Leona's little blue butterfly and its habitat is ongoing. The potential for future spread of cheatgrass in occupied habitat is unknown, as there is uncertainty about its ability to spread in pumice soils.

Summary of Invasive Plants Stressor
One invasive plant, cheatgrass, is known to occur in the range of Leona's little blue butterfly. Through competition, invasive plants can reduce host and nectar sources for Leona's little blue butterfly. Cheatgrass, in particular, can also increase the risk of fire and contribute to fire spread; however, this has not been observed within the range of Leona's little blue butterfly. The stressor is ongoing and affects an unknown proportion of the Leona's little blue butterfly range on private lands; invasive plants are not present within the Fremont-Winema National Forest portion of the species' range.

Invasive plants may be a low- to moderate-level stressor acting on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur across a large proportion of the species' range, it is not currently a considerable source of loss of individuals or habitat. Similarly, it is not known if cheatgrass is a recent arrival to the area or if it was present when Leona's little blue butterfly was discovered. If cheatgrass is able to spread readily in pumice soils, cheatgrass could result in rapid loss of habitat, which would affect the ability of Leona's little blue butterfly to complete its life cycle successfully.

12. Insect Collection
Description of Stressor
The collection of insects results in the removal of individuals (eggs, larvae, pupae, and adults) from the population. Leona's little blue butterfly is similar in appearance to two other species (glaucon blue and lupine blue butterflies) located in the Sand Creek area. Leona's little blue butterfly could be a target species for commercial or recreational purposes or it may be mistaken for one of the other similar species and taken inadvertently. It is not known if these similar appearing species are sought for collection in the range of Leona's little blue butterfly. Collection of adult Leona's little blue butterfly before and during mating and oviposition results

in the loss of that individual's potential contribution to future generations. Similarly, the collection of eggs, larvae, and pupae has the potential to impact future abundance of Leona's little blue butterfly. We are not aware of any other commercial use of Leona's little blue butterfly beyond collection.

Scope of Stressor
There is potential for insect collection for scientific, recreational, and commercial purposes within the range of Leona's little blue butterfly. The Sand Creek area has been a popular location for insect collection over the last half century (Ross and Johnson 2012, p. 9). The area is popular because it supports a unique assemblage of rare invertebrate species. There is no information as to which species may be favored by collectors who visit the Sand Creek area. Similarly, we are not aware of unauthorized insect collection within the range of Leona's little blue butterfly.

Fidelity National Financial, previous owners of the Whitefish property, denied the Service access to their property since 2012 (Lidell 2012, pers. comm.). However, other research appears to have been conducted on this ownership between 2011 and 2013 that records collection and handling of 414 adult Leona's little blue butterfly (James *et al.* 2014, pp. 264, 269).

Permission is needed to collect butterflies for scientific, recreational, or commercial purposes on lands owned by Fremont-Winema National Forest (Callaghan 2014, pers. comm.) It is reasonably assumed that collection of insects on other small private lands (likely associated with residences) would not be allowed or if it were, would not result in collections of large numbers of individuals.

Severity of Stressor
Collection of Leona's little blue butterfly is most likely to occur during the flight period when adults are active and larvae are present. Leona's little blue butterfly emergence in June is staggered on an individual and sex basis, with males emerging first, followed by females. Collectors are likely to select freshly emerged adults which are brighter and do not have wear on the wing edges. Adult Leona's little blue butterfly are the most visible life form and therefore would be subject to greater collection pressure than eggs, larvae, or pupae. Collection of adult Leona's little blue butterfly at this stage would impede breeding and oviposition. Eggs of Leona's little blue butterfly are miniscule and would be very difficult to find without systematic searching of spurry buckwheat flower buds. Larvae are most commonly pink and white in color, providing camouflage among the white flowers and reddish-pink stems of spurry buckwheat; therefore, detection of larvae is possible with substantial effort. Pupae occur on or below ground level near the base of spurry buckwheat and are a drab brown color, helping them to blend in with surroundings and reducing their detection.

The severity of insect collection as a stressor on Leona's little blue butterfly is low. The severity is low because there is a short window of opportunity to collect the species when they are active, emergence of adults is staggered, and larvae are camouflaged.

Timing of Stressor
<u>Past</u>

Approximately 130 Leona's little blue butterfly were collected for scientific purposes from 1996 to 1998 to describe the species (Hammond and McCorkle 1999, p. 77). Since that time, Leona's little blue butterfly have been collected for scientific purposes on several occasions, although data on how many butterflies, eggs, or pupae and when are largely not available (Ross 2009, p. 1). In 2011, 35 adult female Leona's little blue butterfly, 7 eggs, and one fourth instar larva were collected as part of a study to document the life history of Leona's little blue butterfly (James 2012, p. 93). A mark-release-recapture study resulted in the collection and release of 414 adult Leona's little blue butterfly between 2011 and 2013; 25 of these butterflies were recaptured (James *et al.* 2014, p. 269).

Current and Future

It is unknown if Whitefish will allow access to their property currently or in the near- or long-term future. Collection of Leona's little blue butterfly for non-recreational purposes on the Fremont-Winema National Forest would require permission from USFS. Collection on other small private parcels is not expected to occur.

Summary of Insect Collection Stressor

The collection of adult Leona's little blue butterfly could result in loss of reproductive output and affect the number of individuals present in subsequent years. Collection of eggs, larvae, and pupae is possible, but would require more effort by collectors, so it may be less likely to occur. Past collection has resulted in the removal of at least 579 adult Leona's little blue butterfly, seven eggs, and one fourth instar larva. Current and ongoing collection is limited by a presumed lack of accessibility to Whitefish lands and the permissions required by the Fremont-Winema National Forest.

Insect collection may be a low-level stressor acting on Leona's little blue butterfly. The lack of access to the majority of the range of the species and low severity of the stressor suggests that this stressor is not a considerable source of loss of individuals.

13. Competition with Other Invertebrates

Description of Stressor

We reasonably assume that competition with other species is a natural condition in which Leona's little blue butterfly has evolved. Limited information exists on potential competitive interactions between Leona's little blue butterfly and other species that occur within its range. A study conducted in 2011 identified 37 species of butterflies and 159 species of moths as potential competitors for nectar (Ross and Johnson 2012, p. 8). Species that potentially compete with Leona's little blue butterfly may indirectly reduce the fitness of Leona's little blue butterfly.

Scope of Stressor

Competition from species that utilize the same host and nectar plants as Leona's little blue butterfly may occur within the entire range of the species.

Severity of Stressor

Competition between species is considered to be a natural condition under which Leona's little blue butterfly evolved. Competitors are relatively abundant in the Leona's little blue butterfly range (Ross and Johnson 2012, p. 24). There is no information to suggest that populations of

competitors have increased, which could increase competitive interactions among species. Pressure from competition is assumed to be higher in areas with greater Leona's little blue butterfly densities. Leona's little blue butterfly is capable of utilizing a variety of nectar species, lessening the potential impact of competitive interactions for food. Ross and Johnson (2012, p. 2) indicate that competition for spurry buckwheat occurs from herbivorous species of insects; the only insect identified using spurry buckwheat as an herbivore is the stiltbug, which uses piercing mouthparts to suck nutrients from plants (Ross and Johnson 2012, p. 17, 41).
The severity of competition acting as a stressor on Leona's little blue butterfly is low. The severity is low because Leona's little blue butterfly evolved with competitors, utilizes a wide variety of nectar plants, and is reasonably expected to be able to find food resources when competitors are present. Similarly, the host plant is not known to be used as a larval host plant by other species within the range of the Leona's little blue butterfly.

Timing of Stressor
The stressor of competition with other species is ongoing. Competition between species is considered to be a natural condition under which Leona's little blue butterfly evolved.

Summary of Competition with Other Invertebrates Stressor
Competition for resources can reduce Leona's little blue butterfly fitness; however, competition is part of a natural condition under which the butterfly evolved. Reduced fitness can result in lost productivity and affect overall population size. Leona's little blue butterfly is known to utilize multiple plant species for nectar, which should lessen the competitive pressure for nectar. Competitive interactions specific to the host plant are limited to the stiltbug. There is no information to suggest that any other species uses spurry buckwheat as a larval host plant in the range of Leona's little blue butterfly.

Competition with other invertebrates may be a low-level stressor acting on Leona's little blue butterfly. The low severity and the natural condition of the stressor suggest that even though competition may occur range-wide, this stressor is not a considerable source of loss of individuals.

14. Predation
Description of Stressor
We reasonably assume that Leona's little blue butterfly and its predators evolved together. Limited information exists on actual predation events of Leona's little blue butterfly. If it occurs, predation on Leona's little blue butterfly could result in reduced numbers of eggs, larvae, and adults. A study conducted in 2011 identified hornets, dragonflies, damselflies, robberflies, stiltbugs, and spiders as potential predators of Leona's little blue butterfly (Ross and Johnson 2012, pp. 16–17). The authors of the study concluded that predators are relatively rare within the range of Leona's little blue butterfly. The Asian lady beetle (*Harmonia axyridis*), suggested as a predator of the Leona's little blue butterfly by the Xerces Society for Invertebrate Conservation (Matheson 2010, p. 16), is not known to occur within the Leona's little blue butterfly range (Ross and Johnson 2012, pp. 33–48). Leona's little blue butterfly lay eggs on or very near flower buds and do not attempt to hide them (e.g., laying on underside of leaves). This behavior suggests that there may be a low relative risk of predation on eggs (Henry and Schultz 2013, p. 190). Similarly, Leona's little blue butterfly larva are typically pink and white, which may

provide camouflage from predators. James *et al.* (2014, pp. 271–272) suggests that Leona's little blue butterfly mortality from predation is likely very low, as this was not observed during their three-year study.

Scope of Stressor
Predation of Leona's little blue butterfly may occur within the entire range of the species. Predation is a natural condition under which Leona's little blue butterfly evolved.

Severity of Stressor
Predation of Leona's little blue butterfly was not observed during a three-year study conducted by James *et al.* (2014, pp. 271–272). The authors suggest that Leona's little blue butterfly mortality from predation is likely very low. Leona's little blue butterfly likely evolved with predators and they are part of the natural condition. Predators may have an impact on Leona's little blue butterfly populations, but there is not information to suggest that the number or types of predators have increased.

The severity of predation acting as a stressor on Leona's little blue butterfly is low. The severity is low because Leona's little blue butterfly evolved with predation and predation events are expected to be very rare, and camouflage of larvae likely reduces risk of predation.

Timing of Stressor
The stressor of predation on Leona's little blue butterfly is ongoing and is part of the natural condition in which the butterfly evolved.

Summary of Predation Stressor
Predation can reduce overall abundance of Leona's little blue butterfly. While potential predators are present when Leona's little blue butterfly are active, predation has not been observed. Similarly, pressure from predation is likely one that Leona's little blue butterfly evolved with and has adapted.

Predation may be a low-level stressor acting on Leona's little blue butterfly. The low severity and natural condition of the stressor suggests that even though predation may occur range-wide, this stressor is not a considerable source of loss of individuals.

15. Disease
Description of Stressor
As part of the natural condition in which they evolve, butterflies are susceptible to infections from parasites, viruses, bacteria, and fungus (Davis and Lawrence 2006, p. 1; Altizer and de Roode 2010, p. 18). For example, parasites can infect eggs, larvae, and pupae of butterflies and have been estimated to cause mortality of up to 30 percent of monarch butterflies (*Danaus plexippus)* in some areas (Altizer and de Roode 2010, p. 20). Parasitoid wasps (Families Braconidae, Chalcididae, Chrysididae, and Ichneumonidae) and flies (Families Bombyliidae, Conopidae, and Tachinidae) were also identified in this study, but parasitism (deposition of parasitoid eggs into a host) was not observed (Ross and Johnson 2012, pp. 27, 34–38). Viruses and bacteria can be common in butterfly larvae, which ingest capsules or spores incidentally (Davis and Lawrence 2006, p. 1; Altizer and de Roode 2010, p. 20). The *Wolbachia* sp. of

bacteria are known to occur in Karner 'Melissa' blue butterfly (*Plebejus melissa*) and models suggest that infected populations are at higher risk of extinction than uninfected populations (Altizer and de Roode 2010, pp. 22–23). Fungi can grow on the outside or inside of infected caterpillars, ultimately killing the caterpillar (Altizer and de Roode 2010, p. 21). Symptoms of disease include changes in color, size, shape, and movement (Davis and Lawrence 2006, p. 2). These examples of known butterfly diseases are from Monarch and Karner 'Melissa' blue butterfly research; however, these butterflies are not known to co-occur with Leona's little blue butterfly (Ross and Johnson 2012, pp. 42-46).

Scope of Stressor

Disease impacts to Leona's little blue butterfly may occur within the entire range of the species.

Severity of Stressor

Disease is part of the natural condition in which Leona's little blue butterfly likely evolved. There is no information on diseases affecting Leona's little blue butterfly from wild or captive-reared individuals. Ross and Johnson (2012, p. 27) recommend that additional research on potential parasitoid species be conducted, as it is expected that a "certain percent of wild-caught caterpillars should be parasitized." If diseases that affect butterflies are present within the range of Leona's little blue butterfly, reduced fitness and mortality of all stages is possible.

The severity of disease on Leona's little blue butterfly as a stressor is low. Severity is low because even though diseases may be present, they have not been observed in wild or captive-reared individuals.

Timing of Stressor

The stressor of disease on Leona's little blue butterfly is ongoing and is part of the natural condition in which Leona's little blue butterfly likely evolved.

Summary of Disease Stressor

Diseases affect butterflies and are part of the natural condition; however, there is no information on diseases affecting Leona's little blue butterfly. If diseases do occur in the range of the species, they may affect fitness and result in mortality.

Disease may be acting as a low-level stressor on Leona's little blue butterfly. The low severity and natural condition of the stressor suggests that even though disease may occur range-wide, this stressor is not a considerable source of loss of individuals.

16. Pesticides

Description of Stressor

Pesticides may result in mortality of invertebrates. Pesticides may result in mortality of invertebrates. The Oregon Department of Agriculture oversees the implementation of the Oregon State Pesticide Control Act for proper application and use of pesticides (Legislative Counsel Committee 2014, Chapter 634). The Oregon Department of Agriculture is also responsible for ensuring impacts to sensitive species and their environments are protected from improper pesticide use and application through education and reporting (Oregon Department of Agriculture 2015, entire).

Pesticide application is used by the Animal and Plant Health Inspection Service (APHIS) to suppress Mormon crickets (*Anabrus simplex*) and grasshoppers (Order Orthoptera) (hereafter grasshoppers) on rangelands used for livestock production in Klamath County, Oregon (APHIS 2002, p. 1; APHIS 2014a, p. 2). The chemicals used for grasshopper control are carbaryl, diflubenzuron, and malathion; all are applied as sprays, with the exception of carbaryl, which is also applied as a bait (APHIS 2014a, p. 4). Application normally occurs once per year and locations are not typically treated in consecutive years (APHIS 2014a, p. 4). Chemicals may drift into non-target areas and increase exposure of non-target insects to pesticides; however, aerial application of chemicals is not applied in winds exceeding 10 mile per hour to minimize the potential for drift (APHIS 2014b, pp. 3–4). Further, APHIS utilizes buffers to avoid application of pesticides in areas occupied by federally listed species and some species that are proposed or candidates for listing (APHIS 2014a, p. 9–11).

Carbaryl inhibits nervous system function and affects insects exposed to spray or bait (APHIS 2014a, p. 6). Carbaryl bait must be consumed by the insect in order for it to be effective. Diflubenzuron is an insect growth regulator (APHIS 2014a, p. 4). Insect larvae that are exposed to diflubenzuron are unable to molt and ultimately die. Malathion inhibits nervous system function in insects and affects insects exposed to spray (APHIS 2014a, p. 7).

Scope of Stressor

The Fremont-Winema National Forest does not use pesticides in the area occupied by Leona's little blue butterfly. APHIS is the agency that implements grasshopper control on rangelands in Oregon. The range of Leona's little blue butterfly is not mapped as rangeland (APHIS 2014c, p.3); therefore, grasshopper control is not expected to occur in the species' range. Areas of rangeland do occur between the eastern edge of Leona's little blue butterfly range and the western edge of the Klamath Marsh National Wildlife Refuge (NWR) (APHIS 2014c, p. 3). Rangeland is separated from the species' range by forests and residential communities.

Pesticide for grasshopper control may be applied on the Klamath Marsh NWR, which is situated approximately 3 miles east of the Leona's little blue butterfly range. Klamath Marsh NWR uses dimilin, also known as diflubenzuron, to control grasshoppers when outbreaks exceed economic thresholds of 14 to 24 grasshoppers per square yard (Service 2010b, p. 68). Outbreaks on Klamath Marsh NWR are treated under a Reduced Area Agent Treatment Strategy (RAATS) with the application of dimilin by sprayers attached to all-terrain vehicles on 50 percent of the affected area (Service 2010B, p. 68). The most recent outbreaks occurred in 2007 and 2013 resulting in treatment of 12.5 ac (5.1 ha) and 292 ac (118 ha), respectively (Service 2010b, p. 70; Austin 2014, pers. comm.); grasshopper egg beds were located approximately 4 miles east of the current Leona's little blue butterfly (Service 2010b, p. 69).

Drift of pesticides applied to Klamath Marsh NWR and the rangelands between Klamath Marsh NWR and the Leona's little blue butterfly range may occur if winds are blowing from the east. This does not seem very likely as prevailing winds in the Sand Creek and Scott Creek area typically come from the west. Drift from pesticides varies depending upon weather variables including wind speed and direction, temperature, and humidity (Foster and Onsager 2000, p. II.3-2; Sanderson and Huddleston 2000, p. II.7-1). Windbreaks (e.g., rows of trees) serve as effective barriers to pesticide drift (Adamson *et al.* 2012, p. 8). Small needled evergreens provide the best

protection from pesticide drift (Adamson *et al.* 2012, p. 8). Lodgepole pine have small needles and occur in forested stands surrounding the habitat occupied by Leona's little blue butterfly. Forests separate the range of Leona's little blue butterfly from areas where pesticides may be applied and therefore provide a barrier for any eastward drift of pesticides.

Severity of Stressor
Leona's little blue butterfly is susceptible to mortality from pesticides. Application of pesticides that occur outside the flight period of Leona's little blue butterfly are not expected to impact the species. Exposure is most likely when adults are flying or larvae are feeding.

The severity of pesticides acting as a stressor on Leona's little blue butterfly is high. The severity is high because pesticides are used for the purpose of killing insects; therefore, exposure by Leona's little blue butterfly to pesticides poses a high likelihood of mortality.

Timing of Stressor
The range of Leona's little blue butterfly is not considered rangeland and therefore likely has not been and will not be subject to grasshopper control measures. The stressor of pesticides on Leona's little blue butterfly from adjacent rangelands is ongoing. Near- and long-term future use of pesticides may occur on Klamath Marsh NWR and the rangelands that occur between the species' range and Klamath Marsh NWR during grasshopper outbreaks. APHIS conducts an Environmental Analysis annually to describe the actions they propose; therefore, information is not available beyond the near-term future. The long-term future use of pesticides on the Klamath Marsh NWR is limited to the duration of the current Klamath Marsh NWR Comprehensive Conservation Plan, which is in place through 2025 (Service 2010b, p. 1).

Summary of Pesticide Stressor
Pesticides may be lethal to Leona's little blue butterfly. Grasshopper control is not expected to occur within the range of Leona's little blue butterfly because the area is not considered rangeland. Pesticides applied outside the range of Leona's little blue butterfly are not likely to impact the species because pesticides are not applied in winds in excess of 10 miles per hour, prevailing winds would push any drift away from the species' range, and lodgepole pine surrounding the occupied habitat form a barrier to pesticide drift should winds blow from the east.

Pesticides may be acting as a low-level stressor on Leona's little blue butterfly. Despite the high severity of this stressor to Leona's little blue butterfly, exposure to pesticides is only likely from sources outside the range of the species; further, pesticide application guidelines, wind direction, and lodgepole pine surrounding the occupied habitat form a barrier to pesticide drift. Based on these reasons, this stressor does not represent a considerable source of loss of individuals.

17. Stressors on Isolated Populations
Description of Stressor
Leona's little blue butterfly is an endemic species known from one geographic area. Because Leona's little blue butterfly is only known from this one location, the population is confined, or isolated, by the elements that compose suitable habitat. Isolated populations of species with specific habitat requirements are more vulnerable to effects from disease, inbreeding, and habitat

loss because individuals are not replaced through immigration from other populations and are not always able to occupy new areas. For Leona's little blue butterfly, there simply are no other known populations to supplement the Sand Creek population and suitable habitat appears to be locally confined by the boundaries of alluvial fan deposits.

Stochastic events (e.g., drought and catastrophic fire) and inbreeding occurring within "small populations" and species with a "limited range" as identified by the Xerces Society for Invertebrate Conservation (Matheson 2010, p. 17), may act as a stressor on Leona's little blue butterfly. Leona's little blue butterfly is currently known from one population. Random events in small populations may have a large impact on population dynamics and persistence for a species. If the rate of population growth varies from one generation to the next, random stochastic events in successive generations can lead to population declines even if the population is growing, on average (Holsinger XXXX, pp. XXXX). Recent population estimates by James *et al.* (*2014*, p. 272) indicate that there may be 20,000 Leona's little blue butterfly, which is larger than the original population estimates of 1,000 to 2,000 (Ross 2008, p. 4). The difference in population estimates is a result of more thorough search of potential habitat and more rigorous sampling methods.

Drought. Drought over a prolonged period can alter the species composition, relative abundance, and growing season of plants. Drought may result in indirect impacts to individuals using these plants if they are less abundant or have reduced vigor due to competition for resources (Ehrlich *et al.* 1980, p. 101). Drought may shorten the period of growth for plants due to diminished water availability resulting in early senescence. Early plant senescence can limit the amount of time butterfly larvae have to reach pupa diapause (Holdren and Ehrlich 1981, p. 128; Ehrlich and Murphy 1987, p. 124).

Catastrophic Fire. Catastrophic, or stand replacing, fire is a wildfire event that burns at high intensity and high severity causing widespread destruction of resources (Carey and Schumann 2003, p. 2). The specific mechanisms of fire are described in the fire stressor discussion above. Species dependent upon resources damaged by catastrophic fire will have limited or no ability to persist in the affected landscape depending upon the catastrophic fire event. Catastrophic fires are typically associated with extreme weather conditions, high fuel loading, and densely stocked forests (Brown and Smith 2000, pp. 58–59; Keeley and Fotheringham 2001, p. 1565). Areas that are not heavily vegetated lack the ability to accumulate high fuel loads or create fuel ladders, which contribute to fire intensity and fire spread. Catastrophic fire is more likely to occur in areas of contiguous fuels and forest; gaps in fuels and forested areas can interrupt fire spread and limit the potential for catastrophic fire events.

Disease. Disease in isolated populations may result in loss of individuals, which could reduce population numbers. Because isolated populations are not able to replenish lost individuals through immigration, diseases can result in dramatic reductions in population levels.

Inbreeding. Inbreeding is most common in small or isolated populations where immigration and emigration are not occurring regularly enough to maintain genetic variability (Lande 1988, pp. 1455–1456; Frankham and Ralls 1998, p. 441). Inbreeding can result in changes to morphology, survival, lifespan, and sterility in invertebrates (Lande 1988, p. 1456; Frankham and Ralls 1998,

p. 441). Inbreeding in small populations of butterflies has not been a sole factor associated with butterfly extinction (Murphy *et al.* 1990, p. 43); rather, extinction is more likely from other sources such as demographic effects from habitat loss or environmental factors (Ehrlich and Murphy 1987, p. 127; Lande 1988, p. 1457; Murphy *et al.* 1990, p. 43).

Scope of Stressor

Drought. Drought has the potential to affect all habitat and individuals with the range of Leona's little blue butterfly. Information specific to Leona's little blue butterfly as it relates to the impacts of drought on small populations is not available.

Catastrophic Fire. Catastrophic fire has the potential to occur within the range of Leona's little blue butterfly. Within the privately owned portion of the Leona's little blue butterfly range, there are non-forested, recently logged, and forested areas. Catastrophic fires may occur here under extreme weather conditions; however, the areas most heavily affected would be the forested areas that have high accumulated fuels and dense tree stocking. Open areas may burn under high wind events when wind carries embers but would otherwise lack the ability to contribute to rapid fire spread due a lack of accumulated ground fuels.

Within the Fremont-Winema National Forest portion of the Leona's little blue butterfly range, there is a mix of open and forested areas. The open areas are located between stands of dense conifer. This portion of the Leona's little blue butterfly range has a higher potential for catastrophic fire than the remainder of the range due to these conditions.

Disease. As discussed above, there is no information to suggest that diseases are present in the area occupied by Leona's little blue butterfly (see discussion of Disease stressor above).

Inbreeding. Inbreeding occurs at the scale of a population. There is no information available regarding inbreeding in Leona's little blue butterfly.

Severity of Stressor

Leona's little blue butterfly is known from one location with population estimates ranging from 1,000 to 2,000 in 2008 (Ross 2008, p. 4) to more current estimates of 20,000 (James *et al.* 2014, p. 272). Increases in population estimates are due to expanded survey efforts and a mark-release-recapture study that occurred since the Service completed the 90-day finding for Leona's little blue butterfly.

Drought. Isolated populations may be more susceptible to the impacts of drought if drought results in widespread loss of habitat. Because of the uniqueness of the habitat, widespread loss of habitat could result in loss of a significant proportion of Leona's little blue butterfly.

Desert plants are adapted to short growing seasons and extreme variation in temperatures (Went 1948, p. 248). The Sand and Scott Creeks area is an "extremely xeric environment" (Hammond and Dornfeld 1983, p. 120). Spurry buckwheat is a desert restricted annual (James 2012, p. 93) that grows in dry conditions (Hickman 1993, p. 879) and is locally abundant within the range of Leona's little blue butterfly. It is reasonable to assume that nectar plants used by Leona's little blue butterfly also occurring in this area are also adapted to dry conditions. The timing of larval

host plant growth is important to allow for proper Leona's little blue butterfly larvae development from egg to pupa. If spurry buckwheat senesces before Leona's little blue butterfly larvae diapause as a pupa, larvae will not have the resources to complete its lifecycle. Similarly, if nectar plants have a shortened flowering time or flowers are less abundant, adult Leona's little blue butterfly may not have the resources needed to reproduce to their full ability. Impact to larval survival and adult reproductive effort can lead to reductions in future population levels.

There is no information on drought relating directly to Leona's little blue butterfly population size or apparent geographic isolation. The available literature does contain information on drought response from other butterfly species. In two species of checkerspot butterflies (*Euphydryas editha* and *Euphydryas chalcedona*) from California, drought effects were observed in relationships with the host plant and competition for food (Ehrlich *et al.* 1980, p. 101). While the life history traits and habitats of these two species are dissimilar from Leona's little blue butterfly, the study suggests that drought resistant host plants and the use of a variety of food plants provide protection from the harmful effects of drought (Ehrlich *et al.* 1980, p. 105).

Catastrophic Fire. Isolated populations may be more susceptible to the impacts of catastrophic fire if it results in widespread loss of habitat. Because of the uniqueness of the habitat, widespread loss of habitat could result in loss of a significant proportion of Leona's little blue butterfly.

The area within the range of Leona's little blue butterfly is a fire-adapted ecosystem with a mixed severity fire regime (Dunn 2011a, pp. 1, 4). The potential for catastrophic fire events is limited by the mix of forested, recently logged, and non-forested areas contained with the range of Leona's little blue butterfly. The potential rates of fire spread and intensity vary widely based on fuel loading. Some areas within the occupied habitat are barren or sparsely vegetated and would not be able to promote fire spread in the manner that could occur in areas of denser brush or forest (Dunn 2011a, p. 3). The forested areas in particular are able to torch and create the potential for long-range spotting of fires from embers carried by wind (Dunn 2011b, p. 12). These areas are not occupied by Leona's little blue butterfly. Open areas occupied by Leona's little blue butterfly are not as likely to be subject to catastrophic fire; Leona's little blue butterfly are expected to persist in these areas after fire (Dunn 2011b p. 12).

If Leona's little blue butterfly are exposed to fire, there is potential for lethal effects to all life stages. While this is a stressor and can result in direct mortality, there is no information to suggest that fire would kill all individuals. An assessment completed by Dunn (2011a, p. 8) determined that significant mortality of Leona's little blue butterfly could occur if the entire landscape burned, but he did not expect that extinction would occur unless other factors relating to population viability were of concern. Fire history information does not indicate that catastrophic fires are likely; fires are quickly suppressed or are kept small in size, reducing the potential for widespread reduction of resources or individuals. Even under extreme fire weather conditions, areas that currently support the highest density of spurry buckwheat and Leona's little blue butterfly are in areas that are not likely to carry fire due to the open and barren condition. The most likely scenario based on the current situation and past fire events is a rotation of habitat availability whereby fires of various sizes burn some areas, while other areas are not burned or are otherwise recovering from recent fire events (Dunn 2011a, p. 9). This

scenario allows for the persistence of Leona's little blue butterfly. Alternatively, if a high-severity fire did burn through the lodgepole forests intermixed with Leona's little blue butterfly habitat, the result could be an increase in Leona's little blue butterfly habitat through the creation of additional open habitats.

Disease. Disease in isolated populations may result in loss of individuals, which could reduce population numbers. Because isolated populations are not able to replenish lost individuals through immigration, diseases can result in dramatic reductions in population levels; therefore, when present, disease may act as a moderate to high severity stressor. There is no information to suggest that diseases are present within occupied habitat (see Disease stressor discussion above).

Inbreeding. Isolated populations may be more susceptible to the impacts of inbreeding. Because the Leona's little blue butterfly population is isolated, immigration of individuals from other populations is not occurring. Without immigration into the known population, genetic depression may occur at faster rate than would be expected for populations that experience immigration and emigration.

There is no information available regarding inbreeding in Leona's little blue butterfly; therefore, the severity of this stressor on Leona's little blue butterfly is unknown. Inbreeding is associated with the loss of genetic diversity from mating between close relatives in small populations (Frankham and Ralls 1998, p. 441). Fitness and population effects from inbreeding result in reduced fecundity, juvenile survival, and lifespan (Frankham and Ralls 1998, p. 441; Lande 1988, p. 1456). Information on Leona's little blue butterfly dispersal is not known, nor have additional populations been located; these factors suggest that emigration and immigration may not be occurring. A lack of immigration and emigration could lead to reduced genetic variability in Leona's little blue butterfly.

Overall, stochastic events and inbreeding may be stressors on geographically isolated populations. The vegetation within the Leona's little blue butterfly range is adapted to drought conditions. Catastrophic fire has a very low likelihood of occurrence within the range of Leona's little blue butterfly and would not lead to complete loss of the species. It is unknown if inbreeding is occurring; however, the literature suggest that demography and environmental factors are more likely to contribute to a species' extinction than inbreeding alone (Lande 1988, p. 1457). Based on these reasons, the severity of stressors associated with geographic isolation is low.

Timing of Stressor

Portions of Oregon near the Leona's little blue butterfly range have been in a drought situation for the last two years; this stressor is tied to weather patterns and ocean currents that are cyclic in nature. Therefore, drought is expected to continue to act as a stressor in the near- and long-term future (next few decades), following a cyclic rather than continual pattern. There is no evidence of catastrophic fire in range of Leona's little blue butterfly. The area occupied by Leona's little blue butterfly has a mixed severity fire regime and in the near-term is not likely to see catastrophic fire. Long-term (next few decades) potential for catastrophic fire increases if the fire regime changes from mixed severity due to forest management that would create a more homogenous, continual cover of forest; however, there is no information to suggest that this will

occur. There is no information to suggest that disease is present within the range of Leona's little blue butterfly; we do not have evidence to suggest that this will change in the future. Similarly, it is unknown if inbreeding is occurring within the range of Leona's little blue butterfly; it may be an ongoing stressor if immigration or emigration are not occurring.

Summary of Isolated Populations Stressor
Isolated populations may be subject to greater pressure from stressors if populations are not able to recover from widespread loss of individuals and habitat. Because the Leona's little blue butterfly is only known from one population, it may be more susceptible to events related to drought, catastrophic fire, disease, and inbreeding.

Drought has the potential for widespread impacts to host and nectar plants used by Leona's little blue butterfly, which could result in effects to future population growth. Leona's little blue butterfly occupy a desert ecosystem that is composed of drought tolerant plants. Because the plants are drought tolerant, they are expected to survive drought years and continue to provide resources for Leona's little blue butterfly. Droughts follow cyclic patterns and not a persistent stressor for Leona's little blue butterfly habitat.

There is no information to suggest that catastrophic fires have occurred within the range of Leona's little blue butterfly. Catastrophic fires could result in the widespread loss of forested habitats adjacent to areas occupied by Leona's little blue butterfly. However, given the mixed severity fire regime of the Leona's little blue butterfly range, catastrophic fire is not expected to occur in the near-term future. If forest management practices change so that there is an increase in forest cover or fewer open areas between forested patches, the potential for catastrophic fire will increase.

Diseases may result in significant reductions of individuals in isolated populations. There is no information to suggest that diseases are present within the range of Leona's little blue butterfly.

Information is not available relating to inbreeding in Leona's little blue butterfly. Inbreeding is associated with small and isolated populations where the mixing of genetic material may be inhibited and can result in effects to fitness and population demographics. Inbreeding may be an ongoing stressor if immigration is not occurring.

Stochastic events, disease, and inbreeding related to geographic isolation may be acting as low-level stressors on Leona's little blue butterfly and its habitat. These stressors are not contributing to widespread loss of individuals or habitat. The severity of the stressor is low because even though this stressor may occur across the species' range, it is not a considerable source of loss of individuals or habitat.

18. The Effects of Climate Change
Description of Stressor
The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). The term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements (IPCC 2013a, p. 1450). The term "climate change" thus refers to a change in the mean or

variability of one or more measures of climate (for example, temperature or precipitation) that persists for an extended period, whether the change is due to natural variability or human activity (IPCC 2013a, p. 1450).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions (for these and other examples, see Solomon *et al*. 2007, pp. 35–54, 82–85; IPCC 2013b, pp. 3–29; IPCC 2014, pp. 1–32). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (Solomon *et al*. 2007, pp. 21–35; IPCC 2013b, pp. 11–12 and figures SPM.4 and SPM.5). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011, p. 4), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl *et al*. 2007, entire; Ganguly *et al*. 2009, pp. 11555, 15558; Prinn *et al*. 2011, pp. 527, 529). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (Meehl *et al*. 2007, pp. 760–764 and 797–811; Ganguly *et al*. 2009, pp. 15555–15558; Prinn *et al*. 2011, pp. 527, 529; IPCC 2013b, pp. 19–23). See IPCC 2013b (entire), for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation.

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables (for example, habitat fragmentation) (IPCC 2014, pp. 4–11). Identifying likely effects often involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (Glick *et al*. 2011, pp. 19–22; IPCC 2014, p. 5). There is no single method for conducting such analyses that applies to all situations (Glick *et al.* 2011, p. 3). We use our

expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Global climate projections are informative, and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (IPCC 2013b, pp. 15–16). Therefore, we use "downscaled" projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick *et al*. 2011, pp. 58–61, for a discussion of downscaling).

With regard to our analysis for the Leona's little blue butterfly, downscaled projections are available for the Klamath Basin that includes the range of this species. Ecosystems vary within the Klamath Basin, ranging from low elevation redwood forests along the coasts of California to high elevation deserts in Klamath and Lake Counties, Oregon; therefore, projections that span the entire Klamath Basin are expected to vary locally. Climate change information is not available at these finer scales; subsequently, the projection information provided below is the based on the best available information.

Data from 1961 to 1990 represent the baseline conditions used in climate change projections for the Klamath Basin. Overall trends indicate warmer temperatures for annual (2.1–7.2 °F (1.1– 4.6 °C)), summer (2.2–11.8 degrees °F(1.2– 6.6 °C)), and winter (1.7– 6.5 °F (1.0–3.6 °C)) periods measured at two future time intervals, 2035 through 2045 and 2075 through 2085 (Barr *et al.* 2010, p. 9). Projections for changes in annual precipitation are more variable than projections for temperature over the same time intervals. Annual precipitation is projected to drop by 11 percent, but could increase by as much as 24 percent (Barr *et al.* 2010, p. 9). Despite this variability, the data generally indicates that summers are likely to be drier and winters will be wetter (Barr *et al.* 2010, p. 9). Snowpacks are expected to decrease by as much as 90 percent through 2085 (Barr *et al.* 2010, p. 9), indicating that increases in winter precipitation will be in the form of rain rather than snow.

Barr *et al.* (2010, p. 9) include projected changes to areas burned and vegetation composition. Burned areas will increase by 13 to 18 percent for years 2035 through 2045 and by 11 to 22 percent for years 2075 through 2085. Loss of subalpine habitats will occur between 2035 and 2045, followed by complete loss of maritime conifer between 2075 through 2085. Oak (*Quercus* sp.) and madrone (*Arbutus menziesii*) expansion will occur in both time intervals and grasslands may replace sagebrush (*Artemesia* sp.) and juniper (*Juniperus occidentalis*) habitats for years 2075 through 2085.

Because of projected increases in temperature and the seasonal increases and decreases in precipitation, effects on stream flow, invasive species, shifts in vegetation composition, disruption of interactions between animals and their habitats are similarly projected (Barr *et al.* 2010, pp. 11, 14). Stream flow from groundwater-fed springs is expected to be reduced due to drier summers. Invasive species are likely to increase their distribution and abundance. Warmer temperatures and drier or wetter conditions will affect the distribution and abundance of native vegetation; for example, small, high elevation lakes may become meadows. Earlier and longer

growing seasons can shift the timing of florescence in plants, resulting in potential impacts to the species that use those plants.

Scope of Stressor
The effects of climate change have the potential to impact the entire range of Leona's little blue butterfly. Variation in effects of climate change across the range are not expected because the area is relatively small and does not have topographic relief, which could allow for differences due to latitudinal and altitudinal gradients.

Severity of Stressor
The effects of climate change may result in changes to plant phenology through timing of growth and flowering as well as overall plant species diversity, distribution, and abundance (Kittel 1998, p. 79). Changes to growing season can change when host plants bud and flower resulting in asynchrony with Leona's little blue butterfly larval development. Larvae that do not complete the progression through all instar stages before plants senesce will not survive to overwinter and emerge as adults the following summer. James *et al*. (2014, p. 268) notes that the emergence of the butterfly from pupa corresponds to temperature and humidity, which also influence plant growth. By following these external cues, the emerging adults have some certainty that nectar resources will be available.

Changes to flowering period can also create asynchrony with adult Leona's little blue butterfly flight period and result in shortened or missed opportunities for nectaring on some or all plants (Memmott *et al.* 2007, p. 713; Caldas 2011, p. 80). Generalist pollinators that have a variety of nectar sources, like Leona's little blue butterfly, are less likely to be significantly affected by feeding disruption due to asynchrony than specialists (Memmott *et al.* 2007, p.713). Nutrients obtained during juvenile and adult life stages are directly linked to reproductive success (Boggs 1997, p. 192). Larvae that are well fed prior to diapause are better suited to reproduce when they emerge as adults. Larval food reserves can be used to develop mature oocytes (unfertilized egg cells) in butterflies before adults emerge (Boggs 1997, p. 193). Well-fed larva that do not use all the food stores prior to emergence as adults may retain reserves of resources that may benefit the adult (Boggs 1997, p. 192); this could help female butterflies persist if they emerge during conditions that may restrict food intake.

Potential responses of butterflies to climate change are shifts in range, distribution, and population size (Caldas 2011, p. 80). Habitat occupied by the Leona's little blue butterfly appears to be correlated to the presence of the unique combination of geology and vegetation in the Sand Creek and Scott Creek alluvial fans. Given this potential limitation on Leona's little blue butterfly distribution, the butterfly likely would not be able to shift its current range or adjust its distribution to follow changes in habitat related to climate change as has been suggested for other invertebrates (Caldas 2011, p. 80).

Butterfly activity is affected by changes in weather. Butterflies are reported to emerge earlier in the spring in response to warmer temperatures (Caldas 2011, p. 80). Rain limits butterfly flight time and results in reduced or delayed oviposition, interrupting timing for larval development with implications for reduced population size in the following year (Dobkin *et al.* 1987, p. 165; Murphy *et al.* 1990, p. 45). Longer snow-free periods allow for increased survival of conifer

seedlings (Horn 2009, p. 208), which could increase the rate of encroachment of lodgepole pine into open areas occupied by Leona's little blue butterfly. Increased temperatures and drier conditions may increase fire frequency and severity. As described for other stressors, fire is most likely to impact forested areas that are not occupied by Leona's little blue butterfly. Fires produce a potential beneficial impact of creating more open area habitats for Leona's little blue butterfly. Because the projection data for precipitation indicates that conditions may be drier or they may be wetter, there is uncertainty as to how this may affect the butterfly. Because of this uncertainty, we lack information to suggest a change in precipitation trend in the near- and long-term future.

During the winter of 2011–2012, pupae overwintered in temperatures as low as 5 ° F (-15 °C; we believe there is an error in text on p. 268 of James 2014 indicating a low temperature of -5 °C because Figure 8 in his document appears to show the low value near -15 °C) at a depth of 0.2 in (0.5 cm) below ground, with snow cover maintaining a constant temperature of 32 °F (0 °C) during winter months (James 2014, pp. 266, 268). Projections for reduced snowpack do not indicate if the reduction is in total area covered by snow, the depth of snowpack, or some combination of these two; rather the projections are based on a proportional projected change to stream flow (Goodstein and Matson 2004, p. 6). If the total area covered by snow is reduced, Leona's little blue butterfly pupae may be exposed to colder temperatures for longer periods of time. Information is not available to determine how this scenario may impact Leona's little blue butterfly. Similarly, because the information on snowpack projections does not specify the nature of the reduction, we do not have information to suggest that Leona's little blue butterfly would be subject to longer exposure to colder temperatures.

The severity of climate change as a stressor on Leona's little blue butterfly is low to moderate. The severity is low to moderate because climate change is projected to result in factors that will change plant phenology and vegetation composition over time, which may shift the timing of Leona's little blue butterfly habitat use and reduce the overall suitability of the habitat. However, it is expected that the butterfly will continue to follow external cues from temperature and humidity for emergence from pupa such that nectar resources will be available.

Timing of Stressor

The effects of climate change as a stressor to Leona's little blue butterfly is ongoing. Climate change is projected into the future with 30 years being a typical period for such measurements (IPCC 2013a, p. 1450). Projections for the Klamath Basin include time scales measured 20 to 30 years and 60 to 70 years into the future (Barr *et al.* 2010, p. 9).

Summary of Climate Change Stressor

Climate change is an ongoing stressor with projections into the future indicating trends towards warmer temperatures, drier or wetter conditions, and less snowfall in the Klamath Basin. The entire Leona's little blue butterfly range is subject to impacts from climate change. Negative impacts to Leona's little blue butterfly habitat arise from shifts in plant growing season, diversity, distribution, and abundance. In turn, Leona's little blue butterfly larvae and adults may have a reduced ability to complete lifecycle events relating to development and egg laying. However, it is expected that the butterfly will continue to follow external cues from temperature and humidity for emergence from pupa such that nectar resources will be available. Increases in

wildfires may benefit Leona's little blue butterfly by working to maintain open habitat areas. Because of the uncertainty surrounding precipitation, we lack information to suggest a change in precipitation trend in the near- and long-term future.

Climate change may be acting as a low- to moderate-level stressor on Leona's little blue butterfly and its habitat. The range-wide scope and low to moderate severity of the stressor suggests that it will result in changes to vegetation that may influence Leona's little blue butterfly occupancy. However, it is unknown if this will result in considerable loss of habitat or individuals.

19. Change in Land Ownership

Description of Stressor

The petition to list the Leona's little blue butterfly raised concerns about a change in land management that would occur when the ownership of the land changed (Matheson *et al.* 2010, p. 5). Specifically, the petitioners were concerned that a change in land ownership to the Klamath Tribes would result in the development of a biomass facility on the Mazama Forest, which they believed would increase activities associated with timber management (Matheson *et al.* 2010, p. 15). Similarly, the petitioners were also concerned that the Klamath Tribes would allow grazing on the Mazama Forest if they were to acquire the property(Matheson *et al.* 2010, p. 16).

The Mazama Forest portions of lands within the range of the Leona's little blue butterfly were recently sold to Whitefish and therefore will not be under the ownership of the Klamath Tribes. While we have no information on how the land will be managed, we assume that Whitefish will continue to manage timber similar to the previous landowners. A rotation of harvest and non-harvest would probably be followed to allow for tree growth to sizes desirable for the timber products the company produces. The petitioners concerns about construction of biomass facility and grazing were specific to a potential change in landownership to the Klamath Tribes. We have no information regarding whether or not Whitefish is considering the construction of a biomass facility or the allowance of grazing on their property.

Scope of Stressor

The change in ownership applies to approximately 7,653.6 ac (3,097.3 ha) within the range of Leona's little blue butterfly, recently acquired by Whitefish from Fidelity National Financial.

Severity of Stressor

While previously owned by an industrial timber company, the Mazama Forest has been managed for timber production. Large areas of the Mazama Forest were most recently logged between 2006 and 2008 within the area occupied now by Leona's little blue butterfly. Logging created more openings, allowing spurry buckwheat and other plants to colonize these openings, many of which now provide suitable habitat for Leona's little blue butterfly (see Timber Management discussion above). The change in ownership to Whitefish is expected to result in similar land management as practiced by previous owners.

No changes in land management are expected so the change in ownership is not a stressor for the species. The stressor does not existent because we assume future timber management and prescribed fire will be very similar to past management. Further, as described above timber

management and prescribed fire are expected to create and maintain the open habitats used by Leona's little blue butterfly. Finally, we are not aware of plans to establish a biomass facility within the currently occupied habitat or to allow grazing on the Mazama Forest.

Timing of Stressor
Whitefish recently purchased the lands for sale by Fidelity National Financial. The Service has no indication timber management will change nor that a biomass plant will be established or grazing permitted in currently occupied habitat in the near- or long-term future.

Summary of Potential Change in Land Ownership Stressor
Whitefish Cascade Forest Resources, LLC recently purchased approximately 93.7 percent of the land within the range of Leona's little blue butterfly. We expect that timber management and prescribed fire will continue under the ownership, which may impact the species and its habitat negatively and positively. The Service has no indication that a biomass plant will be established or grazing permitted in currently occupied habitat in the near- or long-term future.

Cumulative, Synergistic, and Beneficial Effects
Stressors combine and interact, resulting in impacts to species not accounted for when stressors are analyzed individually. Stressors that appear minor when viewed individually may have greater impacts when analyzed cumulatively with other stressors. Furthermore, some stressors may act synergistically to cause impacts greater than the sum of the individual stressors. Beneficial effects from stressors may outweigh the potential negative effects from that stressor or others.

Cumulative Effects
Potential cumulative effects to Leona's little blue butterfly habitat may occur when lodgepole pine encroachment and invasive plant stressors are viewed together. The larval host plant, spurry buckwheat, grows in open areas, making openings an essential component to the survival of Leona's little blue butterfly. Lodgepole pine encroachment gradually replaces open habitat with forested habitats. One invasive plant, cheatgrass, is known to occur in a portion of the area occupied by Leona's little blue butterfly. This plant has the ability to rapidly colonize open areas and outcompete native plant species. The combination of lodgepole pine encroachment and invasion by cheatgrass has the potential to create unsuitable habitat conditions for Leona's little blue butterfly.

Synergistic Effects
When stressors occur together, one stressor may exacerbate the effects of another stressor, causing effects not accounted for when stressors are analyzed individually. Synergistic effects can be observed in a short amount of time. If stressors hinder Leona's little blue butterfly ability to lay eggs in one year, the number of adult butterflies that emerge the following year will be reduced. Stressors that act on the ability of larvae to reach the diapause stage successfully will also reduce the number of adult number butterflies that emerge the following year. Stressors that contribute to synergistic effects for Leona's little blue butterfly are insect collection, pesticides, predation, disease, competition, drought, and climate change. Even when considered together, the severity of these stressors is low. The severity is low because even though these stressors

may be acting on the population, the observed impact has been very low in the past and under current conditions. Long-term future impacts may increase synergistic effects if the models for climate change are correct; it is unknown if Leona's little blue butterfly will be able to adapt its life cycle to changes in plant growing seasons.

Beneficial Effects

A large number of the stressors discussed above have the ability to reduce habitat for the Leona's little blue butterfly. In particular, timber management activities can remove habitat when new roads or landings are constructed; vegetation may also be trampled, resulting in damage to host and nectar plants. These activities, however, create or maintain habitat for Leona's little blue butterfly at a disproportionate scale to those that remove or damage habitat. Based on past timber harvest practices in the range of Leona's little blue butterfly, the amount of forested area that is harvested does not remove all the habitat within the area but is selective. These newly open areas have the potential to become the next area of suitable habitat for Leona's little blue butterfly and may be much greater than the amount of habitat damaged or removed. The creation of new habitat through timber management can occur over large areas in short periods of time and be very effective at offsetting the potential loss of habitat from lodgepole pine encroachment.

Summary of Stressors

Of the stressors reviewed, lodgepole pine encroachment and invasive plants can result in considerable loss of habitat and ultimately individuals. The impacts of climate change are less certain; however, if models are correct, this could also interfere with the ability of Leona's little blue butterfly to reproduce. Table 2 is a summary of the stressors described above.

Table 2: Summary of potential stressors action on Leona's little blue butterfly and its habitat.

Potential Stressor	**Stressor Impacts**	**Timing**	**Scope**	**Severity**	**Overall Level of Impact to Species and Habitat**	**Summary**
Timber Management	Habitat and Individuals	Past	Range-wide (100%)	Federal land: Low Whitefish: Low Other private land: None to very low	Low-level	Timber management acts as a low-level stressor on Leona's little blue butterfly and its habitat. The limited scope and low severity of the stressor suggest that this is not a considerable source of loss of individuals or habitat. Rather, the longer-term benefits from timber management promote habitat for the butterfly.
		Current	Range-wide (100%)	Federal land: None Whitefish: None to low Other private land: None to very low		
		Near- and long-term future	Range-wide (100%)	Federal land: Low Whitefish: Low		

				Other private land: None to very low		
Lodgepole Pine Encroachment	Habitat and Individuals	Past	Range-wide (100%)	All ownerships: Moderate	Moderate-level	Lodgepole pine encroachment and natural regeneration act as a moderate-level stressor on Leona's little blue butterfly and its habitat. The scope and moderate severity of the stressor suggest that this could be a considerable source of loss of habitat and subsequently individuals.
		Ongoing	Range-wide (100%)	All ownerships: Moderate		
		Near- and long-term future	Range-wide (100%)	All ownerships: Moderate		
Fire	Habitat and Individuals	Past			Low-level	Fire acts as a low-level stressor on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur range-wide, this stressor is not a considerable source of loss of individuals or habitat. Additionally, the benefits from fire promote habitat for the butterfly.
		Ongoing	Range-wide (100%)	All ownerships: Low		
Fire Retardant	Habitat and Individuals	Past	Range-wide (100%)	All ownerships: Low	Low-level	Fire retardant may act as a low-level stressor on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur
		Ongoing	Range-wide	All ownerships:		

			(100%)	Low		range-wide, it this is not a considerable source of loss of individuals or habitat. Use of fire retardant can slow or inhibit the progression of fire spread in areas occupied by Leona's little blue butterfly.
		Near- and long-term future	Range-wide (100%)	All ownerships: Low		
Fire Suppression	Habitat and Individuals	Past	Range-wide (100%)	All ownerships: Low	Low-level	Fire suppression may act as a low-level stressor on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur range-wide, it is not a considerable source of loss of individuals or habitat. Beneficial effects from ground disturbance and tree felling will promote colonization of spurry buckwheat, which will create or enhance habitat for Leona's little blue butterfly.
		Ongoing	Range-wide (100%)	All ownerships: Low		
		Near- and long-term future	Range-wide (100%)	All ownerships: Low		
Right-of-Way Maintenance	Habitat and Individuals	Ongoing	Whitefish (105 ac (43 ha) and 9.8 mi (15.9 km) of roads) Other private land: 1.1	Whitefish: Low Other private land: Low	Low-level	Right-of-way maintenance may act as a low-level stressor on Leona's little blue butterfly and its habitat. The scope and low severity of the stressor suggest that this is not a considerable source of loss of individuals or habitat. Maintenance of the rights-of-way retains open habitat areas.

			mi (1.8 km) of roads			
Cinder Mining	Habitat and Individuals	Near- and long-term future	Not present (0%)	All ownerships: Non-existent to low	Not present	Cinder mining does not appear to be a stressor that is acting on Leona's little blue butterfly and its habitat. The scope and non-existent to low severity of the stressor suggest that this is not a considerable source of loss of individuals or habitat
Livestock Grazing	Habitat and Individuals	Ongoing	Not present (0%)	Whitefish: Moderate Other private land: Moderate	Not present	Livestock grazing does not appear to be a stressor that is acting on Leona's little blue butterfly or its habitat. The scope of the stressor is non-existent, but the severity is moderate. Because this activity is not occurring and is not expected to occur within the range of the Leona's little blue butterfly, this is not a considerable source of loss of individuals or habitat despite a moderate severity.
Herbivory from Native Animals	Habitat and Individuals	Ongoing	Range-wide (100%)	All Ownerships: Low	Low-level	Herbivory from native animals may be a low-level stressor that is acting on Leona's little blue butterfly and its habitat. However, the butterfly likely evolved with this stressor and there is no information to suggest that the pressure from herbivory has changed. The low severity and natural condition of the stressor

						suggests that even though this stressor may occur range-wide, it is not a considerable source of loss of individuals or habitat.
Herbicide	Habitat and Individuals	Ongoing	Private land only (98.5%)	Whitefish: Low Other private land: Low	Low-level	Herbicide application may be a low-level stressor that is acting on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur across a large proportion of the species' range, it is not a considerable source of loss of individuals or habitat.
Invasive Plants	Habitat and Individuals	Ongoing	Private land only (98.5%)	Whitefish: Low Other private land: Low	Low- to Moderate-level	Invasive plants may be a low- to moderate-level stressor acting on Leona's little blue butterfly and its habitat. The low severity of the stressor suggests that even though this stressor may occur across a large proportion of the species' range, it is not currently a considerable source of loss of individuals or habitat. Similarly, it is not known if cheatgrass is a recent arrival to the area or if it was present when Leona's little blue butterfly was discovered. If cheatgrass is able to spread readily in pumice soils, cheatgrass could result in rapid loss of habitat, which would affect the ability of Leona's little blue butterfly to complete its
		Near- and long-term future	Private land only (98.5%)	Whitefish: Low Other private land: Low		

						life cycle successfully.
Insect Collection	Individuals	Past	Range-wide (100%)	All ownerships: Low	Low-level	Insect collection may be a low-level stressor acting on Leona's little blue butterfly. The lack of access to the majority of the range of the species and low severity of the stressor suggests that this stressor is not a considerable source of loss of individuals.
		Ongoing and near-and long-term future	Fremont-Winema National Forest (1.5 %)	Federal Land: Low		
Competition with Other Invertebrates	Individuals	Ongoing	Range-wide (100%)	All ownerships: Low	Low-level	Competition with other invertebrates may be a low-level stressor acting on Leona's little blue butterfly. The low severity and the natural condition of the stressor suggests that even though competition may occur range-wide, this stressor is not a considerable source of loss of individuals.
Predation	Individuals	Ongoing	Range-wide (100%)	All ownerships: Low	Low-level	Predation may be a low-level stressor acting on Leona's little blue butterfly. The low severity and natural condition of the stressor suggests that even though predation may occur range-wide, this stressor is not a considerable source of loss of individuals.
Disease	Individuals	Ongoing	Range-wide (100%)	All ownerships: Low	Low-level	Disease may be acting as a low-level stressor on Leona's little blue butterfly. The low severity and natural condition of the stressor suggests that even though disease

						may occur range-wide, this stressor is not a considerable source of loss of individuals.
Pesticides	Individuals	Ongoing	Range-wide (100%)	All ownerships: High	Low-level	Pesticides may be acting as a low-level stressor on Leona's little blue butterfly. Despite the high severity of this stressor to Leona's little blue butterfly, exposure to pesticides is only likely from sources outside the range of the species; further, pesticide application guidelines, wind direction, and lodgepole pine surrounding the occupied habitat form a barrier to pesticide drift. Based on these reasons, this stressor does not represent a considerable source of loss of individuals.
Isolated Populations	Habitat and Individuals	Ongoing	Range-wide (100%)	All Ownerships: Low	Low-level	Stochastic events and inbreeding related to geographic isolation may be acting as low-level stressors on Leona's little blue butterfly and its habitat. These stressors are not contributing to widespread loss of individuals or habitat. The severity of the stressor is low because even though this stressor may occur across the species' range, it is not a considerable source of loss of individuals or habitat.

Climate Change	Habitat and Individuals	Long-term future	Range-wide (100%)	All Ownerships: Low to moderate	Low- to Moderate-level	Climate change may be acting as a low- to moderate-level stressor on Leona's little blue butterfly and its habitat. The range-wide scope and low to moderate severity of the stressor suggests that it will result in changes to vegetation that are likely to influence Leona's little blue butterfly occupancy. However, it is unknown if this will result in considerable loss of habitat or individuals.
Change in Land Ownership	Habitat and Individuals	Near- and long-term future	Whitefish (93.7%)	Whitefish: Low	Non-Issue	A change in ownership would not be a stressor stressor on Leona's little blue butterfly and its habitat as long as management actions do not change. We have no indication that any management activities will change because of land ownership, as it does not represent a change from past sources or amounts of loss of individuals or habitat.

Current Regulations, Management, and Conservation

Laws, Policies, or Management Plans

There are no current laws, policies, or management plans in place to ameliorate or reduce stressors to Leona's little blue butterfly.

State Regulatory Mechanisms and Conservation Measures

Oregon State agencies do not have responsibilities for the conservation of invertebrates (Oregon Department of Fish and Wildlife 2006, p. 316). The Oregon State Endangered Species Act does not include protections for invertebrates (Oregon Natural Heritage Program 2003, p. 18). Scientific taking permits are only required for birds, mammals, amphibians, and reptiles in the State of Oregon (*www.dfw.state.or.us*).

The Oregon Biodiversity Information Center (ORBIC) is the State agency responsible for tracking rare invertebrates in Oregon. Through section 6 of the Act, the Oregon Natural Areas Program has limited regulatory authority to assist in the conservation of Oregon's invertebrate species (Oregon Biodiversity Information Center 2013, p. 6). This cooperation between agencies provides opportunities to gather information that can be used to help understand and conserve invertebrates in Oregon (Oregon Biodiversity Information Center 2013, p. 6). The 2013 book of Rare, Threatened, and Endangered Species of Oregon identifies and categorizes species (including Leona's little blue butterfly) into several levels of regulatory or conservation status based on various factors (e.g., Federal or State listed, NatureServe/Natural Heritage ranking, ORBIC list) ((Oregon Biodiversity Information Center 2013, entire). The ORBIC list identifies species on a scale of 1 to 4 with 1 having the most conservation concern (Oregon Biodiversity Information Center 2013, p. 4). Leona's little blue butterfly has an ORBIC list value of 1. ORBIC list 1 species are defined as those "taxa that are threatened with extinction or presumed to be extinct throughout their entire range" (Oregon Biodiversity Information Center 2013, pp. 4, 32). The NatureServe/Natural Heritage ranking is divided into five categories (identified as 1 again having the most conservation concern) on both a Statewide (S) and global (G) scale. Leona's little blue butterfly is considered a S1, G1 species with "1" defined as species that are "[c]ritically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences" (Oregon Biodiversity Information Center 2013, pp. 5, 32). However, the document further explains that the compilation of information on invertebrates has been difficult due to the acknowledgement that "[l]ittle is known about the status and distribution of most invertebrate taxa found in Oregon, especially those which appear to be rare, threatened or otherwise vulnerable." The document then further qualifies its rankings by stating that "[a]s a result state ranks may not accurately reflect the true population status for some species" (Oregon Biodiversity Information Center 2013, p. 6). From the information available, it appears that occurring on this list does not necessitate the use of any conservation measures for actions that may impact the listed species.

Federal Regulatory Mechanisms and Conservation Measures

There are no Federal regulatory mechanisms in place to ameliorate or reduce stressors on Leona's little blue butterfly. However, the Leona's little blue butterfly was added to the USFS Region 6 list of Sensitive Species on December 1, 2011 (USFS 2014, p.1). With this status, Leona's little blue butterfly is now considered in USFS Region 6 biological evaluations when

proposed projects have the potential to affect the species or its habitat. The objective of this status is to avoid project impacts that result in a loss of viability or contribute toward trends for listing under the Act (USFS and Bureau of Land Management (BLM) 2002, pp. 2, 4). According to USFS Forest Service Manual (FSM) 2670, "[t]here must be no impacts to sensitive species without an analysis of the significance of adverse effects on the populations, its habitat, and on the viability of the species as a whole. It is essential to establish population viability objectives when making decisions that would significantly reduce sensitive species numbers." The loss of population viability is a concern, when evidenced by either a significant current or predicted downward trends in population numbers or density; or a significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution. Proposed activities that occur within the Fremont-Winema National Forest portion of the Leona's little blue butterfly range will include measures to avoid or minimize project-related impacts to Leona's little blue butterfly and its habitat. In addition, the Fremont-Winema National Forest is managed for conservation of resources, per their Land and Resource Management Plan (USFS 1990, entire).

The only example of conservation measures specific to Leona's little blue butterfly are included in a USFS proposal to improve habitat for the butterfly. The Fremont-Winema National Forest has initiated a habitat improvement project for the Leona's little blue butterfly that will implement conservation measures specific to the butterfly (USFS 2014, p. 3). Because Leona's little blue butterfly are known to occupy the project area, project operations will occur over frozen ground or snow in winter to minimize the potential for crushing pupae. Logging slash should be piled at least 50 feet from occupied habitat and, to the extent possible, where timber operations just occurred to avoid piling and burning of this material in areas with a high likelihood of occupancy by Leona's little blue butterfly. Similarly, staging areas for equipment will be coordinated to minimize the potential for impacts to Leona's little blue butterfly or its habitat.

Changes since Previous Federal Action

The last Federal action was the determination during the 90-day finding that the petition presented substantial information indicating that listing under the Endangered Species may be warranted. Since the 90-day finding, additional surveys have been conducted within and outside the areas of occupancy described in the petition. These efforts have led to an increase in the areas of known occupancy, but have not located additional populations. Access to the Whitefish portion of the Leona's little blue butterfly range was denied by the previous landowners in 2012, restricting the gathering of additional information about the species and its habitat. Region 6 of the USFS added Leona's little blue butterfly to its list of sensitive species on December 1, 2011.

Overall Summary

The Leona's little blue butterfly is known from one population in the pumice desert region of south central Oregon. The known range of the species doubled in size from 6 sq mi to 12.8 sq mi (15.5 sq km to 33.1 sq km) from 2009 and 2013. Similarly, population size estimates increased from 2,000 to 20,000 during the same period. The expansion of the range and increase in population size are attributed to a better understanding of habitat requirements, focused survey

efforts, and more rigorous sampling methods. Since the petition, the USFS has designated the butterfly a sensitive species, which directs that USFS actions avoid or minimize effects to the butterfly and its habitat.

Leona's little blue butterfly is dependent upon spurry buckwheat for the development of its larvae. A variety of nectar plants, including spurry buckwheat, are used by adult Leona's little blue butterfly. The assemblage of plant species found within the range of the species appears to be unique and shows a strong correlation with the presence of alluvial fans deposited after the eruption of Mt. Mazama 6,600 to 7,700 years ago.

Stressors that potentially act on Leona's little blue butterfly include, but are not limited to, timber management, lodgepole pine encroachment, fire, fire suppression, invasive plants, and competition. Of the stressors reviewed, lodgepole pine encroachment and invasive plants may contribute to considerable loss of habitat and individuals. Timber management has the potential to alter habitat; however, the reduction of forested areas provides almost immediate benefits to Leona's little blue butterfly that overcome negative impacts from this action and the stressor of lodgepole pine encroachment.

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